AN ASSESSMENT OF FLOOD MITIGATION MEASURES IN ACCRA, GHANA

By

ATTIPOE, Selasi Kofi

(BSc. Human Settlement Planning)

A Thesis submitted to the Department of Planning, Kwame Nkrumah University of Science and Technology, in partial fulfillment of the requirements for the award of Degree of

MASTER OF SCIENCE IN DEVELOPMENT PLANNING AND MANAGEMENT

Department of Planning

College of Architecture and Planning

October 2014

DECLARATION

I hereby declare that this submission is my own work towards the M.Sc. in Development Planning and Management and, to the best of my knowledge, it contains no material previously published by another person nor material which has been accepted for the award of any other degree of the University, except where due acknowledgement has been made in the text.

ATTIPOE, SELASI KOFI ……..... .....

(PG7193512) Signature Date

Certified by:

DR. JUSTICE K. OWUSU-ANSAH ……..... .....

(Supervisor) Signature Date

Certified by:

DR. DAN K. B. INKOOM ……..... .....

(Head of Department) Signature Date

ABSTRACT

Flooding has been a perennial problem in parts of Accra for many years now resulting in loss of lives and properties. Some flood prone areas have received major flood management interventions from the government to prevent floods and others have not. This research sought to analyze the causes of flooding and assessed the effectiveness of flood controls to address the problem.

To analyze the problem two communities in different parts of Accra namely, Glefe which is a coastal community and Alajo, located inland were selected for this study. Face-to-face interviews were conducted with key city officials to identify the main causes of flooding and the flood control measures implemented. Surveys were held with home owners in the study communities to capture their views on causes of flooding as well as the effectiveness of mitigation measures implemented by either the government or themselves.

The research found that storm drains had been constructed to prevent flooding in Alajo while Glefe had no major defence against flooding. The result was that Alajo no longer experienced flooding. Although Alajo has been a success story, the drains need regular maintenance and management by the Hydrological Services Department to desilt the drains and to sanction residents found dumping domestic wastes into the drains. In Glefe, the high sea waves persistently inundate dry lands while the two nearby lagoons (Dzatapkor and Gbugbe) are filled with refuse. Spells of rainfall cause the lagoons to overflow into the surrounding homes. Though home owners have made attempts like constructing temporary drains, clearing choked drains and building flood protection walls to mitigate the effects of the flood in Glefe, very minimal success has been achieved.

The research recommends short and long term interventions to mitigate flooding in Glefe. Residents need to refrain from damaging activities like reclamation of the lagoons and sand mining. City officials also need to provide effective solutions to prevent flooding in Glefe. Solutions like building of a sea wall, demolishing buildings in encroached areas, drain improvement and total relocation of the community can be explored with funding from international development partners and the government.

ACKNOWLEDGEMENTS

This thesis has been successfully completed through the grace granted by the Almighty God. This work would not have been fruitful without the unrelenting support from several people. First of all, I am most grateful to my parents for their financial, emotional and spiritual support throughout this program.

I am sincerely grateful to my supervisor, Dr. Justice K. Owusu-Ansah, who guided and supported me in every step to complete the thesis. He was always available for discussions and gave me insightful advice.

My thanks also goes to individuals who availed themselves to me during the interview stage. First, I would like to thank Mr. Seth Kudzordzi of the Hydrological Services Department, Mr. B. B. Boyor, the Assemblyman for Glefe, Mr. Aziz, the Assemblyman for Alajo, Mr. Richard Appiah and Cecilia of the Town and Country Planning Department and Mr. Emmanuel Abeka who opened up and provided valuable information for the thesis. I wish to extend my appreciation to my friends Daniel Twum-Danso and Promise Eweh who assisted me in the data collection exercise. I am also deeply grateful to all others for the support provided to me at various stages of my master's programme.

TABLE OF CONTENTS

Page

DECLARATION ..... **ii**
ABSTRACT ..... **iii**
ACKNOWLEDGEMENTS ..... **iv**
TABLE OF CONTENTS ..... **v**
LIST OF TABLES ..... **ix**
LIST OF FIGURES ..... **x**
LIST OF APPENDICES ..... **xi**
LIST OF ACRONYMS ..... **xii**

CHAPTER ONE: BACKGROUND TO PERENNIAL FLOODING IN ACCRA

1.1 Introduction **1**
1.2 Problem Statement **3**
1.3 Aim and Objectives of the Study **6**
1.4 Research Questions **7**
1.5 Scope **7**
1.6 Limitations **9**
1.7 Thesis Organisation **9**

CHAPTER TWO: FLOODING IN URBAN AREAS

2.1 Introduction **10**
2.2 Background to Flooding in Urban Areas **10**
2.3 Definition of Key Terms **12**
2.3.1 Flooding *12*
2.3.2 Natural Hazards and Natural Disasters *13*
2.3.3 Vulnerability *13*
2.4 Causes of Floods **14**
2.4.1 Heavy and prolonged rainfall *14*
2.4.2 Seismic activities *14*
2.4.3 Topography of land *14*
2.4.4 Earthquakes *14*

2.4.5 Poor enforcement of development control regulations *15*
2.4.6 Pressure on land *15*
2.4.7 Reduced Capacity of Drainage Channels *16*
2.4.8 Poor drain system *16*
2.4.9 Obstructions *16*
2.4.10 Deforestation and Poor Farming Practices *16*
2.4.11 Poor Water Management *17*
2.4.12 Encroachment on Wetlands *17*
2.4.13 Dam and Levee failures *18*
2.5 Types of Floods **18**
2.5.1 Coastal Flooding *19*
2.5.2 Inland flooding *19*
2.5.3 River flooding *19*
2.5.4 Estuarial Flooding *20*
2.6 Effects of Flooding **20**
2.6.1 Positive Effects of Flooding *20*
2.6.2 Negative Effects of Floods *21*
2.6.3 Other Effects of Flooding *22*
2.7 Mitigating Floods **25**
2.7.1 Engineering approaches *26*
2.7.2 Regulatory Approaches to Reduce Vulnerability *27*
2.7.3 Preservation of Wetlands *28*
2.7.4 Flood Mitigation in Bangladesh and Vietnam *30*
2.8 Conceptual Framework **34**
2.9 Summary of Literature Review **35**

CHAPTER THREE: RESEARCH METHODOLOGY

3.1 Introduction **36**
3.2 Research Design **36**
3.2.1 Alajo *36*
3.2.2 Glefe *37*
3.3 Desk study **37**
3.4 Preliminary Field Investigation **38**

3.5 Sampling Technique 39
3.5.1 Institutions 39
3.5.2 Community-Alajo 40
3.5.3 Community-Glefe 41
3.6 Pretesting of Data Collection Instruments 41
3.7 Data Collection Exercise 42
3.7.1 Secondary Data 42
3.7.2 Face to face interviews with Key Institutions 42
3.7.3 Primary data 42
3.8 Data Processing and Analysis 44
3.9 Limitations 44

CHAPTER FOUR: PROFILE OF STUDY AREA

4.1 Introduction 45
4.2 History of Accra 45
4.3 Location and size 45
4.4 Geology, Climate and Vegetation 46
4.4.1 Geology 46
4.4.2 Climate 46
4.4.3 Vegetation 47
4.5 Demographic Characteristics 50
4.6 Economy 51
4.7 Sewerage and Solid Waste Management 51
4.8 Housing 52
4.9 Description of Study Communities 53

CHAPTER FIVE: FLOOD MITIGATION IN GLEFE AND ALAJO

5.1 Introduction 59
5.2 Flood Mitigation in Accra 59
5.3 Bio-Data of Respondents in study areas 60
5.4 Causes of flooding in Study Areas 61
5.4.1 Causes of flooding in Alajo 62
5.4.2 Causes of flooding in Glefe 63

5.5 Effects and experience of Flood 72
5.5.1 Reason for continuous stay in flood prone area 73
5.5.2 Reports to Authorities about floods in Glefe. 75
5.5.3 Effects of Flooding 77
5.6 Flood Prevention and Management 78
5.6.1 Belief in Flood prevention. 80
5.6.2 Flood Mitigation by Households. 81
5.6.3 Flood Mitigation by Responsible institutions 82
5.6.4 Mitigation efforts by community members in Glefe 85
5.7 Impact of interventions 85
5.7.1 Impact of intervention in Glefe 85
5.7.2 Impact of intervention in Alajo 86
5.8 Roles of Institutions in Flood Mitigation. 88
5.9 Summary of Results and Discussions 90

CHAPTER SIX: SUMMARY OF FINDINGS, RECOMMENDATIONS AND CONCLUSION

6.1 Introduction 91
6.2 Causes of flooding 91
6.3 Mitigation measures 92
6.4 Recommendations 93
6.4.1 Short term mitigation measures 93
6.4.2 Long term mitigation measures 94
6.5 Impact of mitigation measures 97
6.6 Conclusion 97
REFERENCES 99

LIST OF TABLES

TABLE **PAGE**

3.1 Potential Study Sites 38

3.2 Parameters for selecting study communities……..…….…….39

3.3 Respondents in Institutions..... 40

3.4 Summary of Data Required and Sources 43

5.1 Floodable areas and intervention received..... 59

5.2 Major cause of flooding according to respondents in Alajo 62

5.3 Waste Disposal Methods in Glefe 69

5.4 Household's experience with flooding..... 72

5.5 Willingness to move from Glefe to better location..... 74

5.6 Report of floods in Glefe to authorities..... 75

5.7 Effects of flooding in communities 77

5.8 Immediate action upon suspicion of flooding in community 78

5.9 Action during flood in communities..... 79

5.10 Respondents view of how flooding can be prevented in Glefe. 80

5.11 Reason respondents think flooding cannot be prevented in Glefe. 81

5.12 Success of mitigation measures by the government..... 86

5.13 Degree of success of government mitigation measures..... 86

LIST OF FIGURES

FIGURE **PAGE**

1.1 Accra Metropolis showing study areas……..……8

2.1 Community based flood management framework……...35

3.1 The After-only Design.....37

4.1 Rainfall Distribution in Accra from 1961 to 2011.....47

4.2 Google Image showing the location of Alajo 55

4.3 Glefe located in the Densu wetland area.....58

5.1 Drainage pattern of Accra.....64

5.2 Vulnerable state of the Glefe beach.....65

5.3 Sand bar separating the sea from the lagoon in Glefe.....66

5.4 Sand mining at Glefe beach. 67

5.5 Embankment separating lagoon in Glefe from Panbros Salt Ponds.....67

5.6 Lagoon reclaimed for development in Glefe 68

5.7 Poor waste management in Glefe. 69

5.8 Poor drainage in Glefe.....70

5.9 Major cause of flooding according to respondents in Glefe.....71

5.10 Wall affected by flooding in Glefe 73

5.11 Reasons for still staying in flood prone area 74

5.12 Willingness to relocate from Glefe to better location 75

5.13 Institution/Agency that flood cases in Glefe are reported to. 76

5.14 Action taken after the floods occur 80

5.15 Flood mitigation measures by households in Glefe.....82

5.16 Storm drain in Alajo (Odaw).....83

5.17 Stagnant water from sea in Glefe. 84

5.18 Choked drain in Glefe 84

5.19 Floodable area at a section of Onyasia River 87

5.20 Alajo drain used as refuse dump 87

6.1 Waves breaking over seawall at Sea Bright, New Jerseyy 95

6.2 House on pilings in Holgate, New Jersey 96

LIST OF APPENDICES

APPENDIX **PAGE**

1 HOUSEHOLD QUESTIONNAIRE.....106

2 QUESTIONNAIRE FOR HYDROLOGICAL SERVICES DEPARTMENT 110

3 QUESTIONNAIRE FOR NADMO 114

4 QUESTIONNAIRE FOR ACCRA METROPOLITAN ASSEMBLY PLANNING DEPARTMENT.....117

5 QUESTIONNAIRE FOR EPA.....121

6 QUESTIONNAIRE FOR TCPD 125

7 QUESTIONNAIRE FOR GMA 129

8 NADMO PUBLIC EDUCATION MESSAGES 132

9 SAMPLE SIZE CALCULATION FOR GLEFE.....133

LIST OF ACRONYMS

AMA	Accra Metropolitan Assembly
DUR	Department of Urban Roads
ECG	Electricity Company of Ghana
EPA	Environmental Protection Agency
GMA	Ghana Meteorological Agency
HSL	Hydrological Services Department
ILGS	Institute of Local Government Studies
IPCC	Intergovernmental Panel on Climate Change
IWMI	International Water Management Institute
MLGRD	Ministry of Local Government and Rural Development
MWD	Metropolitan Works Department
MWRWH	Ministry of Water Resources, Works and Housing
NADMO	National Disaster Management Organisation
TCPD	Town and Country Planning Department
UNFCC	United Nations Framework Convention on Climate Change
UN-ISDR	UN-International Strategy for Disaster Reduction

CHAPTER ONE

BACKGROUND TO PERENNIAL FLOODING IN ACCRA

1.1 Introduction

Flooding is a natural phenomenon that occurs in many parts of the world. It has many devastating effects on the lives and properties of its victims. Human beings in the pursuit of development disturb the natural environment in order to create a built environment. The intrusion into the natural environment has its repercussions such as flooding. Though flooding is a natural phenomenon, anthropogenic activities further worsen the effects of flooding in urban areas. Climate change and global warming over the years have increasingly received media attention. The earth's climate is warming at an increasingly rapid rate because of higher volumes of greenhouse gases entering the atmosphere. Hofmann et al., (1998) explained that climate change results in variations in oceanic and atmospheric circulation which in turn affect temperature and precipitation and impact. In addition, relatively small changes in temperature and precipitation, together with the effects on evapo-transpiration and soil moisture, can result in relatively large changes in the magnitude and timing of runoff and the intensity of floods and droughts. Hence, climate change also has a direct impact on floods in the world.

The United Nations Framework Convention on Climate Change (2007) intimated that flooding has undesirable socio-economic impacts on the wellbeing and livelihoods of flood prone communities. Huge populations get displaced, buildings collapse, lives are lost and people migrate as a result of severe floods. It echoes that flooding has critical effects on the social, economic, environmental, physical and psychological wellbeing of people. Furthermore, Lawford et al, (1995) together with Dhar and Nadargi, (2002) and Schanze et al (2006) have explained that, though flooding is one of the most hazardous, frequent and widespread disasters, it seems to be part of the lives of some communities in the world. This shows how severe the flooding situation exists in some locations in the world.

Some countries have embarked on large scale interventions to control flooding. In Bangladesh for instance, flooding has caused considerable damage to lives and properties. According to Thompson and Sultana (1996) Bangladesh is most likely, the

world's most flood-prone country. This can be explained by the drainage pattern in the country whereby three rivers drain a vast area that is even greater than the area of Bangladesh itself. Over 20 percent of Bangladesh is inundated in a "normal" flood year and more severe floods regularly cause loss of lives and economic suffering. To reduce the effects of floods in communities, flood control projects need to be embarked on to save lives and properties. Thompson and Sultana (1995) explain that in Bangladesh, following severe floods in 1954, a Master Plan for water resource development identified flood control measures which were implemented. In June 1990, the Bangladesh Water Development Board (BWDB) reported the completion of 437 projects resulting in 7,555 kilometres of embankments and 7,907 hydraulic structures. Overall, 3.37 million hectares of land were reported to have benefited from flood protection (23 per cent of the area of Bangladesh). This was thought to be a success till 1987 when it was reported that over 39 per cent of the country was flooded. The World Bank (1989) reported that about 1,279 kilometres of flood control embankments were damaged, and total losses were US$ 0.5 billion. Hence, the measures put in place were not effective in controlling the floods.

Ghana has also experienced floods over the years. Flooding occurs often in urban areas in Ghana especially Accra. Karley (2009) expounds that flooding problems in Accra date back to the late 1930s when the city started to expand. Flooding has become a perennial issue in Accra. During the rainy seasons each year, there are reports of flooding in many parts of the city. Studies by Hofmann et al., (1998) show a link between climate change and flooding. Nevertheless, the consequences of flooding in Accra are further exacerbated by human activities like building in flood-prone areas, encroachment on wetlands and poor enforcement of development control. There is also a lack of storm drains and waste disposal is done indiscriminately. Institutions that are responsible for flood control have also failed to manage floods. Nonetheless, some measures have been adopted to control floods or mitigate floods in the city. Educational campaigns have been done to sensitize residents in flood prone areas about the risks associated with flooding. Some engineering solutions like drain construction and dredging of rivers and streams have been attempted. The next section explains the flooding problem in Accra.

1.2 Problem Statement

The existing inability to control floods in Accra arises from various issues. Natural as well as human-induced factors have led to the persistent occurrence of floods in Accra. In parts of Accra, proximity to the sea is a problem for residents because of flooding. Amoani et al (2012) explain that some areas in Accra like Glefe experience severe flooding due to an upsurge in storm activities and tidal waves. Some areas experience a high incidence of coastal erosion which also influences flooding. In other communities, the low lying nature (topography) of the land makes it susceptible to flash floods especially when it is downstream of a river. Oppong (2011) explicates that the steep slope of a river channel may enhance a sudden rush of water down the river channel leading to flooding as it approaches areas of gentle slope along the river channel. Some of the major human-induced factors that cause flooding in Accra are explained.

Firstly, the provision of infrastructure facilities in Accra has lagged behind the increased rate of physical expansion. Inadequate storm water drainage is one of the most crucial issues facing Accra today. The Korle - Chemu catchment which contains the major urbanized areas of Accra has many of the drainage channels poorly constructed and maintained. Erosion and siltation of drains is a critical problem. In low-lying areas flooding is a serious problem, with many houses being inundated by floodwater during and after heavy rains.

Institutions responsible for drainage have failed to provide adequate drainage infrastructure. The institutions lack the financial capacity to embark on major drainage works to prevent flooding. Some areas that have been provided with drains still suffer from flooding due to the poor maintenance of the drains. AMA (2010) explains in the 2010-2013 MTDP that, flooding is predominant in Dansoman area and along the Lafa stream where few of the drainage channels in the catchment area are constructed. As a result, there is heavy erosion of drainage channels - many of which flow down existing tracks and roads. Access to this area is often cut off and roads become impossible to use during heavy rains. The problem of inadequate provision of drains is aggravated by poor design of drains.

AMA (2010) explains that, in low lying areas near the Accra Academy in Kaneshie, rapid run off from Asoredanho overflows into the Bank of Ghana flats because the

inlet to the Kaneshie drains is inadequately designed. Similar problems occur in the industrial land cemetery area around the Obetsebi Lamptey Circle where the interceptor drain and gullies are inadequate. There are many other areas, like Nima, Dzorwulu and Darkuman which have localized flooding problems caused by inadequate drainage channels and the flat nature of the terrain (AMA 2010).

Poor waste management also has a direct impact on flooding in Accra. Solid waste management especially, is one of the most challenging and critical issues in the city (Alhassan et al, 2010). A report by WaterAid and EU (2008) shows that refuse generation in Accra is estimated to have increased three-fold over the last two decades, due to factors including population growth, increased urbanization and lifestyle changes. Moreover, approximately 2,000 metric tonnes of waste are generated daily but only 1,200-1,300 tonnes are properly collected (AMA, 2009). This huge backlog of uncollected waste usually manifest in choked drains, overflowing garbage heaps, littered pavements, streams and rivers. These large amounts of uncollected metropolitan waste that block streams, rivers and engineered drains prevent the free flow of flood waters out of the city. Streams, rivers and lagoons choked with rubbish easily accumulate silt and this reduces their capacities.

Another anthropogenic cause of flooding is the poor enforcement of development control. Various issues like encroachment on wetlands, building in flood plains and building on water ways also contribute to flooding. Institutions like the Town and Country Planning Department and the Public Works Department have failed to ensure that development is done according to schemes that have been designed. Some areas like Glefe do not even have planning schemes, thus making development control more difficult. Developers flout planning and building regulations and build in floodable areas with impunity.

In addition, the spate of physical development in Accra has increased the amount of impervious surfaces in the city. This therefore has reduced the amount of area available for water to peculate into the natural soil. Areas designated as open spaces that are reserved are encroached on, thus worsening the situation.

Furthermore, the deliberate spilling from the Weija Dam also floods parts of Accra. According to AMA (2010), flooding is common along an eight kilometre stretch of the Densu River below the Weija dam whenever there is a deliberate release of water

over the spillway. Areas like Glefe and Opetekwei which are low lying areas get flooded during water spillage from the dam. Most settlers there are squatters and have lived in these floodable areas for years.

Flooding in Accra as seen in the discussion so far is caused by many different factors. Other areas in the city that have suffered severely from floods are Avenor, Odawna, Mallam, Santa Maria, Sowutuom, Apenkwa, Sakaman and Alogboshie. According to AMA (2010), the principal areas that are liable to flooding in the metropolitan area are:

• Panbros Salt Ponds;
• Dansoman - Mpoase - South Odorkor corridor;
• Dansoman - Sukura - Chorkor corridor;
• Mataheko - Abossey Okai - Korle Lagoon corridor;
• Odaw - Dzorwulu - Awudome - Industrial Areas System; and
• Darkuman - North Kaneshie.

In examining the above mentioned causes which seem to be significant locally, it is also important to take note of climate change and variability which is a global phenomenon. Research conducted over the years shows that the globe is getting warmer and this influences flood occurrences. Dasgupta et al (2007) acknowledge that, in this 21st century, hundreds of people are likely to be displaced by sea level rise and accompanying economic and ecological damage will be severe for many people. Local solutions must always take note of the changing climatic conditions.

These problems notwithstanding, some interventions have been made to mitigate the effects of floods in Accra. Different programmes have been aimed at controlling floods and other natural hazards but the problem has persisted. To help reduce flood occurrences in the city, the government implemented some engineering solutions. The immediate area of concern was to dredge the major rivers and streams to increase their capacities as part of the Urban Environmental Sanitation Projects. Component One (Storm Drainage) of the Second Urban Environmental Sanitation Project (UESPII) covered storm drainage at a cost of US$16.5m. Communities within Accra which were subject to flooding benefitted from this project. It aimed at reducing the frequency, severity and duration of flooding in low-lying areas. This component considered lining of primary and secondary drains, construction of small bridges and

erosion control. The End-of-Project (EOP) target for Component One of the UESP II was "to achieve at least half the people living or working near the newly lined drains report of reduced flooding" (World Bank, 2004). This was however a short term measure since many streams and rivers easily get silted after a short period. This can be seen as a cosmetic solution which did not deal with the siltation problem over the long term.

Furthermore, Adams (2010) stated that in July 2001, the French government donated US$5 million to help the Ghanaian government de-silt, construct and restructure primary drains to solve the perennial problem of flooding in Accra. Also, following the Netherlands Engineering Consultants (NEDECO) report in 1963, a considerable amount of work was done, particularly in connection with the Korle Lagoon and the Odaw River, but work was eventually stopped. The drainage channels, until recently, had not been maintained resulting in the silting of the major watercourses and the lagoon (AMA, 2010).

Though some flood prone communities in the city have benefitted from various interventions, others have not gotten any help yet. For purposes of this study two of the floodable communities in Accra namely Alajo and Glefe were selected. The basis for selecting these communities is explained in the methodology found in chapter three. Over the years, media reports show that flooding in Glefe is perennial and the community has been suffering. Various reasons have been associated with flooding in the community especially the high tidal wave action. Flooding in Alajo seems to have been managed significantly. The research explored to know the residents' perspectives on the particular causes of flooding in their respective communities. The study investigated the impact of the intervention in Alajo after the intervention on flood occurrences. The study was a typical before and after approach to examine the effectiveness of the intervention. The study also investigated other means that have been put in place by institutions as well as households to reduce the effect of floods.

1.3 Aim and Objectives of the Study

The main aim of the study was to assess the impact of flood control measures to mitigate floods in the various communities. Specifically, the study considered the following objectives.

1. To identify and analyze the causes and the impacts of floods in Accra;

2. To analyze the effectiveness of flood mitigation measures put in place by households and institutions; and
3. To make recommendations to enhance flood mitigation in Accra.

1.4 Research Questions

Considering the objectives, the general question was to find out what impact the intervention made has had in terms of mitigating the effects of floods. Specifically, the following questions were asked.

1. What are the major causes of flooding in the study areas?
2. What flood mitigation measures have been put in place to mitigate flooding in the study areas?
3. What has been the impact of the mitigation measures put in place?

1.5 Scope

The geographical scope of the study is the Accra Metropolis. More specifically, the study explores two communities in Accra namely Alajo and Glefe. Figure 1.1 shows the locations of the study communities. Contextually, the study considered the intervention made to mitigate the floods. The main interest was to know what impact the interventions have had on the beneficiary communities.

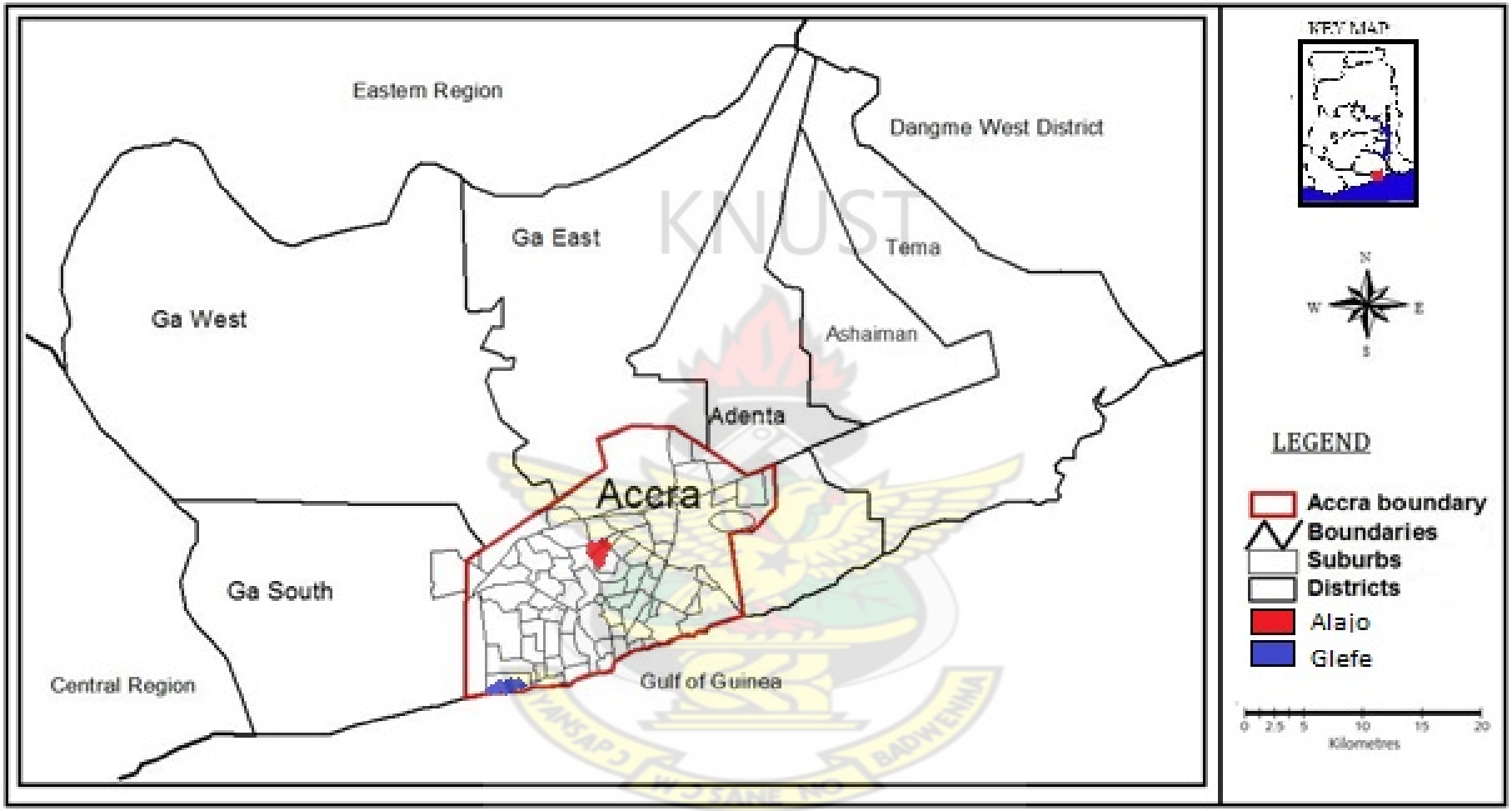

Figure 1.1 Map of Accra Metropolis showing study areas

Source: Author's construct

1.6 Limitations

Some limitations were encountered during the study. The absence of data from some of the institutions was a problem. In such cases other data sources like newspapers were consulted in order to get some relevant information. The ability of respondents to recall situations before the drain construction in Alajo was very critical. The uncertainty of some respondents was resolved by corroborating the stories from other people within the community.

1.7 Thesis Organisation

This report consists of six chapters. Chapter One introduces the research by giving a brief background to flooding in Accra. Also the problem statement, research questions, objectives as well as limitations are discussed in Chapter One. Chapter Two contains the literature review that discusses various themes on flooding and how attempts have been made to mitigate floods. It also discusses the conceptual framework in brief. In the third chapter, the methodology is detailed out. Chapter four discusses the profile of the study area. The fifth chapter shows how institutions responsible for flooding issues as well as households have responded to mitigate the effects of flood in the study areas. The perceptions of households that have benefitted from some flood mitigation measures were sampled and analyzed. Chapter six focuses on findings, recommendations and conclusion.

CHAPTER TWO

FLOODING IN URBAN AREAS

2.1 Introduction

This chapter discusses the existing body of knowledge on flooding. It explores the causes of flooding, effects of flooding as well as mitigation measures to reduce floods. The key variables are embodied in the conceptual framework at the end of the chapter.

2.2 Background to Flooding in Urban Areas

According to the Intergovernmental Panel on Climate Change (IPCC) (2007) flooding is considered as a primary example of climate change related events in all parts of the World. Munich Re, (2002) also explains that during the last forty years, economic losses due to natural hazards like flood disasters have risen in proportion and also resulted in major loss of human lives and livelihoods, the destruction of economic and social infrastructure, as well as environmental damages during this period. This is supported by Askew (1999) who says that perennial floods and other disasters have been identified as a serious threat to sustainable development. Askew (1999) furthers explains that floods are the reason for about one third of all deaths, one third of all injuries and one third of all damage from natural disasters. Though flooding is a natural phenomenon, humans contribute to the flooding problem. Hualou (2011) explains that flood disasters result from anthropogenic vulnerability which is an outcome of our interaction with the natural environment by some human activities like designing and locating infrastructure, exploiting natural resources and concentrating our population.

It is estimated that, about more than 50 per cent of the world's population currently lives in cities, but this figure is expected to increase more than 60 per cent over the next 30 years. Most of the anticipated growth that is expected in the urban population is likely to happen in the developing world. A study by Haines et al, (2006) reveals that the vulnerable populations of many developing countries are already exposed to shortages of drinking water and poor sanitary conditions and frequently occupy high-risk areas such as floodplains and coastal zones.

The quality of the urban space is important to sustainable livelihood; therefore, it is imperative to understand the relationship between sustainable development and

disaster preparedness and management. Oludare et al, (2012) support this by saying that sustainable development is of great importance and has come to have an associated meaning which concentrates on the nature of communication and relationships encircling development and the way in which development can be self-sustaining. Furthermore, he explains that the trend in the frequency and intensity of disasters both nationally and internationally is as a result of unpredictable climatic changes, severe flooding, fire, drought, terrorism, epidemics and urbanization particularly in developing nations. Increasing urbanization and lack of good governance have been seen as a major cause of urban flood risk (UN-ISDR, 2009, Darteh, 2010).

Urbanization aggravates the damages caused by flooding by constraining where flood or storm water can pass. Odemerho, (1988) says that vast parts of the ground with roofs, roads and pavements are covered; impeding sections of natural channels and building drains that ensure that water moves to rivers faster than it did under natural conditions. This is shown in urban environments where the infiltration capacity is minimized by the replacement of ground cover with impervious urban surfaces

Considering the increase in the number of urban dwellers globally, the number of people at risk or susceptible to flood hazards is likely to increase. Any increase in disasters, whether in small or large proportions may threaten development gains and hinder the implementation of the Millennium Development Goals (UN-ISDR, 2008). Disasters create serious challenges to the economy of a nation. It should be observed that the economic environment of a nation is constituted of its financial systems, social welfare, power sector, transportation, investments, commerce, manufacturing and construction as well as banking. The aftermath of disasters is pain and huge losses to the economy and it is quite complex when quantifying the actual cost of damages and recovery.

Flooding is caused either by natural or man-made phenomena. It is usually followed by negative effects which mostly entail extensive socio-economic and environmental implications. These negative effects may include loss of lives and properties, mass migration of people and animals, environmental degradation, and shortages of basic human needs and services. Musa and Usman, (2013) assert that, in comparison with

other natural disasters, flooding has the largest damage potential and as well affects a larger number of people.

In most countries, natural disasters interrupt economic development. According to Mathur (2006), developing countries which already suffer from resource constraints, are compelled to divert their vital resources from ongoing development projects to relief-and-rescue operations which can sometimes set back their development by as much as ten years. Floods constitute a major natural hazard which are rapidly resulting in disasters and exerting a heavy burden on the inhabitants of floodplains and the economic activities therein.

To have a good understanding of flooding as a disaster, a look would be taken at natural hazards and natural disasters. Flooding in urban areas become disasters when they cause harm to human lives and properties.

2.3 Definition of Key Terms

2.3.1 Flooding

Flooding like other environmental hazards can be described as a natural and inexorable process which occurs when a river's channel cannot contain all the water supplied to it by its watershed, that is, the land area that drains into the river. When this happens in the lower part of a watershed, water spills out onto the floodplain immediately next to the river channel that has been built by the river (fluvial) processes.

Basically, flooding can also be said to be the situation when water inundates an area usually for a period of time for various reasons. Floods have an element of damage that makes it undesirable. Floods may cause damage to lives as well as property. The repercussions of flood on the socioeconomic activities in society may be prevented when appropriate measures are put in place. Nyarko, (2000) describes flooding as the inundation of an area by unexpected rise of water by dam failure or extreme rainfall duration and intensity in which life and properties in the affected area are under risk.

Tapiwa et al, (2010) intimated that flooding is a high-water stage in which water overflows its natural or artificial banks onto normally dry land, such as a river inundating its floodplain. Uncontrollable floods likely to cause extensive damage commonly result from excessive rainfall in a short period but may also result from ice

jams during the spring rise in rivers and from tsunamis. Flooding may also be described as a relatively high flow of water, which overflows the natural channel provided for runoff (ILGS, IWMI, 2012). In addition, when there is an overflow or accumulation of an expanse of water that submerges land then we can say there is flooding. All the various definitions have a common understanding that floods inundate the dry land and when this dry land is built, then lives and properties are affected. It should always be remembered that flooding is considered as a serious issue because of the damage to lives, property and infrastructure.

2.3.2 Natural Hazards and Natural Disasters

Nelson (2013) gives a clear explanation of a natural hazard and a natural disaster. He explains that, a natural hazard is a threat or danger of a naturally occurring event that can have an adverse effect on humans. This negative effect that can happen to humans is called a natural disaster. To be precise when the hazardous threat actually happens and harms humans the event is called a natural disaster. He explains further that, natural hazards (and the resulting disasters) are the result of natural occurring processes that have operated throughout earth's history. Most hazardous processes are also geologic processes.

Nelson (2013) adds that geologic processes affect every human on the earth all of the time, but are most noticeable when they cause loss of life or property. If the process that poses the hazard occurs and destroys human life or property, then a natural disaster has occurred. Among the natural hazards and possible disasters are earthquakes, volcanic eruptions, tsunamis, landslides, subsidence, floods, droughts, hurricanes, tornadoes and asteroid impacts. However, in Africa, flooding is the most frequent natural disaster and results in the highest mortality (UN-Habitat, 2009).

2.3.3 Vulnerability

The impacts of hazardous events are usually unevenly distributed among and within nations, regions, communities, and groups of individuals. Vulnerable groups are those who are likely to suffer a disproportionate share of the effects of hazardous events. Dow, (1992, 1993) defines 'vulnerability' to hazards as people's differential incapacity to deal with hazards, based on the position of groups and individuals within both the physical and social worlds. Building on this vulnerability can be seen as a function of two attributes: 1) exposure (the risk of experiencing a hazardous event); and 2) coping ability, subdivided into resistance (the ability to absorb impacts and

continue functioning), and resilience (the ability to recover from losses after an impact). In everyday use of language, the term vulnerability refers to the inability to withstand the effects of a hostile environment.

2.4 Causes of Floods

Floods may arise due to numerous reasons. Oppong (2011) categorizes the causes into natural and artificial. The natural causes refer to those that do not have any direct human influence while the artificial one may be caused by the actions or inactions of humans.

Flood is basically a natural hydrological phenomenon. Its occurrence is mostly the aftermath of meteorological events. These may include an intense and prolonged rainfall and unusually high coastal and estuarine waters due to storm surges or seiches

2.4.1 Heavy and prolonged rainfall

The main cause of flooding that usually comes to mind is the incidence of heavy and prolonged rainfall. This is a generally common cause of flooding in many regions. Heavy rainfall raises the water level of streams and rivers as well as other water bodies beyond the carrying capacity of the channels, thus, leading to the overflowing of excess water onto the immediate floodplains.

2.4.2 Seismic activities

Floods are also caused indirectly by seismic activities. Coastal areas are particularly vulnerable to flooding due to tsunamis (seismic sea waves). Coastal Flooding occurs by virtue of the fact that the sea level at a point in time is higher than the adjoining coastal area. Therefore, flooding occurs because land lying close to the sea can be submerged by sea water during high tides, tsunamis or storms. Under such circumstances, low lying coastal areas are flooded.

2.4.3 Topography of land

The nature of topography is also a natural cause of floods. Flooding is prevalent in low lying areas or lowlands. Since rivers flow more slowly in such areas, if the water volume increases quickly, floods occur.

2.4.4 Earthquakes

Sinking of land due to earthquakes reduces the elevation of land areas. In places where there are lakes and rivers, these areas become flood-prone. Similarly, the uplifting of the lake and river beds from seismic causes sometime results in the

overflowing of these bodies of water. The water then inundates the surrounding and adjacent areas. To some extent, astronomically influenced phenomena such as high tides, coinciding with the occurrence of heavy rainfall frequently cause flooding.

Floods are some of the repercussions of the influence and interventions made by man in the natural environment. Some of the changes made in the natural environment underpin the occurrence of flooding resulting in some serious after-effects on man and the natural environment. Some of the causes are described below.

2.4.5 Poor enforcement of development control regulations

Development in water ways and floodable areas is rampant in some urban areas, especially in developing countries. Blatant disregard of building regulations cause many people to build in the green belt zones of the country depleting these areas of vegetation. This leaves such areas prone to erosion and flooding. Sam (2009) wrote that development of residential buildings and paved roads increase the imperviousness of the catchment areas considerably, giving rise to quicker catchment response to rainfall and therefore increased runoff. Also, housing development has in some cases come into proximity to streams and other primary drainage facilities and rendered hill slopes barren of vegetation. He further explains that, such stream channels have been rendered incapable of coping with the high volume of runoff generated during storms, which invariably carries large amounts of silt.

2.4.6 Pressure on land

Population pressure is possibly the overriding human cause of floods in the world. With world population increasing so rapidly, the need for resources and other basic necessities such as food, water and shelter is putting pressure on nature. According to Oppong (2011), it is very difficult at this rate for resources to regenerate quickly enough to meet the ever increasing needs of the world's teeming population. Forests are quickly vanishing due to the need for wood for furniture and to provide shelter as well as the need for land to be used to cultivate food as well as cash crops. The need to grow more food especially in developing countries has led to over cultivation and over grazing as previously mentioned. Flood plains have been reduced so much that farms can be found close to rivers and streams. Erosion is intensive and this has led to silting of river beds, rising of river beds and consequent flooding at the least opportunity given that there is a heavy down pour or steady rainfall over some hours.

2.4.7 Reduced Capacity of Drainage Channels

The reduced capacity of drainage channels also lead to flooding. Sam (2009) explains that existing drains are often choked with refuse or silted up, as are rivers and streams near the urban centres. This causes a reduction in capacity of the river and stream channels, and flooding may occur. Most rivers and their important tributaries are major receptacles of wastewater including faecal matter, and in some cases solid waste. In the densely built up areas of urban cities, these rivers act as open sewers, posing a serious threat to public health. Growth of grass and weeds are a common sight in many sections of various river channels. This naturally results in retardation of flow and consequent flooding of the banks of the rivers during heavy storms. During dry weather the grass and weeds cause ponding in several sections, which provides breeding grounds for mosquitoes. Sometimes water mains are made to cross existing drains, thus further reducing the capacity of the drains.

2.4.8 Poor drain system

Absence of drain facilities in some areas and inadequate capacities of the existing drainage facilities also contribute to the problem of flooding. Some drains are very small and cannot handle the amount of storm water that passes through them. Such drains are easily overwhelmed and flooding occurs. In an area where there is no proper drainage system, flooding is likely to occur. Good drainage serves as a simple way of carrying away run-off from the dry land into the sea or a river.

2.4.9 Obstructions

Sam (2009) explains that services such as water, telephone and power that cross drains via pipes act as obstructions to the free flow of water. These services hinder the easy flow of water through drains. This compounds the already existing problem of choked drains. In addition, vegetation carried by the flowing water is thus trapped which further reduces the flow capacity of the drains.

2.4.10 Deforestation and Poor Farming Practices

Man's attempt to provide his needs such as settlements, roads, farmlands and other resources such as minerals of all kinds has been detrimental to some extent. This has led to large areas of forests near water bodies such as rivers and streams being cleared to make room for such developments. Oppong (2011) mentions that, in Ghana for example, apart from these uses of land, trees are also cut down to be used as fuel wood and furniture. With less vegetation left to protect the soil, no trees to soak up

water (thus more water flows into the rivers) and to bind the soil particles together, soil erosion quickly sets in with runoff washing the top soil into the water bodies. Such sediments when deposited in the river makes the river channel shallower; raising the river bed such that the river overflows its banks easily with the slightest increase in the volume of water it carries.

Oppong (2011) reiterates that some farming practices can actually lead to the damage of the vegetation cover with the resultant effect of soil erosion and deposition of sediments into riverbeds leading to silting and subsequently, flooding. In Ghana where shifting cultivation as a method of farming has been used for a long time, vast areas of land are left to fallow. The process of fallowing takes a few years during which time the land is left bare with little or no vegetation cover. This exposes the land to direct rainfall and contributes to erosion, silting of river beds and flooding. Over cultivation can also weaken the soil and lead to the soil losing its compactness and resistance to erosion. Also, over grazing is a serious cause of flooding. Farmers rearing animals can sometimes allow the animals to feed on pasture at a particular area for so long that the vegetation cannot grow back in time to protect the soil during the rainy seasons leading to erosion of the top soil into river beds and subsequent flooding.

2.4.11 Poor Water Management

The use of water bodies especially rivers by man over the years has led to various problems especially with the management of water. Dams have been constructed on rivers in order to generate hydroelectric power for man's use. These lead to the formation of artificial lakes like the Volta Lake of Ghana. Oppong (2011) expounds that dams which are poorly constructed or maintained can easily collapse resulting in flooding downstream. In China for example, several lakes along major rivers have been silted and reclaimed. The Dongting Hu along the Chang Jiang River is an example.

2.4.12 Encroachment on Wetlands

Wetlands do more than provide habitat for plants and animals in the watershed. When rivers overflow, wetlands help to absorb and slow floodwaters. This ability to control floods can alleviate property damage and loss and can even save lives. Wetlands also absorb excess nutrients, sediment, and other pollutants before they reach rivers, lakes,

and other water bodies (US EPA, 2006). Despite all these benefits, wetlands are being encroached in many countries especially the developing ones. Wetlands are reclaimed and used for other purposes like industrial, commercial and residential. This kind of change of use affects the natural role that the wetlands play in preventing floods.

2.4.13 Dam and Levee failures

The failure of some man-made structures like dams and levees may result in flooding. Nelson (2012) gives a detailed explanation about how such man-made structures can lead to flooding. He explains that the deliberate release (spilling) of water from dams may also cause flooding downstream. Natural dams result from natural events that block streams, such as landslides, lava flows, or pyroclastic flows into streams. Humans build dams for flood control, water storage, and for the generation of electricity. Dams fail as a result of overtopping, foundation defects, seepage and piping of water under or through a dam, structural failure and inadequate maintenance.

Natural levees are constructed as a result of flooding but they tend to be relatively low and do not offer much protection from large discharge because they can easily be overtopped. Human made levees are much higher and are constructed to prevent flooding from high discharges on rivers. Most levees are constructed of piles of dirt (rock and soil) with a concrete cover on the river side of the levee. Such levees often give a false sense of security for those living on the floodplain the levee was built to protect, because failure of such levees can lead to flooding, either because discharge can become great enough to overtop the levees or the levees can become weakened and fail.

2.5 Types of Floods

Different types of flooding present different forms and degrees of danger to people, property and the environment, due to varying depth, velocity, duration, rate of onset and other hazards associated with flooding. Many authors have identified various types of floods based on different circumstances leading to the flood. The four types discussed below are the main types identified. Other types identified by other authors may fall within the ones discussed here.

2.5.1 Coastal Flooding

Coastal flooding happens when sea levels are higher than normal, largely as a result of storm surges and this can result in the sea overflowing onto the land. Coastal flooding may be influenced by some factors. High tide level and storm surges caused by low barometric pressure worsened by high winds (the highest surges can develop from hurricanes) may influence coastal flooding. Wave action which is dependent on wind speed and direction, local topography and exposure may also be a factor in coastal flooding. Coastal areas may be flooded by storm events at sea, resulting in waves over-topping defences or in serious cases by tsunami or tropical cyclones.

2.5.2 Inland flooding

Inland flooding is due to prolonged and/or intense rainfall. Different forms of inland flooding exist. Inland flooding may occur when the level of water stored in the ground rises as a result of prolonged rainfall to meet the ground surface and flows out over it, i.e. when the capacity of this underground reservoir is exceeded. While water levels may rise slowly, it may be in place for extended periods of time. Hence, such flooding may often result in significant damage to property rather than be a potential risk to life.

2.5.3 River flooding

Another type of flooding is river flooding. River flooding occurs when the capacity of a watercourse is exceeded or the channel is blocked or restricted, and excess water spills out from the channel onto adjacent low-lying areas (the floodplain). This can occur rapidly in short steep rivers or after some time and some distance from where the rain fell in rivers with a gentler gradient. According to McGuire et al (2004) river flooding depends on factors such as the form of the catchment and climatic conditions. Anthropogenic activities such as deforestation and urbanization also contribute to river flooding by increasing surface runoff leading to the modification of a river's hydrograph – which is the curve of discharge over time. Technically, river flooding depends on the relationship between a river's stage (i.e. height of the water level) and its discharge which is the volume of water passing per unit of time. These in turn also depend on factors such as cross-sectional area of the river as well as the gradient of the river's channel. River floods thus occur when the river's discharge increases leading to an increase in the height of the water level such that it overflows its banks (McGuire et al, 2004).

2.5.4 Estuarial Flooding

Estuarial flooding may occur due to a combination of tidal and fluvial flows, that is, interaction between rivers and the sea, with tidal levels being dominant in most cases. A combination of high flow in rivers and a high tide will prevent water flowing out to sea tending to increase water levels inland, which may flood over river banks.

2.6 Effects of Flooding

The effects of flooding are felt both immediately and later. The effects are numerous and in many cases are grave. Floods have many negative effects on lives, property, infrastructure and economy. Nevertheless, there are a few positive effects of floods. The various merits and demerits of floods are discussed below.

2.6.1 Positive Effects of Flooding

Floods are nature's way of managing excess water from precipitation as well as the hydrologic cycle. This helps to maintain a balance in the cycle. Also, when floods occur, much needed nutrients are deposited on the flood plains. The alluvium from such floods provides essential nutrients needed by plants to grow well. This indirectly helps in protecting water bodies since plants which grow on the flood plains help to check erosion and protect against silting. Also, crops cultivated in alluvial soils usually produce bumper harvests and thus provide communities in such areas with sufficient food.

Some alluvial deposits also contain precious minerals such as gold. In Ghana, alluvial deposits which contain gold can be found in streams or rivers that run over areas with Birimian rocks (Oppong, 2011). The gold which is finely divided can be found in riverbeds, riverbanks, dry valleys, gravel beds, beach gravels and sand. Although the mining of gold and other precious materials give rise to environmental concerns worldwide, flood waters which leave these alluvium deposits on river banks provide many nations with foreign exchange when these minerals are exported.

Flooding can however play a beneficial role in natural habitats. Many wetland habitats are dependent on annual flooding for their sustainability and can contribute to the storage of flood waters to reduce flood risk elsewhere. Freshwater floods especially play an important role in maintaining ecosystems in river corridors and are essential in maintaining floodplain biodiversity.

Floods help to recharge ground water and can also make some soils more fertile by increasing the nutrients in them. Flood waters provide needed water in arid and semi-arid areas where rain may be unevenly distributed throughout the year. The negative features of floods which are predominant are discussed below.

2.6.2 Negative Effects of Floods

Generally, the after-effects of flooding have been destructive in nature. This is common particularly in areas where human settlements have been developed on the floodplains of water bodies. When floods occur in cities and other urban areas, many people become homeless and their properties and homes are inundated by water.

Floods may lead to economic losses. The flood in Jiangxi of China in 1998 caused a great deal of damage. The economic loss was HK$156 billion and 400 buildings surrounding the lake were inundated leaving more than one million people homeless. After floods occur, so many resources are needed for reconstruction. Governments have to devote many resources to aid and reconstruction, example the police, fire personnel and aid workers.

Flooding can cause physical injury, illness and loss of life. Flood water cause diarrhea and increase water-borne diseases. Floods have caused death and injuries in many cases. In the year 1998, 230 million people were affected in the flooding of Xian, including three thousand people dead. In the same case one million people lost their homes. In 1996, the monsoon flood in India affected more than five million people in the northern and eastern part of the country. Severe floods have also killed some 200 people in India and Bangladesh and left millions homeless and starved.

Deep, fast flowing or rapidly rising flood waters can be particularly dangerous. For example, even shallow water flowing at 2 metres per second (m/sec) can knock children and many adults off their feet, and vehicles can be moved by flowing water of only 300mm depth. The risks increase if the floodwater is carrying debris. Some of these impacts may be immediate, the most significant being drowning or physical injury due to being swept away by floods. Floodwater contaminated by sewage or other pollutants (chemicals stored in garages or commercial properties) is particularly likely to cause illnesses, either directly as a result of contact with the polluted floodwater or indirectly as a result of sediments left behind. Flood water may also

hide other hazards for wading pedestrians, such as manhole openings where the covers have been lifted by flood flows. Those most likely to be at risk are those outdoors on foot or in a vehicle, in a tent or caravan, or in a building, such as a single-storey bungalow or below ground in a basement.

Flooding can cause severe damage to properties. Floodwater is likely to damage internal finishes, contents and electrical and other services and possibly cause structural damage. The physical effects can have significant long-term impacts, with re-occupation sometimes not being possible for over a year. The costs of flooding are increasing, partly due to increasing amounts of electrical and other equipment within developments. Sea-water flooding may cause additional damage due to corrosion. The damage flooding can cause to businesses and infrastructure, such as transport or utilities like electricity and water supply, can have significant detrimental impacts on local and regional economies.

Flooding of primary roads or railways can deny access to large areas beyond those directly affected by the flooding for the duration of the flood event, as well as causing damage to the road or railway itself. Flooding of water distribution infrastructure such as pumping stations or of electricity sub-stations can result in loss of water or power supply over large areas. This can magnify the impact of flooding well beyond the immediate community. The long-term closure of businesses, for example, can lead to job losses and other economic impacts. Floods may also cause the collapse of bridges and this may lead to certain parts of the city being cut off for days.

Significant detrimental environmental effects of flooding can include soil erosion, bank erosion, land sliding and damage to vegetation as well as the impacts on water quality, habitats and flora and fauna caused by bacteria and other pollutants carried by flood water. Soil infertility through leaching also affects many farmlands after floods occur.

2.6.3 Other Effects of Flooding

Throughout the last century flooding has been one of the most costly disasters in terms of both property damage and human casualties. Major floods in China, for example, killed about 2 million people in 1887, nearly 4 million in 1931, and about 1 million in 1938. Nelson (2012) groups effects of flooding into three. These are

primary, secondary and tertiary effects. He explains that primary effects of floods as those which occur due to direct contact with flood water while secondary effects occur because of the flooding, like disruption of services, health impacts such as famine and disease. On the other hand, tertiary effects are the long term changes that take place as are result of flood like changes in the position of river channels.

Primary Effects of Flooding

Primary effects of floods are perchance the most commonplace since they are apparent during and after the flood waters have subsided. Primary effects occur as a result of the process itself. For example, collapse of buildings and bridges, destruction of farmlands, loss of human life are all primary effects of floods. Such damage caused mostly requires the consolidation of resources to help the affected victims immediately.

Nelson (2012) explains that primary effects of floods are those that occur due to direct contact with flood waters. During floods, water velocities tend to be higher. As the discharge increases, velocity also increases. With higher velocities, streams are able to transport larger particles as suspended load. Such large particles include not only rocks and sediment, but, during a flood, could include such large objects as automobiles, houses and bridges. Immense amounts of erosion can occur because of floods. Such erosion can weaken bridge structures, levees and buildings, thus, causing them to collapse. When water enters man-made structures, they cause damage. Even minimal flooding at homes can ruin furniture, floors and walls. Anything that comes into contact with the water may get damaged or lost. Vehicles that get damaged due to flood are hard to repair.

The high velocity of flood waters allows the water to carry more sediment as suspended load. When the flood waters retreat, velocity is generally much lower and sediment is deposited. After retreat of the floodwaters everything is usually covered with a thick layer of stream deposited mud, including the interior of buildings. Floods also result in crop loss in farmlands. Livestock, pets and other animals can be carried away and drown. Humans also get drowned in high velocity flood waters. Flood waters can gather garbage, debris and toxic pollutants that can cause the secondary effects of health hazards.

Secondary Effects of Flooding

Nelson (2012) states clearly that secondary effects occur only because a primary effect has caused them. These are generally the disruption in service delivery such as contamination of water supply (especially if sewerage treatment plants are flooded). This is likely to result in diseases and other health effects particularly in developing countries. Disruption of gas and electricity supply may also occur. Transportation systems are also disrupted during floods and thus results in shortages of food and clean-up supplies. Disruption of transportation systems occur when bridges are broken and parts of roads are washed away.

Tertiary Effects

Nelson (2012) continues to explain that long term effects are set off as a result of a primary event. For example, the loss of habitat due to flood is a tertiary effect. Permanent changes in the position of a river channel caused by flood may occur. New channels of rivers may develop, leaving the old channels to dry up. Debris and sediment deposited by flooding may destroy farmland though is it also likely to improve agricultural productivity. Jobs may be lost due to the disruption of services, destruction of businesses. On the other hand, jobs may also be created in the construction sector during reconstruction efforts. Insurance rates may increase; corruption may also come about due to misuse of relief funds. Wildlife habitats may also be destroyed.

Effects of Development on Flood Hazard

Anytime humans make an attempt to modify the landscape, changes are anticipated to occur in the way that water drains from the land. Failure to give careful consideration to the possible drainage consequences of such landscape modifications can result in higher incidence of flooding. Therefore, developing on floodplains should only be done with great care. Existing developments that have increased flooding problems can be costly to fix. Nelson (2012) points out some of the factors that enhance flood potential.

Firstly, channelization may have a great effect on flooding. In most cases, it is done to reduce flood hazards. Nonetheless, channelization is undertaken to allow development on the floodplain. If channelization results in decreasing the cross-sectional area of

the stream, then the same discharge that may not have produced flooding before channelization, may overflow the banks and cause extensive flooding after channelization.

Furthermore, subsidence may happen in developed areas because of compaction of the sediment, both due to the increasing weight of the structure and hydro-compaction associated with the lowering of the water table. Any time the elevation of an area is lowered; it becomes subject to collection of more water, and in severe cases, could drastically change the drainage pattern.

In addition, storm sewers may quicken the rate at which flooding may occur at their outlets. In order to collect run off from streets, parking lots, and buildings, all of which block the infiltration of water into the soil, storm sewers are installed to provide underground drainage of the surface. While this may prevent local flooding of streets, it moves water more rapidly to the major stream systems and thus decreases the lag time and increases the peak discharge of the streams collecting the runoff from the storm sewers.

A reduction in infiltration into the soil due to development also leads to floods. Any time the surface materials of the Earth are covered with impermeable materials like concrete, asphalt, or buildings, the infiltration of water into the soil is prevented. Urbanization tends to reduce infiltration, and thus water must collect in storm sewers and eventually in the main drainage systems. Thus, extensive urbanization also decreases the lag time and increases the peak discharge even further. Urbanization can therefore lead to a higher incidence of flash floods

2.7 Mitigating Floods

Many countries have adapted several means of flood mitigation/control. Mitigation refers to the effort to reduce loss of life and property by lessening the impact of the floods. These include desilting of drains and dredging of water bodies, destruction of buildings blocking water ways, reforestation exercises, proper town and country planning and the putting up of levees and other barriers. According to Nelson (2012, mitigation of flood hazards can be attempted in two main ways; an engineering approach, to control flooding and a regulatory approach designed to reduce vulnerability to flooding. Other natural mechanisms like wetland preservation are also helpful.

2.7.1 Engineering approaches

Channel modifications can be done such that it reduces the incidence of flooding. Channelization can enlarge cross-sectional area and thus create a situation where a higher stage is necessary before flooding. In other words by enlarging the cross-sectional area, higher discharge can be held within the channel. Channelization also increases water velocity, and thus reduces drainage time.

Dams can be used to hold water back so that discharge downstream can be regulated at a desired rate. Man-made dams have spillways that can be opened to reduce the level of water in the reservoir behind the dam. Therefore, the water level can be lowered prior to a heavy rain, and more water can be trapped in the reservoir and released later at a controlled discharge.

Retention ponds are also useful in reducing floods. They serve as similar purpose as dams. Water trapped in the retention pond can be released at a controlled rate to avoid flooding downstream.

Levees, dikes, and floodwalls are man-made structures that also have the ability to reduce floods in certain areas. These are structures built alongside the channel to increase the stage at which the stream floods. Some controversy has developed concerning the use of such structures. For example, during the 1993 floods on the upper Mississippi River, the city of St. Louis was prevented from flooding by closing the floodwalls. This essentially narrowed the river channel as it passed St. Louis and caused slowing of the River. Because of the restricted channel, flood waters were forced to flow into areas both upstream and downstream from St. Louis, perhaps increasing the damage in these areas.

Seawalls are also built to protect towns and cities which have developed right up to the beachfront. Enhancing the process of deposition along the coast can aid in preventing coastal floods. Structures like groynes, breakwaters and artificial headlands improve the deposition of sediment on the beach, therefore helping to buffer against storm waves and surges as the wave energy is spent on moving the sediments in the beach than moving water inland.

Furthermore, floodways are areas that can be built to provide an outlet to a stream and allow it flood into an area that has been designated as a floodway. Floodways are

areas where no construction is allowed, and where the land is used for agricultural or recreational purposes when there is no threat of a flood, but which provide an outlet for flood waters during periods of high discharge. The Bonnet Carrie Spillway west of New Orleans is such a floodway. During low stages of the Mississippi River the land between the River and Lake Pontchartrain is used for recreational purposes - hunting, fishing, and dirt bike riding for example. During high stages of the River when there is a potential for the river to rise to flood stage in New Orleans, the spillway is opened so that water drains into Lake Pontchartrain. This lowers the level of water in the Mississippi and reduces the possibility of a levee break or water overtopping the levee.

2.7.2 Regulatory Approaches to Reduce Vulnerability

Once humans have an appreciable understanding of the behaviour of streams, the probability of flooding as well as the flood prone areas, they can undertake the necessary measures to reduce vulnerability to flooding. Nelson (2012) provides some non-structural measures as discussed below.

Floodplain zoning is a useful way of reducing vulnerability to floods. Laws and regulations that restrict development and habitation of floodplains can be used to ensure that lives are not endangered during floods. Floodplains can be zoned for agricultural use, recreation or other uses where human and animal lives as well as property are not endangered when flood waters re-occupy the floodplain.

Restrictive building codes may be used to ensure that only certain structures are allowed in flood plains. Structures that may be allowed within the floodplain could be restricted to those that can withstand the high velocity of flood waters and are high enough off the ground to reduce risk of contact with water.

In addition, governments may embark on Floodplain Buyout Programs as a means of reducing vulnerability. In areas that have been recently flooded, it may be more cost effective for the government, which usually pays for flood damage either through subsidized flood insurance or direct disaster relief, to buy the rights to the land rather than pay the cost of reconstruction and then have to pay again the next time the river floods.

Another measure that can be used is to enforce mortgage limitations. Institutions that are involved in lending to clients that want to build could decline to give credit when dwellings or businesses are in flood prone areas.

2.7.3 Preservation of Wetlands

Wetlands develop where water creates distinctive soil conditions and plant communities. They are transitional areas, displaying elements of both open water and dry land. The Army Corps of Engineers and the United States Environmental Protection Agency (USEPA) (2006), which regulates wetlands in the United States of America, define wetlands as "those areas that are saturated by surface or ground water... and that under normal circumstances support vegetation adapted for life in saturated soil conditions". Wetlands prevent flooding by temporarily storing and slowly releasing storm water.

Wetlands are important resources which play many functional purposes (Hove and Chapungu, 2013). They vary in size and type and are thus differently defined. The most commonly adopted definition for wetlands is that of the RAMSAR Convention in 1971 which defines wetlands as, areas of marsh, fern, peat land or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water, the depth of which at low tide does not exceed six metres (Hove and Chapungu, 2013).

Dixon and Wood (2003) along with Hove and Chapungu (2013) explicate that wetlands play critical functions ranging from environmental, hydrological and socio-economic benefits to the local communities They recharge rivers and serve as reservoirs for dry water supply (du Toit, 1994, Hove and Chapungu, 2013). In addition, they serve to purify and improve river water quality (Bowden, 1987; Breen et al., 1997; Smith; 2013 Hove and Chapungu, 2013). They also provide important habitats for many bird and animal species (Bowden, 1987, Smith, 2013 Hove and Chapungu, 2013). They are home to large numbers of both terrestrial and amphibious organisms. Wetlands serve as a mini-ecosystem and without such areas; populations of countless species would be threatened.

Wetlands are of value in reducing the impacts of floods. Wetlands can reduce flooding by intercepting storm runoff and storing it. Storage of flood water reduces the sharpness of peak water flows (the peak flows generally cause the most damage)

and allows a slower discharge of water over a longer period of time. This results in less severe flooding and less flood damage. Wetlands associated with rivers generally provide the most benefit in regards to flood control. (Wetlands, Functions and uses, 2014)

The flood control value of wetlands is not completely understood, but there is growing evidence that they can play an important role in flood reduction. Cernohous, (1979) states that storage of runoff in wetlands averages about 12 inches per wetland-surface acre and can be four times that amount. He explains that, it is important to note that water from drained wetlands is that part of runoff that man can control.

The US EPA (2006) gives further advantages of wetlands. It explains that wetlands are transition zones between uplands and deeper water, unique ecosystems characterized by their hydrology, soils and vegetation. They function like natural tubs, storing flood waters that overflow riverbanks and surface water that collects in depressional areas. In this way, wetlands can help protect adjacent and downstream property from flood damage. The effectiveness of wetlands for flood abatement may vary, depending on the size of the area, type and condition of vegetation, slope, location of the wetland in the flood path and the saturation of wetland soils before flooding. A one-acre wetland can typically store about three-acre feet of water, or one million gallons. An acre-foot is one acre of land, about three-quarters the size of a football field, covered one foot deep in water. Three acre-feet describes the same area of land covered by three feet of water. Trees and other wetland vegetation help slow the speed of flood waters. This action, combined with water storage, can actually lower flood heights and reduce the water's destructive potential.

Different types of wetlands play important flood control roles in different situations. In the upper reaches of some river basins, for example, peat lands and wet grassland can act like sponges (saturated peat is typically up to 98% water by mass), absorbing rainfall and allowing it to percolate more slowly into the soil, thereby reducing the speed and volume of runoff entering streams and rivers. This means that water levels in larger channels, further downstream, also rise more slowly and human lives and livelihoods are less likely to be affected by destructive flash flooding. When peat becomes completely saturated and unable to absorb any more water, surface pools and

peat land vegetation – including sedge meadows and some types of forest – help to slow and reduce runoff (Ramsar Convention on Wetlands, n.d.).

The coast also possesses some natural protective structures to guard against coastal flooding. These include physical features like gravel bars and sand dune systems. Also, ecosystems such as salt marshes and mangrove forest have a buffering function in flood mitigation. Mangroves and wetlands are often seen as providing significant protection against storm waves, tsunamis and shoreline erosion through their ability to attenuate wave energy. Hence, it is important to preserve these natural defences.

2.7.4 Flood Mitigation in Bangladesh and Vietnam

River flooding is regarded as a chronic disaster in many parts of Asia. A combination of soft and hard measures is required for flood mitigation, although due to resource constraints, the efforts are mostly restricted to soft measures. Community-based initiatives are found to be more effective in most of the developing countries in Asia, with specific focus on empowerment of local communities, and link the community based activities to local development policies. Asia is the most disaster-prone region of the world. Statistics show that 38% of the world's disasters between 1975 and 2000 occurred in Asia. Fifty seven percent of total casualty in the past 25 years happened in Asia, (ADRC Data Book, 2002). During the same period, flood events contributed to 31% of the total number of events, followed by cyclone or typhoons, contributing 28%.

Maskrey (1989) rightly pointed out that, disaster management should not be treated as one single issue but should be incorporated into the socioeconomic activities of local people. Because community-based activities (and community-based organizations) are deeply rooted in the society and culture of an area, they enable people to express their real needs and priorities, allowing problems to be defined correctly and responsive measures to be designed and implemented (Shaw, 2006).

Flood in Bangladesh is almost an annual feature of peoples' lives that is to a large extent due to its geographical locations and natural drainage system. The major river systems, including the Ganges, the Brahmaputra and the Meghna, pass through Bangladesh to reach the Bay of Bengal. Floods inundate a substantial part of Bangladesh every year from July to September. In a normal year about 20 percent of

the country is affected but under extreme conditions as much 60-70 percent of the country would be inundated.

The Government of Bangladesh with multi-donor support launched the Flood Action Plan (FAP) in order to formulate and implement technical, economic and environmental rehabilitation and protection measures to counter the adverse effects of annual floods throughout the country. FAP 23, one of the major components of the Flood Action Plan, reviewed and evaluated the possible performance of ongoing flood proofing activities. CARE Bangladesh with the financial assistance from the USAID undertook a 5 year Flood Proofing Project. Flood proofing is defined as: the provisioning of long-term, structural or non-structural measures that can be taken by individuals, families or communities to mitigate the effects of floods. The project was implemented through a partnership arrangement by CARE, Local Government Engineering Department of the Government and local partner NGOs and Union Parishads (UP) in 1,000 communities in active flood plains in 20 high flood risk sub-districts. These communities experienced regular annual flood as they were either located in the active flood plains of major river channels or the tectonic depression areas.

The project had the following components: Community Mobilization and Awareness, Household Flood Proofing Measures, Small Scale Agriculture, Social Forestation, Infrastructure (building flood shelter, raised tube well, house levels), Community Resources Management, and Income and Livelihood Protection

All the activities were implemented through a community committee (Local Project Society), with representatives from local government, local residents and local NGOs. The project arranged extensive training for capacity building of LPS members and linked the LPS with other development agencies and local government for sustainability of FPP interventions. The project also formed Mother's club, Adolescents and Children Forum in each community and provided education on flood preparedness, health and nutrition. Apart from training and capacity building, the project also conducted several structural measures with homestead raising, evacuation centers, latrines and tube well raising, and embankment construction. Beside these, the project introduced small-scale agriculture, social forestation and river erosion

control measures. All these elements were linked to the local livelihood and income generation activities.

Vietnam is also a country that suffers from flooding annually. Situated in the tropical monsoon zone close to the typhoon centre of the western pacific, Vietnam is one of the most disaster prone countries in the Mekong region. Currently, 70% of the 73 million people in Vietnam live in disaster-prone areas, with the majority of the people in the Central region. Based on the geographical and climatological features and the disaster conditions of all types of the country, the Government of Vietnam made decisive policy for each zone as follows:

- For Northern Part of Vietnam: To strengthen dike system and flood retardation and diversion structures, to improve flood resistant coefficient of constructions, and to protect essential population and economic areas against flood.
- For Central Part of Vietnam: Central Vietnam is narrow and topographically complicated, frequently affected by storms, and rapidly rainwater concentrated resulted in flooding. The decisive policy was to supplement active measures for flood prevention and mitigation, as well as for familiarising with floods.
- For the Mekong River Delta: The decisive policy was to prepare measures for living with floods, to minimise damage caused by floods as well as to make use of the advantages of floods for the sustainable development.

Thus, in the northern region, it was more on "*positively prepare for and prevent flood*", while, in the Mekong region in the south, it was more on the "*coexiss with flood* (living with flood)", and in the Central part, it was on "*positive preparedness, mitigation and management*".

Many international donors were assisting the Vietnam Government to create a partnering strategy and prepare disaster resistant investment projects for sustainable development of Central Vietnam through the Natural Disaster Mitigation. One significant initiative was that of CECI, a Canadian NGO, and was funded by CIDA (Canadian International Development Agency), under Canada Climate Change Development Fund. The project components were: 1) stakeholder and resource mapping, 2) vulnerability, capacity and need assessments, 3) training programs for the "Change Agents," 4) development of simplified climate change scenario and its

impacts as flood, 5) awareness raising campaign, 6) participatory development of "Safer Village Plans" and "Safer Production Plan", and 7) Implementing specific components of the planning through sub-projects (CECI 2004).

The important part of the project was the initial discussion with the local communities and local government officials to identify the needs and priorities at local levels. This was done through series of mapping exercises, and vulnerability, capacity and need assessments. This was a rather lengthy process, but was effective in generating local participation of the government and communities. The other aspect of the project was training and capacity building of the "Change Agents", which in this case were the leaders of the mass organizations. In Vietnam, there are several mass organizations as a part of the communist party system, targeting different groups, like farmers association, women association, fisherman association and youth association. The leaders of these mass organizations play important roles in community mobilization during disasters, and were also crucial in the reconstruction and recovery process

The two cases in Bangladesh and Vietnam show that the flood effect on the communities goes beyond the damages of buildings and infrastructures. It affects the livelihood of the people, and it also has an impact on the development issues in the communities. The two case studies tried to focus on linking the community activities with the local government initiatives, and a strong cooperation between the government, community and the NGOs was observed in both cases. Both these projects were implemented by NGOs; however, their roles were more as facilitators and catalysts. Although working in two different geo-political contexts, CARE and CECI's approaches had significant similarities, especially on community consultation and decision making, training of change agents, and institutionalizing the initiatives in the local government systems. For an initiative to be sustained over a number of years, it needs a system, which consists of key people, key instructions. In both cases, the key people were the change agents: for Bangladesh, it was the local elected leaders, mosque head, teachers, local businessman; and in Vietnam, it was the mass organization leaders. The institutions were the local governments in both cases: the project society formed in the local government in Bangladesh, and the commune government in Vietnam.

2.8 Conceptual Framework

The concept of flooding has been examined in detail by various authors and it is clear that flooding is a natural phenomenon which may be caused by natural causes as well as artificial causes. The artificial causes are man-made ones while the natural causes are not influenced by humans. The incidence of flooding has devastating effects on nations and needs to be managed in order to curb the adverse effects it has. Floods have both positive as well as negative effects. Flood control or flood mitigation is very essential to make sure that the numerous lives and properties that may be lost during floods are preserved. Community based initiatives can be very useful in flood mitigation. Policy and institutions are key factors for the sustainability at government level, while the incorporation of change agents and appropriate information make it sustainable at grass-root level. It is imperative to strengthen local institutions rather than to create new ones. Regulatory approaches and engineering approaches can be used to mitigate the effects of floods. Interventions that are made to reduce the effects of flooding have various impacts. Some interventions may be successful in reducing the effects of flooding while others may not yield substantial results.

Crucial information dissemination to different stakeholders is important, and state-community partnership is critical for the initiation and sustainability of community based disaster management. Genuine people's participation within capacity building objectives, with specific focus on important vulnerable groups like women, elderly and children is found to important. For training and capacity building, wider stakeholder involvement and participation, effective networking and knowledge capitalization are essential to make training effective into actions. Legislation and in-corporation of community based disaster management in development planning and budgeting is extremely crucial and serves the major pillar of the policy integration.

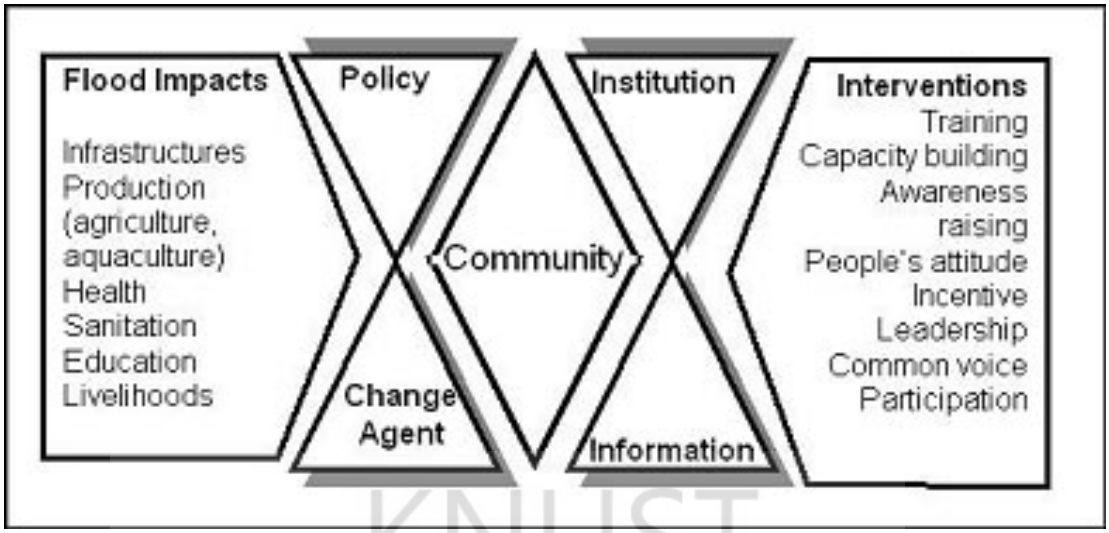

Figure 2.1 Community based flood management framework

Adapted from Shaw, 2006

2.9 Summary of Literature Review

This chapter has extensively considered the views of various authors on flooding issues. Issues looked at in the chapter included causes of flooding, effects of flooding, effects of development on flood hazard as well as mitigation measures. This chapter is important because it has pulled together, integrated and summarized what is known in the subject area of flooding. The next chapter sheds light on methods employed in undertaking the study.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

The review of literature on flooding highlighted the causes, effects, types and mitigation of floods in urban areas. The literature review revealed how floods have been mitigated in parts of the world. It was therefore important to collect primary data from the study areas as well as from institutions to fill the gaps that the secondary data had. The main aim of the study was to assess the impact of the flood control measures in the study areas. This chapter discusses the research design and the rationale for its selection. The variables that were measured; data types; sources and methods of analysis are discussed.

3.2 Research Design

Research design includes all decisions made in planning the study, including sampling, sources and procedures for collecting data, measurement issues and data analysis plan. Research design is very useful since it involves collecting and analyzing data to arrive at acceptable answers to research questions. As observed by Ditsa, (2004) the research design helped to answer research questions as validly, objectively, accurately and economically as possible. Bearing these in mind, the research was planned to ensure that the objectives were achieved. The study was a qualitative one. From the secondary data reviewed, Alajo had benefitted from a major intervention, that is, the construction of storm drains whereas Glefe had not benefitted from any major intervention to control flooding. Instead of the typical before and after design, the after-only lonely design was used. This is explained below.

3.2.1 Alajo

The after-only design was used in Alajo as there was no baseline study. In the after-only design, it is known that a population is being, or has been, exposed to an intervention and its impact on the population is studied. In this design as shown in Figure 3.1, information on baseline (pre-test or before observation) is usually constructed on the basis of respondents recall of the situation before the intervention or from information available in existing records. Therefore, since a survey was not conducted before the construction of the drains, respondents in Alajo were asked to recall the situation that existed before the intervention. Therefore, one of the major

problems of this design was that the two sets of data were not strictly comparable. However, the design has been widely used in impact assessment studies, as in real life many programs operate without the benefit of a planned evaluation at the program planning stage. The intervention in Alajo is a typical example since no survey was conducted before the intervention. The research had to adopt this design since it was identified as the most appropriate.

3.2.2 Glefe

In Glefe, secondary data revealed that, no major intervention had been embarked on to control flooding in the community. However, it was identified that home owners had put in some interventions to protect their properties from the floods. Therefore, the study set out to investigate the particular mitigation measures used by the home owners and the impact that it had on reducing floods. In Glefe, the after only design was also adopted since there was no survey to investigate the conditions before home owners adopted flood control measures. Hence, the study set out to know the situation that existed before they adopted flood control measures as well as the effect that these measures had. The process that was followed during the study is explained below.

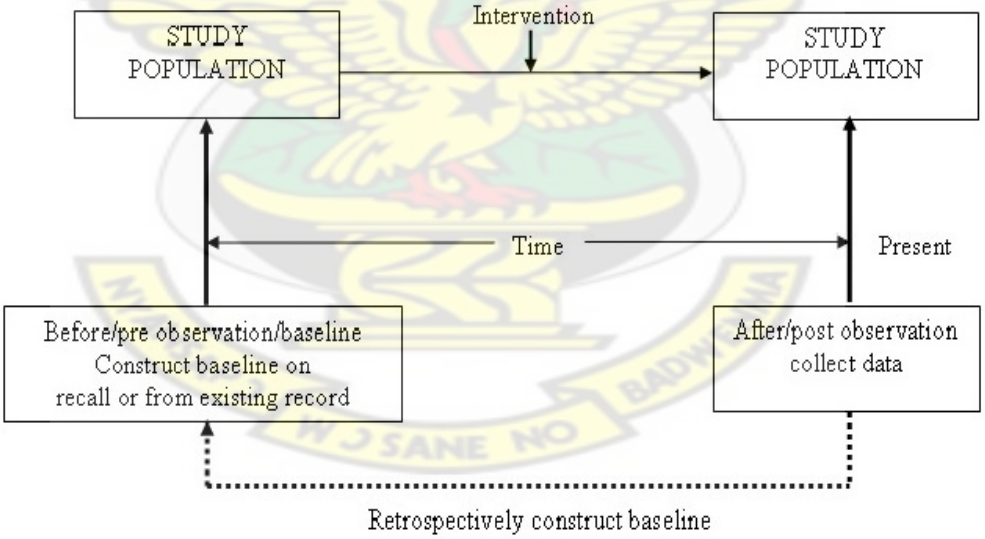

Figure 3.1 The After-only Design

Source: Author's Construct

3.3 Desk study

The research started with the identification and clear definition of the problem. After developing objectives for the study, a comprehensive desk study was done. Relevant literature was reviewed to understand the various perceptions and theories concerning flooding in urban areas. Secondary sources were consulted to identify previous

research or surveys done in the area of flooding in Ghana as well as outside Ghana. The 2010-2013 MTPD of AMA was very useful in getting a good idea of development issues in Accra. Studies by Amoani et al (2012) about coastal erosion in Glefe and work by Atuguba and Amuzu (2006) on Climate Change and Flooding in Alajo were very informative for the study. Other studies by Nyarko (2000), Oppong (2011) and Karley (2009) were very imperative to the study. This created a good platform to guide the process of the study.

3.4 Preliminary Field Investigation

A preliminary field survey was done to glean firsthand information about flooding in Accra. An interview with key officials of the National Disaster Management Organisation (NADMO), Hydrological Services Department, Accra Metropolitan Assembly (AMA) and Town and Country Planning Department (TCPD) led to the identification of potential study sites. The following sites were considered.

Table 3.1 Potential Study Sites

Site	Description	Water bodies	Population
Alajo	-Urbanized community with high population density -Planning scheme available -Located between two water bodies -Inland community -River flooding	Odaw and Onyasia	75,497 (2013 estimate)
Glefe	-Coastal community -Planning scheme not available -Low lying terrain -Bordered by two lagoons and the sea.	Gulf of Guinea, Dzatapkor lagoon and Gbugbe lagoon.	8,238 (2013 estimate)
North Kaneshie	-Inland community -Planning scheme available -Drainage improved	None	87,216 (2013 estimate)
Sakaman	- Coastal community -Drainage improved but incomplete -Partially planned	Gulf of Guinea	Unavailable

Source: Author's Construct

Subsequent visits were made to these potential study areas to observe conditions of drains (if any); the closeness of houses to drains or water bodies, environmental conditions and building conditions. The assembly men in the community were contacted to have an overview of the situation in the communities. The list of

potential sites was reduced to two after some considerations. The communities were chosen based on three parameters; type of flooding, location and intervention made to mitigate floods. Available literature on the community was also an important consideration. Communities with very limited or no literature on flooding were eliminated. The rapport developed with the assemblymen also made some communities more favourable than others.

Alajo is known to have experienced river flooding while Glefe suffers from coastal flooding. Alajo is located inland while Glefe is located along the coast. Alajo has received a major engineering intervention by way of drain construction and Glefe has not received any major intervention. This selection was done to capture different experiences in different locations and situations.

Table 3.2 Parameters for selecting study communities

Community	Type of flooding	Location	Major intervention by government agency
Alajo	River flooding	Inland	Yes (drain construction)
Glefe	Coastal flooding	Coast	None

Source: Author's Construct

Relevant institutions (Hydrological Services Department, Town and Country Planning Department, Planning Department of AMA, NADMO and EPA) that would provide vital information were also visited. This preliminary data collection exercise was also necessary to establish a rapport with key officials and some home owners. During the visit, the 2010-2013 Medium Term Development Plan (MTDP) for AMA was also picked and this served as a good source of secondary data. This exercise helped in the formulation of survey questionnaire and interview guides for the main data collection exercise. The preliminary field investigation served as a good basis for the actual data collection process which is discussed below.

3.5 Sampling Technique

3.5.1 Institutions

In the institutions, purposive sampling was used to select the respondents. These were people who were deemed capable of answering the questions. The key people chosen to respond had the necessary information, adequate knowledge and experience on issues concerning flooding in the study areas.

Table 3.3 Respondents in Institutions

Institution	Position
TCPD	Director
NADMO	Metropolitan Coordinator
Hydrological Services Department	Hydro Engineer
AMA Planning Department	Metropolitan Planning Officer

Source: Author's Construct

3.5.2 Community-Alajo

From a study by Atuguba and Amuzu (2006), the location of Alajo between two major water bodies (Onyasia and Odaw) was identified as the major cause of annual flooding, thus the drain construction. Lined drains have been constructed on both streams. For the households in Alajo, houses that fell within a hundred feet from the centre of the drains on both sides were considered. One hundred feet was selected because according to planning regulations in Ghana, properties should not be built within one hundred feet away from water bodies. Though Alajo had a planning scheme that had been prepared, it was not accessible from TCPD. Therefore a rough sketch of the community was done and the houses that fell within the buffer were counted. About 230 houses were counted, 110 on the Onyasia drain and 120 on the Odaw drain. Though the planning scheme was not available, a walk through the community showed that development was done haphazardly. Accessibility to houses was poor within the core areas.

Home owners that had stayed at their current locations (within one hundred feet from centre of drain) before the construction of the drains were surveyed. This was done to make sure respondents were there to know the situation before and after the drain construction. The general views on causes of flooding and mitigation measures were elicited from respondents. Home owners were surveyed but in situations where they were not available, household members who had stayed in the house for at least 15 years were surveyed. Home owners were preferred because they were most likely to answer the questions correctly. Respondents were called upon to recall how the situation was before and after the drain construction. The damage caused during the time before the intervention was compared to the situation after the intervention. In

Alajo, after surveying 100 home owners, repetitive responses were observed, thus that number was considered for further analyses.

3.5.3 Community-Glefe

The Glefe community was an interesting case. The assemblyman revealed that most parts of the community had been inundated by sea water. A study by Amoani et al (2012) confirms that the coast of Glefe is suffering from erosion. Investigations revealed that Glefe does not have a planning scheme. Residents had been living in the community for many years and had endured the effects of floods. A sketch of the town was done with the help of aerial photos from Google Maps. The assemblyman of the area who was very familiar with the community helped demarcate the community into three sectors based on the size of each sector and an assumption of a uniform household size in each sector. To determine the sample size, a mathematical method was adopted and the actual sample calculated was 248 households. The sample size calculation is found in Appendix 9. The enumerators surveyed home owners in each sector and during the survey repetitive responses were observed and so the sample size was reduced to 150. In each sector, 50 respondents were contacted. The residents within the selected study areas served as important sources of primary data.

The concept of triangulation helped minimize any bias inherent in the data source, investigator and method. The use of other data sources and methods was useful in corroborating responses. Yeasmin and Rahman (2012) describe triangulation as a process of verification that increases validity by incorporating several viewpoints and methods. For this study, some information provided from the institutions was cross-checked using the responses of the households as well as observation. Triangulation was very useful especially when it was realized at a point that the information given by one of the institutions was actually not existent on the ground. Interaction with community members and personal observation revealed something different.

3.6 Pretesting of Data Collection Instruments

The data collection instruments were pre-tested to identify the adequacy or otherwise of the questions. In Glefe, five respondents living within the community were surveyed. In Alajo, ten residents living close to the drains were identified and surveyed. Only respondents who had lived in the community before the construction of the drains were contacted in Alajo. This was done by asking the respondent before

starting the survey. It was important to check the validity and reliability of the instruments. Pre-testing was essential because it helped uncover ambiguity, lack of clarity or biases in question wording. During the pre-test, issues like time used per questionnaire and relevance of questions were noticed. Some questions were reformulated and others eliminated after the pre-test in order to reduce the estimated burden on respondents. A template was then prepared in the Statistical Package for the Social Sciences (SPSS) software at this stage so responses could be entered after each day's survey.

3.7 Data Collection Exercise

The data collection exercise was carried out on the field with the use of interview guides and questionnaires. The secondary data collection was done first, after which the primary data was collected. This was done so that the information gotten from the secondary sources could be verified during the primary data collection. Cameras were very useful to capture the existing situations on the ground.

3.7.1 Secondary Data

Both qualitative data and quantitative data were collected. Qualitative data like the views of the institutions on causes of floods; role in flood control, flood mitigation measures implemented in Accra and collaboration among institutions were collected and analyzed. Face to face interviews were held with the responsible personnel in the various institutions. Quantitative data like rainfall and temperature data were also collected. Existing aerial photographs and maps of the study area were also gotten from the internet and journal publications. To verify some of the secondary data gotten from the institutions, primary data was collected from the field in the study areas.

3.7.2 Face to face interviews with Key Institutions

Secondary data was collected from the various institutions involved in flood issues. The institutions visited were NADMO, Hydrological Services Department, Environmental Protection Agency (EPA), TCPD, Accra Metropolitan Assembly Planning Department (AMA) and Ghana Meteorological Services.

3.7.3 Primary data

Primary data was collected from both institutions and home owners. Structured questionnaires with open-ended and close-ended questions were administered to home owners in the study communities. The respondents were surveyed to know their views

on the causes of flooding and to assess flood mitigation measures implemented either by the government or home owners. The field observation was done by walking through the communities, interaction with residents and taking of pictures.

Table 3.4 Summary of Data Required and Sources

Source of Data	Type of Data Required	Data Collection Method	Tool Required
Home owners	✓ Causes of floods ✓ Mitigation measures adopted ✓ Impact of mitigation measures ✓ Effects of floods ✓ Recommendations to mitigate floods	Questionnaire ✓ Purposive sampling	Questionnaire
TCPD	✓ Causes of floods ✓ Mitigation measures adopted ✓ Development control adherence ✓ Impact of mitigation measures ✓ Recommendations to mitigate floods	Face-to-face interview ✓ Purposive sampling	Interview guide
NADMO	✓ Flood reports ✓ Flood prevention measures ✓ Recommendations to mitigate floods	Face-to-face interview ✓ Purposive sampling	Interview guide
EPA	✓ Wetlands Preservation ✓ Recommendations to mitigate floods	Face-to-face interview ✓ Purposive sampling	Interview guide
Hydrological Services Department	✓ Information on lined drains ✓ Information on flood prone areas ✓ Recommendations to mitigate floods ✓ Mitigation measures adopted	Face-to-face interview ✓ Purposive sampling	Interview guide
Ghana Meteorological Services	✓ Mitigation measures adopted ✓ Recommendations to mitigate floods ✓ Rainfall data	Face-to-face interview ✓ Purposive sampling	Interview guide
AMA Planning Department	✓ Causes of floods ✓ Mitigation measures adopted ✓ Impact of mitigation measures ✓ Recommendations to mitigate floods	Face-to-face interview ✓ Purposive sampling	Interview guide

Source: Author's Construct.

3.8 Data Processing and Analysis

Each day after the survey, the completed questionnaires were edited to check completeness, accuracy and consistency. Subsequent visits were made to seek clarifications on some responses and to complete some questionnaires. The questionnaires were coded afterwards. The responses for the household questionnaires were entered into the SPSS template. The data gathered from various sources were processed and analyzed. Simple descriptive statistical and analytical tools such as frequencies, percentages, bar charts and pie charts were employed in the analysis of the data. Relationships were established by cross tabulations. The processed data were interpreted and discussed.

3.9 Limitations

Some home owners were not available at the time of visit so there was the need to recall hence extending the survey period. For Alajo, there was the need to first screen the respondents considering the length of stay in the community before surveying which caused further delay. In Glefe, many respondents complained of interview fatigue as numerous studies had been done in the past with no concrete results.

CHAPTER FOUR

PROFILE OF STUDY AREA

4.1 Introduction

This chapter provides a profile of the Accra Metropolis to give an idea of its characteristics. Characteristics of the two communities that were studied would also be discussed. History, location, vegetation, relief, size, population characteristics and household characteristics are some of the issues that would be discussed. The 2010-2013 MTDP of AMA was very resourceful for this chapter.

4.2 History of Accra

Accra is derived from the Akan word “nkran” meaning “an army of ants”. The name “nkran” or “nkranfo” is attributed to the thousands of anthills, which dotted the Accra plains. Others say it makes reference to the numerous manner in which the natives of Accra kept re-appearing like army ants during a war with the Ashantis. Ghana's first President, Dr. Kwame Nkrumah, declared Accra a city, the first city of Ghana, in 1961. Initially, Accra was not the most prominent trading centre; the trade hubs of the time were the ports at Ada and Prampram. Accra stretches along the Ghanaian Atlantic coast and extends north into Ghana's interior. Originally built around a port, it served as the capital of the British Gold Coast between 1877 and 1957. Once merely a 19th-century suburb of Victoriaborg, Accra has since transitioned into a modern metropolis; the city's architecture reflects this history, ranging from 19th-century architecture buildings to modern skyscrapers and apartment blocks.

4.3 Location and size

Accra Metropolitan Assembly covers an area of 173 square kilometres and is made up of ten (10) sub-metros namely Ablekuma Central, Ablekuma North, Ablekuma South, Ashiedu Keteke, Ayawaso Central, Ayawaso East, Ayawaso West, Okaikoi North, Okaikoi South and Osu Klottey. The Metropolis is located on Longitude 05°35'N and on Latitude 00°06'W. The Northern boundary of the Metropolis is Ga West Municipal Assembly (GWMA). The Assembly is bounded to the West by Ga South Municipal Assembly (GSMA). The South is bounded by the Gulf of Guinea. The Eastern corridor of the Assembly is the LEKMA which was carved out of the Accra Metropolitan Assembly (AMA, 2010).

4.4 Geology, Climate and Vegetation

4.4.1 Geology

The geology of the AMA consists of Precambrian Dahomeyan Schists, Granodiorites, Granites Gneiss and Amphibolites to late Precambrian Togo Series comprising mainly Quartzite, Phillites, Phylitones and Quartz Breccias. Other formations found are the Palaeozoic Accraian Sediments - Sandstone, Shales and Interbedded Sandstone-Shale with Gypsum Lenses. The coastline of Accra has a series of resistant rock outcrops and platforms and sandy beaches near the mouth of the lagoons. The coastline is exposed and because of the proximity of the continental shelf, a strong coastal and wind action, it is subject to severe erosion. The lagoon systems are relatively small and flushing has been impeded by siltation or the construction of embankments, which have restricted tidal flow. The largest of the lagoons are Sakumo (Densu delta), and the Korle (Central Accra).

Soils

The soils in the Metropolitan area can be divided into four main groups: drift materials resulting from deposits by windblown erosion; alluvial and marine motted clays of comparatively recent origin derived from underlying shales; residual clays and gravels derived from weathered quartzites, gneiss and schist rocks, and lateritic sandy clay soils derived from weathered Accraian sandstone bedrock formations. In many low lying poorly drained areas, pockets of alluvial 'black cotton' soils are found. These soils have a heavy organic content, expand, and contract readily causing major problems with foundations and footings. In some areas, lateritic soils are strongly acidic and when saturated are prone to attack concrete foundations causing honeycombing.

4.4.2 Climate

The Accra Metropolitan Assembly lies in the Savannah zone. There are two rainy seasons. The average annual rainfall is about 730mm, which falls primarily during the two rainy seasons. The first begins in May and ends in mid-July. The second season begins in mid-August and ends in October. Rain usually falls in intensive short storms and gives rise to local flooding where drainage channels are obstructed. Figure 4.1 shows the rainfall distribution from 1961 to 2011. It can be seen here that the average annual rainfall in Accra has not changed significantly.

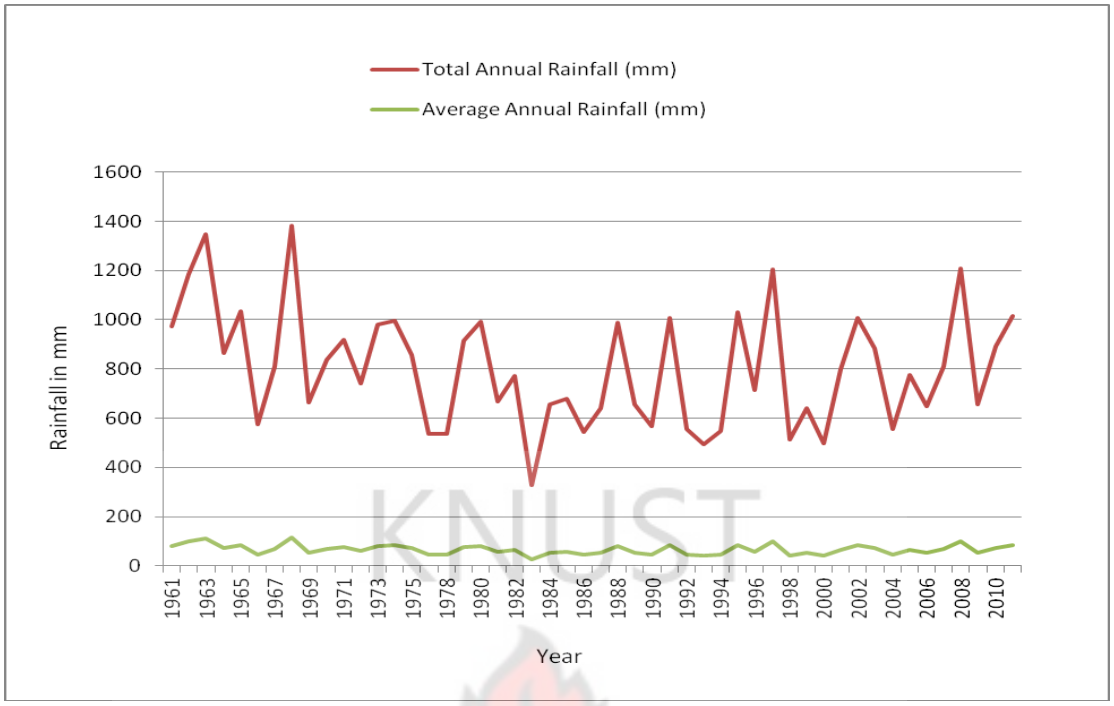

Figure 4.2Rainfall Distribution in Accra from 1961 to 2011. Source: GMA

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 hottest) with annual average of 26.8°C. As the area is close to the equator, the daylight hours are practically uniform throughout the year. Relative humidity is generally high varying from 65% in the mid-afternoon to 95% at night. The predominant wind direction in Accra is from the WSW to NNE. Wind speeds normally range between 8 to 16 km/hr. High wind gusts occur with thunderstorm activity, which pass in squall along the coast. The maximum wind speed recorded in Accra is 107.4 km/hr (58 knots). Strong winds associated with thunderstorm activity often cause damage to property and mostly removing roofing materials. Several areas of Accra experience micro climatic effects. Low profile drainage basins with a North-South orientation are not as well ventilated as those orientated East-West. Air is often trapped in pockets and an insulation effect gives rise to local increase in air temperature of several degrees.

4.4.3 Vegetation

Terrestrial Vegetation

There is evidence to suggest that the vegetation of the Metropolitan areas has been altered in the more recent past century by climatic and other human factors. Much of the Metropolitan area was believed to have been covered by dense forest of which

only a few remnant trees survive. A climatic change combined with the gradient of the plains and cultivation has imposed vegetational structures similar to those of the southern shale, Sudan and Guinea Savannahs all of which lie north of the Accra plains.

There are three broad vegetation zones in Accra Metropolitan area, which comprise shrub land, grassland and coastal lands. Only the shrub land occurs more commonly in the western outskirts and in the north towards the Aburi Hills. It consists of dense clusters of small trees and shrubs, which grow, to an average height of five metres (5m). The grasses are mixture of species found in the undergrowth of forests. They are short, and rarely grow beyond one metre (1m).

The coastal zone comprises of two vegetation types, wetland and dunes. The coastal wetland zone is highly productive and an important habitat for marine and terrestrial life. Mangroves, comprising of two dominant species, are found in the tidal zone of all estuaries and sand lagoons. Such areas are important in flood control. Salt tolerant grass species cover substantial low-lying areas surrounding the lagoons. These grasslands have an important primary production role in providing nutrients for prawns and juvenile fish in the lagoon systems. In recent times, wetlands are however being encroached upon. Protection of the coastal wetland zone is very important to the long-term sustainability of the fishing industry, which the Ga population of the city depend upon for survival.

The dune lands have been formed by a combination of wave action and wind. They are mostly unstable but stretch back several hundred metres in places. There are several shrub and grassland species, which grow and play an important role in stabilizing dunes. Coconuts and palms grow well in this zone, providing protection and also as an economic crop. Most of the coconuts were planted in the 1920s but it is estimated that over 80% of those plantations have disappeared as a result of felling, disease and coastal erosion. The loss of these trees is one of the principal reasons for the severity of erosion in some parts of the Metropolis. This eventually influences flood occurrences in some areas.

In addition to the natural vegetation zones, a number of introduced trees and shrubs thrive in the Metropolitan area. Neems, mangoes, cassias, avocados, and palms are prominent trees on the Accra landscape. Introduced shrubs like bouganvilia are also

very prominent. Achimota Forest is the only forest reserve in the AMA. This is being damaged by residential encroachment, bush fire, sand collection and illegal tree felling.

Most of the open spaces in Accra are used for the cultivation of food crops like corn, okro, tomatoes and other vegetables. Fertilizers and insecticides are used in these areas. Constant felling of trees, bad farming practices and annual burning has altered the vegetation and greatly depleted the fertility of the soil. The deforestation adversely affects the natural flood control mechanism of vegetation cover.

Aquatic Vegetation

Apart from mangroves and salt marsh grasses, which grow in the intertidal zone, sea grasses or attached algae also occur mainly in rocky areas and wave cut platforms. These areas have increased as a result of erosion exposing the underlying bedrock. They have an important role in the coastal ecosystem because of their high rate of primary production in the provision of food and shelter for the survival of shrimps, prawns and many species of fin fishes.

Terrestrial Fauna

Different species of antelopes, squirrels, monkeys and reptiles live in Accra. Many animals such as the grass cutter, bush baby and bossman potto are found in the Achimota Forest Reserve and outside the urbanized area. Most animals have been pushed inland because for the rapid expansion of settlements in the Metropolitan area. Many species of snakes (some venomous) and lizards are found throughout the Metropolitan area. Apart from the above mentioned fauna, a great number of domestic animals - donkey, sheep, goat and chicken are kept domestically in the Metropolitan area.

Aquatic Fauna

The open lagoon systems support a wide range of crustacean, mollusks, gastropods, predatory and bottom feeding fish. The lagoons are important breeding grounds giving adequate protection against large predator species and a continual supply of nutrients and organisms for food. The habitat of the lagoons is or has been modified by development and increasing levels of pollution. Some species in the lagoons - in particular the Korle lagoon - are no longer suitable for human consumption.

Protection of the water quality and vegetation in the lagoons is important to the long-term sustainability of aquatic fauna along the coastline.

The ocean supports a wide range of pelagic and bottom feeding fish. Common species are grouper, mackerel, cassava fish, African lookdown, sole shark and tiger fish. Stocks of off shore species have not been depleted mainly because fishing techniques result in a significant loss of smaller fish from nets. Evidence suggests that on-shore species are nearing exhaustion caused by excessive catches of juvenile and small fish. The loss of this resource will have a substantial impact on the indigenous population of Accra whose livelihood is dependent on fishing.

Weija reservoir, the marshes at the mouth of the Densu River, the Sakumo lagoon near the Panbros salt industry constitute the most important fresh water wetlands for aquatic fauna. Apart from harbouring a variety of important commercial fish species like tilapia and catfish, they also act as breeding grounds for animals, which are adapted to the characteristic coastal Savannah vegetation.

4.5 Demographic Characteristics

The 2010 Population and Housing Census shows the population of Accra Metropolis at 1,848,614 with additional daily influx population of 1 million who commute to the City for various socio-economic activities, which most often are nonexistent. Rural-urban migration accounts for over 35% of the population increase. The AMA has almost 42% of the total population of the Greater Accra Region with a population density of 112 per square kilometre.

The high population figure of the City (1,848,614) is both an asset and source of worry to urban management. While the relatively high population serves as a huge and vibrant market for investors, it also poses problems of sanitation and waste management as well as traffic jam especially during the peak hours of the day. Accra's population like any other urban population is youthful. According to the latest census figures, 51% are females and the remainder being males. This gives a sex ratio of 1:1.04 males to females. The dominance of females over male is a nationwide trend where the estimated ratio is 1:1.03.

4.6 Economy

Accra is considered as the economic capital of the West African Sub-Region though it faces strong challenges from other major cities like Lagos. However, the peace, stability and strong democratic credentials make Accra stand out.

Though, Accra has its own numerous problems such as traffic congestion, slum development among others, the discovery of crude oil and gas, the West African Gas Pipeline being laid in addition to the relative electricity supply has made Accra an alternative investment destination.

Accra, as the Capital of Ghana, has contributed to the economic development of the nation. It hosts a number of manufacturing industries, oil companies, financial institutions, telecommunication, tourism, education, health institutions and other important establishments. These institutions provide employment opportunities to the residents of the City. Their presence continues to attract people from all parts of the country and beyond to transact various businesses.

In reference to varying characteristics and income levels of residents, Accra has been stratified into 4 income zones to enable determination of level of poverty. The stratification is based upon housing characteristics and environmental conditions of the residential suburbs of the city. It was adopted from the block valuation system of the City Authority of Accra where localities are zoned into first, second, third and fourth income zones for property rate collection purposes.

High-income zones are characterized by well-defined sector layouts, high taxable property values and superb neighbourhood infrastructure. The rest of the zones follow suit, as the fourth zone depicts depressed conditions. They are mostly unplanned areas of the city with poor or non-existent neighbourhood infrastructure and utilities. Such areas are those prone to flooding in the city. High inequalities exist in the distribution of income in Accra.

4.7 Sewerage and Solid Waste Management

Sewerage

Accra currently has a sewerage system that covers only 15% of the City, but it is in a complete state of disrepair giving rise to serious environmental pollution and degradation. The concrete sewers are completely eroded at certain sections of the

network. It was laid about four decades ago; hence the situation calls for complete overhaul.

There are highly unacceptable infrastructural facilities that results in spread of diseases due to direct contact with raw human excreta (faeces). There have been annual reports of outbreaks of cholera, dysentery and diarrhea. Sewerage, as at now, is virtually at the initial stages of development. Hence, has a huge potential for all the necessary inputs to make it really modern.

Solid Waste Management

The mandate of the Accra Metropolitan Assembly is to provide municipal services to residents. Key amongst these services is good sanitation and waste management. However, the provision of healthy sanitation and waste management has become burdensome to the Accra Metropolitan Assembly. Some sources of refuse generation are domestic/households, industrial/commercial, markets, schools and hospitals.

Refuse Collection

The City generates about two thousand (2,000) tonnes of garbage daily out of which the Assembly is able to collect one thousand five hundred (1,500) tonnes daily based on the existing equipment holding. The huge backlog is reflected in choked drains, overflowing garbage heaps and littered pavements. The cost of payment has been the problem facing the Accra Metropolitan Assembly. Only twenty per cent (20%) of residents in the first class residential areas pay for the cost of refuse collection. The remaining 80% of the population who form the majority generate the bulk of the waste but do not pay for collection. The Assembly spends on average more than 65% of its revenue to keep the city of Accra clean and healthy. In spite of this effort, there is much more to be done.

4.8 Housing

There is an inner city area comprising a mixture of very low-density development with under-utilized service infrastructure on the one hand, indigenous, low class, and high-density development with depressed conditions and over stretched infrastructure services on the other. Housing can be grouped into 3 broad categories: the low income, middle income and high income areas. The low income housing zones may be divided into indigenous and non-indigenous (dominantly migrant) areas. The low-

income indigenous housing areas comprise Osu, Jamestown, Adedenkpo, Chorkor, La, Teshie and Nungua. The low-income non-indigenous housing areas include Sukura, Kwashieman, Odorkor, Bubiashie, Abeka, Nima, Maamobi and Chorkor. Altogether these areas accommodate about 58% of Accra's population. Most of the informal businesses are located in low-income areas and they are the first place of abode for any new job-seeking migrant.

Slums, Illegal Settlements and Unauthorized Structures

Urbanization in Accra is at an annual rate of 4.2% and is still increasing with a heavy rural-urban drift to the city due to the comparative advantages of the Metropolis. This phenomenon has resulted in upspring of slums and haphazard development due to the gross inadequacy of low-income housing and accompanying infrastructure for the increasing population. About 90% of the populace of the slum dwellers falls within the low to very low income brackets (AMA, 2010).

This has led to the many slums that are currently present in the city. There are about Twenty- Nine (29) slum communities in Accra. Some of the slum settlements are Ga Mashie, Chorkor, Gbegbeyise, Mamobi, Sabon Zongo, Nima, Alajo, Ayidiki, Akweteman and Avenor. Some illegal settlements are Abuja, Sodom and Gomorrah (Old Fadama) and Babylon.

In addition to this challenge, there is also a growing number of unauthorized structures throughout the Metropolis. To solve this challenge, the Assembly undertakes demolition exercises to eliminate or reduce these unauthorized structures especially those on water ways. These unauthorized structures further increase flood risks in parts of the city.

4.9 Description of Study Communities

Alajo

A brief description of Alajo is given by Atuguba and Amuzu, (2006). The community is located just north of Kwame Nkrumah Circle (6 km from the Central Business District) and is home to over 80,000 Ghanaians, mostly members of the Ga tribe. The physical area of the neighborhood is relatively small, approximately one kilometre squared. Alajo has one of the highest population densities in the world. While Alajo is a vibrant and socially resilient community, it has several features inhibiting quality of life.

Several decades ago, Alajo was characterized 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. Alajo is home to families from various ethnic groups and exhibits a variety of housing types. For the most part, however, residents live in small single-story residences with shared dirt courtyards. Electricity is generally available, though it is often brought into homes through illegal wiring. Public standpipes provide water at a cost, and residents also purchase water from tanker trucks. The main thoroughfare, Alajo Road, is lined with small businesses crowded next to each other, and is congested by vehicular traffic and pedestrians traveling and transporting goods. There is little open space, and the community relies on the schoolyard as a gathering place.

A neatly-shaped triangle, Alajo is located at the confluence of the Odaw River and one of its major tributaries called the Onyasia River. The Odaw River has a watershed of about two hundred kilometre squared, and Alajo is located toward the downstream extents, about five miles upstream from the Korle Lagoon, where the river empties into the Gulf of Guinea. This location, bound between two major streams, presented annual flooding problems before the construction of the lined drains.

Figure 4.2 Google Image showing the location of Alajo

Glefe

Glefe, which is part of Accra, the capital city of Ghana, is located at 5.3180°N and 0.1001°W along the Gulf of Guinea. It falls within the western coastal geomorphic section of Accra (Appeaning Addo et al, 2008). The community is bounded on the north by the Gbugbe and Dzatakpor. The study area experiences significant differences in the amount and seasonal distribution of precipitation. It has two rainy seasons, with the major season between April and July, and the minor one between September and November. There is high population density in the community due to relatively lower rental values. The housing structure of the local population in the area is made up of sandcrete buildings which are indiscriminately built along the coast. Appeaning Addo et al (2011) found that these are likely to be destroyed in the event of coastal inundation. He reiterates that, if population density coupled with housing habit should keep on growing at the current trend in the area, the flood periods will pose a major disaster in the future and evacuation of vulnerable people would be difficult since the few routes separating the buildings would be choked up with flood waters. There are virtually no properly engineered drains in the community. Waste management practices are so bad that the community is engulfed in so much filth.

Glefe is low-lying and therefore has stagnant water pools in many parts (Appeaning Addo and Adeyemi, 2013). The township is situated on the barrier (sand bar) separating the sea from the Densu wetland. The population of Glefe consists mostly of fishermen and fishing is the main economic activity in the community and thus the main source of livelihood for the entire community (Amoani et al. 2012). Whilst the men are engaged in 'corporate fishing', the women work as fishmongers and provide other retail supporting services (selling of drinks, food). Most of the children provide fishing assistance to their parents, including the mending of torn nets.

Glefe and its environs experience relatively severe erosion (Amoani et al. 2012; De-Graft 2011; Oteng-Ababio et al. 2011). The area is considered to be extremely vulnerable (Anokwa, Martin & Muff 2005; Appeaning Addo et al. 2008; Appeaning Addo et al. 2011), due to the presence of unconsolidated as well as poorly consolidated sediment. The beach is made up of a long sand bar, traversing about 2 km of the coast. Glefe finds itself between its two lagoons, Gbugbe and Dzatakpor, and the sea. Glefe has a relatively open coastline that enables considerably strong,

unimpeded swell waves to reach the coast (Appeaning Addo, 2009) and to break obliquely, generating long-shore currents (Ly, 1980). The study area presently experiences severe flooding due to an upsurge in storm surge activities and tidal waves (De- Graft, 2011), which can be attributed to a relative sea-level rise as a result of climate change. A significant percentage of the population has lost property due to increased erosion and flooding (Campbell, 2006).

Figure 4.3 Glefe located in the Densu wetland area.

(Source: Adapted from Oteng-Ababio, Owusu, K. & Appeaning-Addo, K., 2011)

CHAPTER FIVE

FLOOD MITIGATION IN GLEFE AND ALAJO

5.1 Introduction

This chapter focuses on analysis of the data collected from the field. This was done to have a better understanding of issues concerning flooding in Alajo and Glefe. This was necessary since it gave deeper insight into the reasons why the prevailing circumstances existed in the study areas. Issues like the perceptions of households on causes of flooding, flood mitigation by households and institutions and the impact of flood mitigations measures were discussed. It was also useful since it served as a good basis for the next chapter that considered the summary of findings, conclusions and recommendations.

5.2 Flood Mitigation in Accra

Efforts have been made by various institutions to mitigate floods in Accra. Secondary data gathered showed that engineering solutions have been the main approach that has been used to deal with flooding in the capital. Occasionally, demolishing exercises are done to clear encroachers from sensitive areas like wetlands and water ways. Educational campaigns have also been adopted to sensitize people on the risks associated with floods. The Hydrological Services Department is in charge of ensuring that drainage improvement is done. Some of the floodable areas in Accra that have received interventions from the Hydrological Services Department (HSL) are listed below in Table 5.1.

Table 5.2 Floodable areas and intervention received

Floodable area	**Intervention/Mitigation measures**	**Remarks**
Avenor	Concrete lining	Quite successful
Kaneshie	Concrete lining, channel widening and deepening	Not effective
Odawna	Construction and concrete lining	Not effective
Mallam	Channel widening and deepening	Quite successful, more work needed
Santa Maria	Channel widening and deepening	Quite successful, more work needed
Sowutuom	Channel widening and deepening	Quite successful, more work needed

Floodable area	Intervention/Mitigation measures	Remarks
Industrial Area	Desilting	Temporal intervention
Apenkwa	Concrete lining	Not effective
Dansoman	Concrete lining	Quite successful
Sakaman	Concrete lining	Quite successful
North Kaneshie	Desilting and cleaning	Quite successful
Achimota	Channel widening and deepening	Needs serious construction
Alogboshie	Channel widening and deepening	Needs serious construction

Source: Field Survey. May, 2014.

5.3 Bio-Data of Respondents in study areas

In a bid to get a good understanding of the issues emanating from the problem and also get the appropriate primary data, it was imperative to obtain the bio-data of the respondents in order to put their various concerns into perspective. Due to the severe nature of the flooding situation in the study areas, it was important to interact with respondents who were old enough to give a good account of issues, preferably home owners.

In Alajo, all the respondents that were contacted were above 25 years of age. This was appropriate since those within that age group were old enough to give an account of how the flooding situation was in Alajo before the construction of the drain. In Glefe, all the respondents were also above 25 years of age. This was appropriate since respondents gave clear and relevant information concerning the issues being investigated. Majority of the respondents surveyed in Glefe were female (59%) while the remainder was males. There was a similar situation in Alajo with the female respondents constituting 61% while the remainder was males. In both communities studied, there was a mixture of different ethnic groups co-existing serenely. In both communities, Akans and Gas formed the majority of residents while the rest were Ewes and groups from the northern part (Upper East, Upper West and Northern regions) of the country. Only about three percent (3%) were foreigners from other African countries. This information is important to give one an idea of the ethnic diversity that exists in the communities. This is relevant since it informs that social cohesion within the communities. Community based approaches to flood mitigation rely on the degree of cooperation and cohesion within the community.

Respondents in both study communities were mainly traders, students, artisans, private businessmen and businesswomen as well as civil servants. Eighty one percent of respondents in Glefe were actively employed and about 70% of Alajo respondents were actively employed. However, five percent (5%) and nine percent (9%) were unemployed in Glefe and Alajo respectively. The remainder was made of students and homemakers. Respondents contacted were mostly of middle and lower class income levels and this is reflected in the educational attainment of the people. In Glefe, about 32% were SHS leavers while in Glefe, 34% were JHS leavers. A meager one percent (1%) in Alajo had been educated up to the tertiary level. Eight percent (8%) in Alajo had never had any formal education while in Glefe 18% had also never been to school. The educational level has a relation with the individual's behaviour towards community development and flood mitigation. In Glefe, there was total disregard for the hazardous environmental conditions.

With regards to tenancy, respondents were free occupants, tenants, caretakers, relatives to owners or owners themselves. The tenancy is important because it is reflected in other issues such as maintenance of building as well as waste management. Seven percent (7%) in Alajo were free occupants of the houses they lived in, while 32% were tenants. Majority of the respondents were owners of the houses consisting about 35%. In Glefe, a majority of 48% was owner occupants and about four percent (4%) were free occupants. About 30% in Alajo were tenants.

5.4 Causes of flooding in Study Areas

One major objective of this study was to find out the causes of floods in the study communities. This was important because the causes revealed would be critical to help in policy making. It is also essential because it would aid stakeholders to plan and mitigate the effects of floods. The respondents in the two communities were surveyed to know from their own perspectives, what they thought were the main causes of flooding. With regards to Alajo, it was observed that an intervention in the form of drain construction had been made, so respondents were asked to recall what they thought was the major cause of flooding in the community before the intervention. In Glefe, it was observed that no major intervention had been made so the respondents were asked to identify what they thought was the major cause of flooding.

5.4.1 Causes of flooding in Alajo

Previously, Alajo was known as one of the worst hit areas anytime flooding occurred in Accra. Respondents explained that, many years back, the smallest amount of rain could cause serious flooding in Alajo. The community is located in between two water bodies, Odaw and Onyasia rivers, and was very vulnerable to flooding. Therefore, houses that were close to the water bodies were easily flooded anytime it rained. The respondents identified the major cause attributed to flooding in the Table 5.2 below.

Table 5.2 Major cause of flooding according to respondents in Alajo

Perceived cause of flooding	Frequency	Percent (%)
Building in water course/water way	0	0
Bad refuse disposal methods	7	7
Building on reclaimed land	6	6
High tidal waves	0	0
Improper planning	0	0
Poor drain construction	17	17
Choked drains	13	13
Low lying nature of land	3	3
Hard landscaping/impervious surfaces	6	6
No idea	4	4
Overflowing of river	44	44
Sand winning	0	0
TOTAL	**100**	**100**

Source: Field Survey. May, 2014

The interaction with respondents revealed interesting views on the causes of flooding in the community. Various reasons accounted for flooding but in the situation of Alajo, it was obvious that the overflow of nearby rivers or water bodies was the main cause of flooding in Alajo as revealed from the secondary data gathered. This is corroborated by the 44% responses that said that the cause was due to the overflow of the nearby water bodies namely, the Odaw and the Onyasia. Other important causes that respondents identified were the poor construction of drains and choked drains which accounted for 17% and 13% respectively. The dumping of refuse in the water bodies were also considered as accounting for siltation of the rivers which also

resulted in the overflow of the rivers. About four percent (4%) had no idea what was causing the floods.

5.4.2 Causes of flooding in Glefe

Glefe's beach is made up of a long sand bar traversing about 2 km of the coast, behind which are two lagoons locally known as Gbugbe and Dzatakpor. The sand bar is only partially divided into an eastern and western section by the Panbros salt production area (Amoani et al. 2012). Although erosion is evident on the entire beach, its signature is mostly seen on the eastern section, where the width of the sand bar is greatly reduced and Glefe is suffering from the consequences of erosion. The western section, though also experiencing erosion, has a wider sand bar (about 80 m wide) with its back beach heavily carpeted by grass. Glefe suffers gravely from flooding all year round. An interaction with the assemblyman revealed that the actual Glefe town is under the sea due to coastal erosion. Figure 5.1 shows the location of Glefe on the drainage map of Accra. The various causes of flooding identified during the field survey are discussed below.

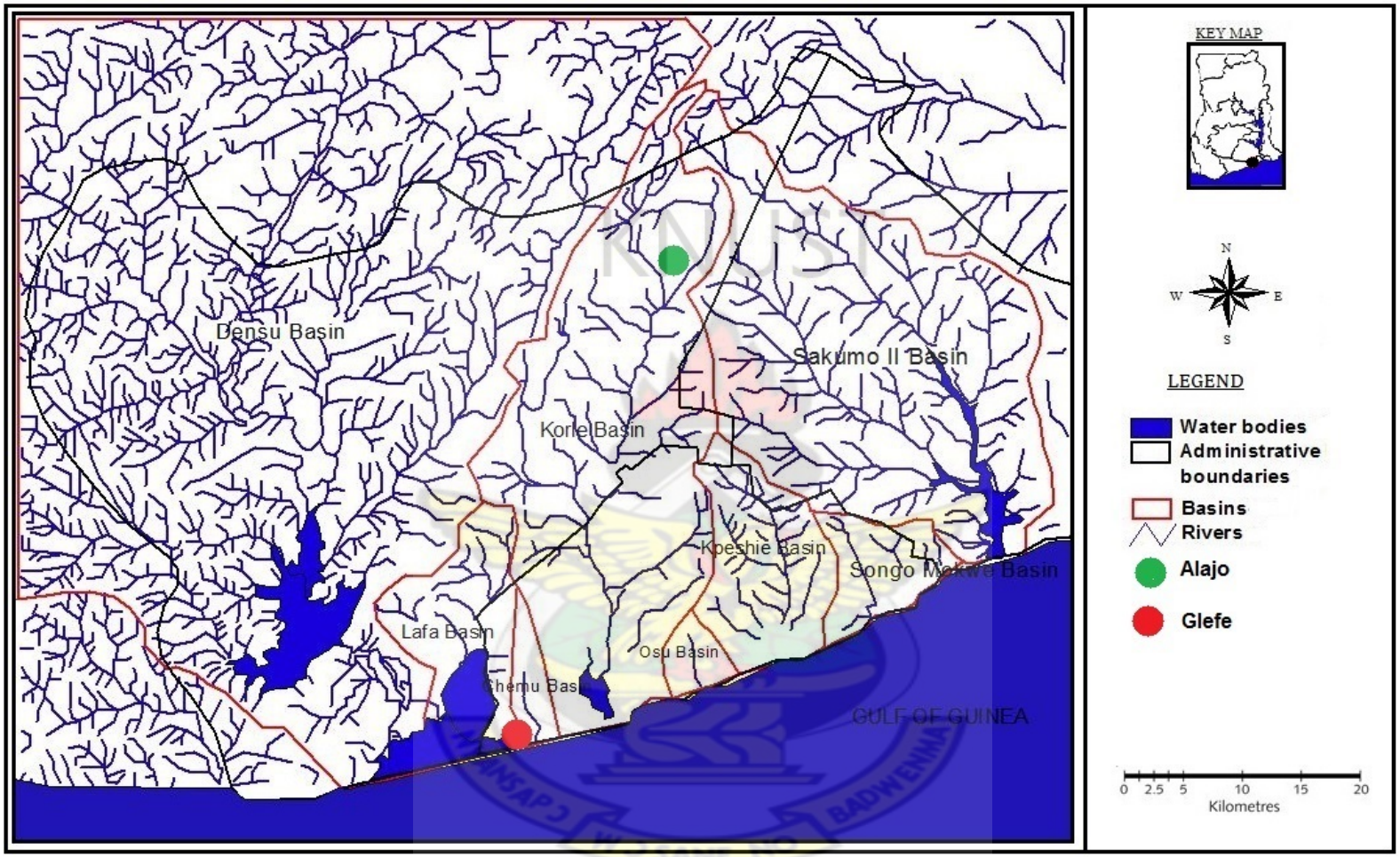

Figure 5.1 Drainage pattern of Accra.
Source: Author's construct

High Tidal Waves

High tidal waves create a big problem to residents of Glefe. When the waves are very high, the sea water comes into the built up area where there are houses and they get flooded. In addition to the unfavourable relief of the area, residents are also compounding the existing problems by engaging in certain activities. The people of Glefe depend on the beach for so many purposes. There is no sea defence mechanism to prevent the sea water from entering the homes of community members as shown in Figure 5.2 and 5.3. A defence mechanism is needed to protect the coast. The community is at the mercy of the tidal waves and becomes helpless anytime the waves are very high. A walk through the community shows that there is beach sand in most compounds.

Figure 5.2 Vulnerable state of the Glefe beach.

Source: Field Survey. May, 2014

Figure 5.3 Sand bar separating the sea from the lagoon in Glefe.

Source: Field Survey. May, 2014

Sand Mining

There is a lot of sand mining activity along the shore and this is rapidly eroding the shoreline, hence making high tidal waves flood the main land easily. The state of the already vulnerable coast is being deteriorated by this activity. One main reason for the excessive sand mining is for the construction of houses for the ever increasing population. The increasing population may also be attributed to the relatively low rental values in the area. Though sand mining activities have been prohibited and strict regulations are in place to ensure compliance at the district level, some residents still engage in the activity as seen in Figure 5.4. However, the absence of enforcement encourages those from other communities to join in this activity.

Figure 5.4 Sand mining at Glefe beach.

Source: Kwadwo Amoani Kwasi Appeaning-Addo, Wahab Laryea (2011)

Creation of Embankment

Figure 5.5 shows an embankment that has been created by the Panbros Salt Company to separate the lagoon water from their waters. The embankment was created to prevent the lagoon waters from polluting the water used for salt production. In dire cases when it rains heavily and the lagoons get full, the men in the community excavate the tunnel under the embankment to allow the excess water from the lagoon to flow out. This brings about conflicts between the community's men and Panbros Salt Company.

Figure 5.5 Embankment separating lagoon in Glefe from Panbros Salt Ponds.
Source: Field Survey. May, 2014

Land Reclamation

Residents are also engaged in serious land reclamation. The lagoons in the community have been encroached upon severely as shown in Figure 5.6. Due to loss of houses and other properties to the sea, many residents reclaim the land by filling the lagoon gradually with refuse and building on it. This reduces the capacity of the lagoons to hold water and any small downpour results in floods. The reclamation exercise greatly affects the Gbugbe and Dzatakpor lagoons. They are heavily polluted with refuse and serve as breeding grounds for mosquitoes. When it rains heavily and the lagoon gets full it has no outlet into the sea, therefore men in the community have to excavate channels for the water to flow out into the sea. Though this is done the outlet easily get filled up with sand and the people need to dig it up again.

Figure 5.6 Lagoon reclaimed for development in Glefe.

Source: Field Survey. May, 2014

Poor Sanitation

In addition to the reasons already discussed, the sanitation situation in Glefe is so appalling. Refuse is thrown haphazardly and the community is gutted in so much filth as seen in Figure 5.7. Community members stay in this filth without any regard for their health. The refuse generated is used for reclaiming land and for filling areas that easily get flooded. The community is so engulfed in rubbish and the temporary drains that have been constructed by community members are all choked. This contributes

directly to the flooding problem since the poor drainage system is further deteriorated by poor sanitation and exacerbates the effects of floods.

Table 5.3 Waste Disposal Methods in Glefe

Waste Disposal Method	Frequency	Percentage
Public Dump Site	80	53
Door to door	6	4
Dumping in drains/gutters	6	4
Burning	8	5
Burying	14	9
Dumping in nearby water body	38	25
Other	0	0
Total	**150**	**100**

Source: Field Survey, May 2014.

Table 5.3 confirms the extent to which the water bodies in the community are being polluted. About 25% of the respondents dump their refuse in the lagoons and this contributes to the serious breeding of mosquitoes in the community. A walk through the community in the evening shows how serious the mosquito infestation is. The continuous dumping of refuse in the lagoons would eventually cause the lagoons to shrink in size and finally dry up. A critical intervention should be made to stop the dumping in order to save the lagoons which form an important part of the ecosystem.

Figure 5.7 Poor waste management in Glefe.

Source: Field Survey. May, 2014

Poor Drainage System

Glefe suffers from a chronic lack of drainage facilities. The drainage situation in the community is so bad. There are no properly designed gutters and this has resulted in ponds of water all over even when it has not rained. Domestic waste water is readily disposed of in the open. The temporary drains constructed were also not in good shape. A discussion with the assemblyman revealed that a project dubbed Mamponse Infrastructure and Upgrading Project was implemented in nearby Mpoase and other areas. This project focused on roads and drainage. Glefe residents did not benefit from this project. All the drains were linked into the lagoons, thus no outlet into the sea. This also causes the lagoon to easily get full and overflow and inundate the adjoining dry land. Figure 5.8 shows the poor condition of drains in some part of the community.

Figure 5.8 Poor drainage in Glefe.

Source: Field Survey. May, 2014

Causes of flooding as Identified by Community Members

Upon surveying the residents in Glefe, they expressed what they thought were the causes of flooding in their community. From Figure 5.9, the highest proportion of respondents (38.7%) attributed the flooding to the poor drainage in the community. A walk around the community shows that there are parts of the community without any drains at all. Other parts with drains still have problems because they are choked with

rubbish and do not allow free flow of water. The lack of proper drainage in Glefe is very threatening. Another cause that was observed during the field observation was the high tidal waves causing sea water to enter the main land and this is also corroborated with about 13% agreeing that it was one major cause of flooding in the community. An issue like sand mining which was observed on the field as very crucial was identified by only about one percent (1%) of respondents as the main cause of flood in the community. None of the respondents thought that the increase in impervious surfaces contributed to flooding in Glefe.

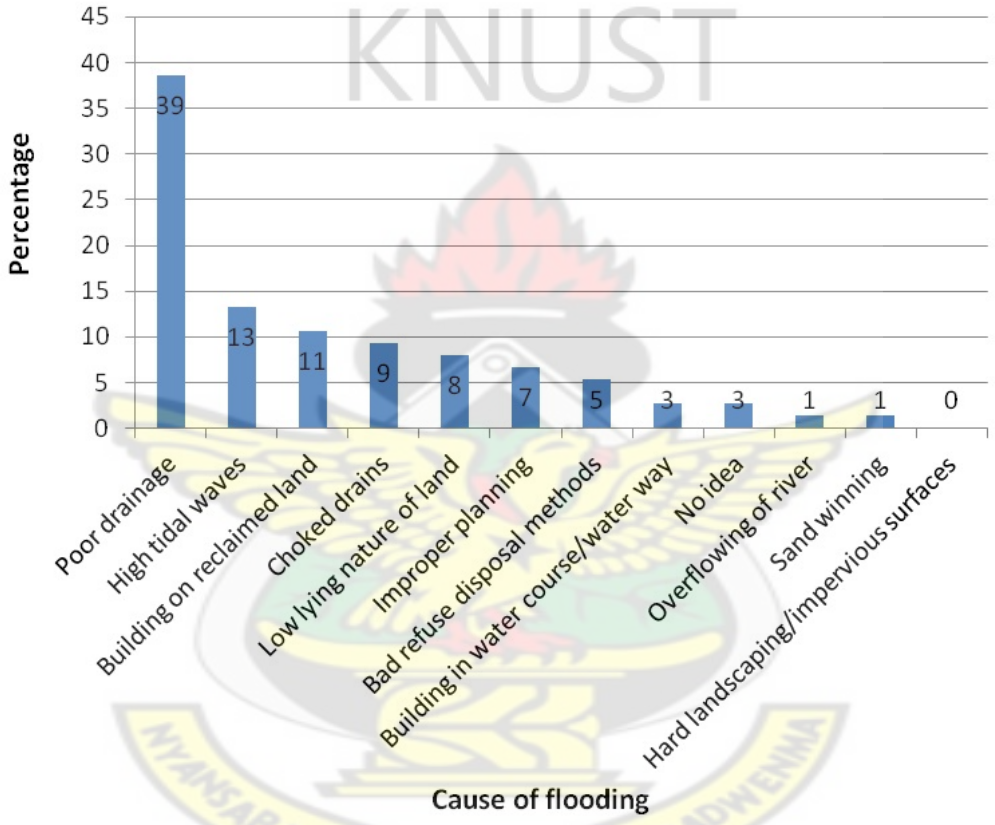

Figure 5.9 Major cause of flooding according to respondents in Glefe.
Source: Field Survey. May, 2014

Weija Dam Spillage

Residents whom are already in a dire situation have to endure more disaster anytime there is a spillage from the Weija Dam. The Ghana Water Company Limited opens the gates of the dam any time it reaches its limit. This is done in order to protect the facility. During dam spillage, some communities are affected and Glefe is one of the unfortunate communities. A recent spillage in June 2014 affected Glefe and Opetekwei both in the Ga South Municipality. The situation was so severe that the

residents were compelled to pack their belongings to safety. The experiences people had with flooding were sampled as shown in the next section.

5.5 Effects and experience of Flood

The respondents were asked if their houses or properties had ever been affected by flood waters.

Table 5.4 Household's experience with flooding

		Community				Total	
		Glefe		Alajo			
		Frequency	%	Frequency	%	Frequency	%
Household's experience with flooding	Yes	124	82.6	94	94	218	87.2
	No	26	17.4	6	6	32	12.8
Total		**150**	**100**	**100**	**100**	**250**	**100**

Source: Field Survey. May, 2014

Table 5.4 shows that in Glefe, about 82% had encountered flood waters before. During the field observation most of the buildings were in poor condition and had marks of water levels on the walls (see Figure 5.10). The smaller proportion of about 18% of the respondents in Glefe who had not experienced flooding before gave various reasons. Some were lucky to live on the higher floors in storey buildings and were safe from flood so their personal properties were not affected when it flooded. Some respondents had raised the foundations of their buildings so were not affected during floods. In Alajo, about 94% had experienced flooding before the drain construction. Only six percent (6%) in Alajo were never affected when flooding used to occur. Though flooding has its adverse effects, some community members had various reasons for continuous stay in flood prone areas.

Figure 5.10 Wall affected by flooding in Glefe.
Source: Field Survey. May, 2014

5.5.1 Reason for continuous stay in flood prone area

With the continuous threat to lives and property, some residents had no plans of relocating elsewhere. In both communities, the respondents who had actually experienced flooding before were asked reasons for still staying in the community. Though residents in Alajo were no longer experiencing flooding at the time of the survey they were asked about the reasons why they did not relocate when the community used to get flooded. In Glefe, the respondents were asked about reasons for not relocating despite the flooding. From Figure 5.11, it is clear that the residents in Glefe stayed mainly because of low cost/affordability of housing, social /family ties and proximity to work place. These are very strong reasons which made it difficult for them to move. This was not surprising since most of the residents were low income workers who usually prefer to stay close to the work place. The rental values in Glefe are quite low as compared to other communities within the district. In Alajo, it was also shown that affordability of housing, proximity to work as well as social ties were major reasons why they stayed during the times flooding used to occur. This importance attached to the various issues mentioned is worth noting since they inform the location of people. Any intervention to be made concerning flooding must consider these factors.

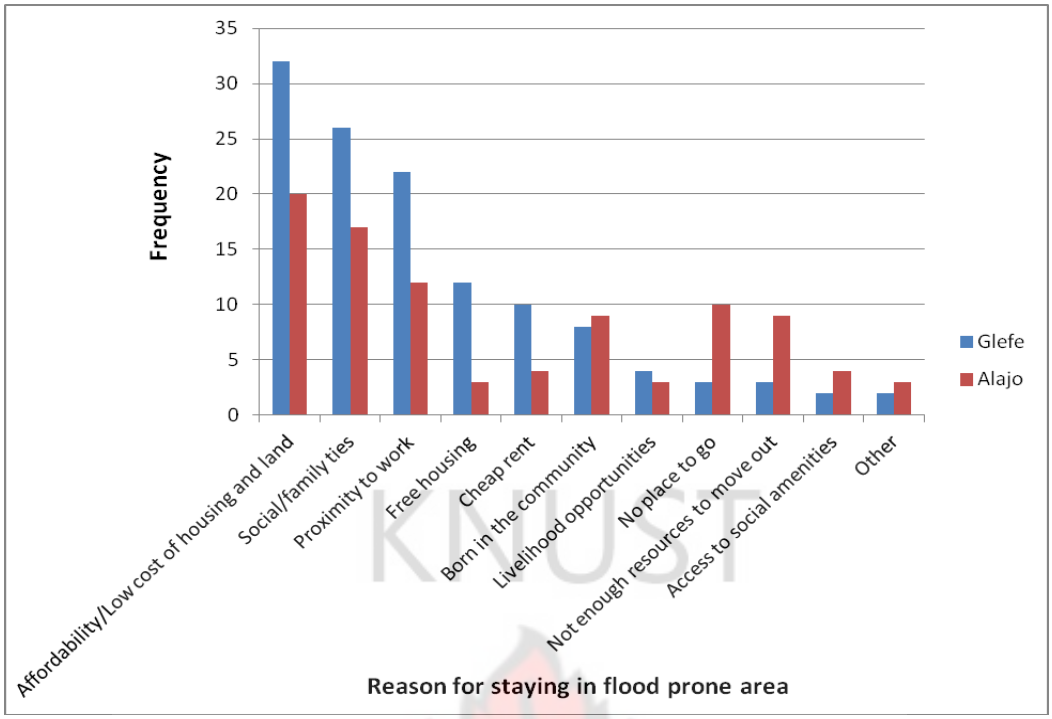

Figure 5.11 Reasons for still staying in flood prone area.

Source: Field Survey. May, 2014.

Willingness to move to better location outside Glefe

Respondents in Glefe were asked further questions concerning their stay in the community. They were asked about their willingness to move to another community free from flood if they had the opportunity.

Table 5.5 Willingness to relocate elsewhere from Glefe

Response	**Percentage**
Yes	68
No	32
Total	**100**

Source: Field Survey. May, 2014

From Table 5.5, about 68% of the respondents were willing to move to a better location once the opportunity was presented to them. This is encouraging since it is a sign of the desire to enjoy better living and environmental conditions. This is essential to inform policy so that when an intervention to improve their conditions is drafted, there would be support from the people. The remaining 32% were ready to remain there for reasons like low rent, social ties and proximity to work. Respondents were further asked why they were willing to relocate. From Figure 5.12, the major reason was the fact that the floods were a major hindrance to comfortable living.

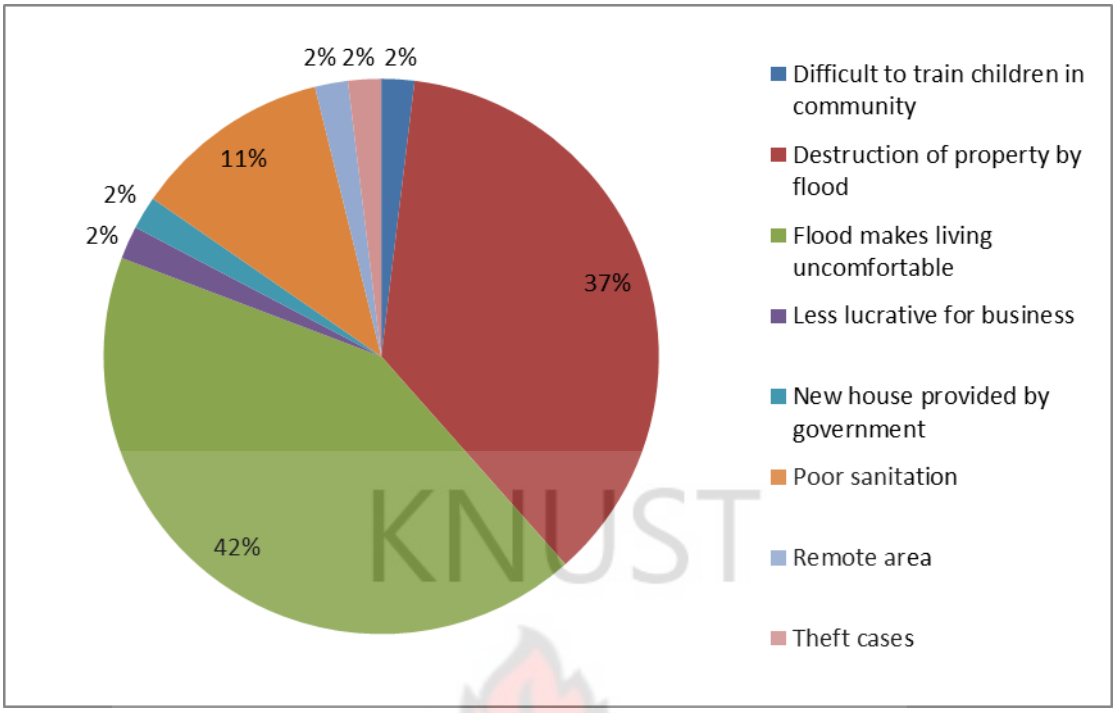

Figure 5.12 Willingness to relocate elsewhere from Glefe

Source: Field Survey. May, 2014.

Others also cited destruction of property especially household items like fridges and television sets. They had to buy these items anew any time there was a flood that carried away their belongings. Respondents in Glefe were further asked about the reports they made to city authorities when flooding occurred.

5.5.2 Reports to Authorities about floods in Glefe.

Respondents were asked whether they reported flooding incidents to city authorities. They gave some reasons for not bothering to report cases. In cases of loss of lives or people getting missing, they reported to the District Police.

Table 5.6 Report of floods in Glefe to authorities

Response	**Frequency**
Yes	41
No	59
Total	**100**

Source: Field Survey. May, 2014

From Table 5.6, a majority of 59% did not report flood occurrences to any institution due to the lack of trust to intervene. They also mentioned that at certain times, some people from the city authority actually came to assess the situation and made promises only to return no more. Politicians also visited them after floods and made promises

only to disappoint them. In situations when floods occurred, 41% of respondents mentioned that they reported the cases to some agency or institution.

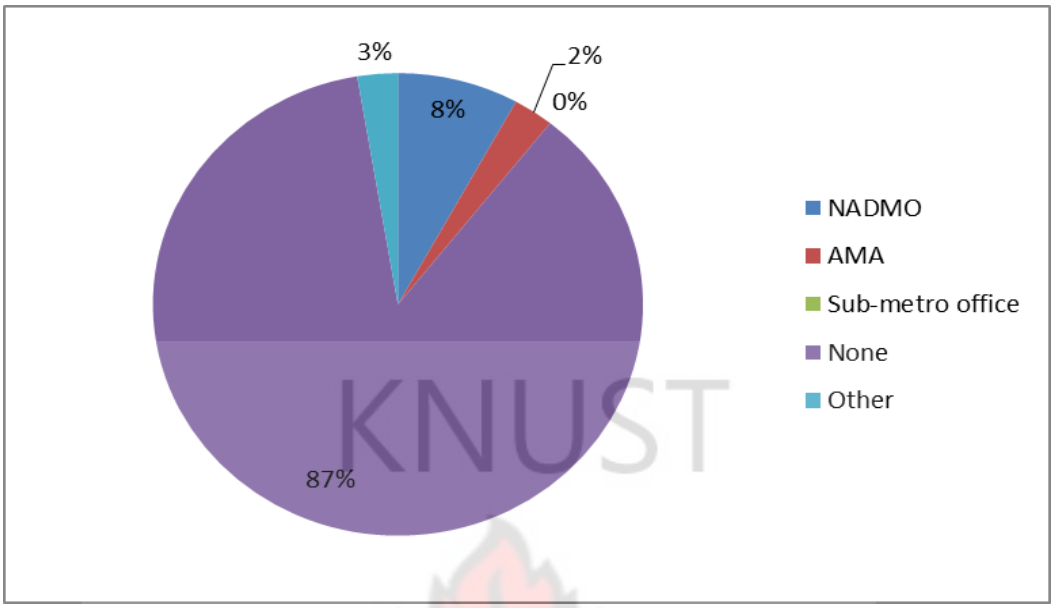

Figure 5.13 Institution/Agency that flood cases in Glefe are reported to.

Source: Field Survey. May, 2014.

From Figure 5.13, the main office that received reports from residents in Glefe was NADMO. AMA also received reports and complaints about losses. About three percent (3%) also explained that they made reports to the assemblyman, Member of Parliament (MP) for the constituency or chief when flooding occurred. About 87% of the respondents declined to report any case to any institution. Some mentioned that the media was always around to cover the story and they did not bother themselves to report. Others just believed that nothing would be done about the situation so there was no need making a report. For instance, the recent spillage by GWCL at the Weija Dam caused some flooding in Glefe and an interview with some people revealed that NADMO representatives came around to assess the situation but left without doing anything concrete and have never returned after that. This shows the amount of mistrust that the people have in the authorities. Respondents also mentioned that some aid was given in times of floods from NADMO. They gave them relief items like food, building materials, blankets, medicine and mattresses. The various effects of flooding on the people are also captured in the next section.

5.5.3 Effects of Flooding

Flooding causes a lot of damage especially when there is no protection against it. Respondents in Glefe and Alajo were asked how they were affected when there was flood. With the Alajo, respondents, they were asked to recall how they were affected by floods when they used to happen in the community. Since Glefe experiences flooding currently, they gave a vivid description of how they are affected.

Table 5.7 Effects of flooding in communities

		Community				Total	
		Glefe		Alajo			
		Freq	%	Freq	%	Freq	%
Effects of flooding	Outbreak of disease	56	38	4	4	60	25
	Personal injuries	21	14	1	1	22	9
	Collapse of building	15	10	3	3	18	8
	Disruption of activities (e.g. schooling for children)	18	12	5	5	23	10
	Loss of household items (e.g. TV, fridge, furniture, etc.)	12	8	55	59	67	28
	Loss of livelihood/income generating activities (e.g. home-based industry)	10	7	5	5	15	6
	Disruption of services (e.g. electricity, water, etc.)	2	1	3	3	5	2
	Other	6	4	10	11	16	7
	Not affected	6	4	8	9	14	6
Total		**146**	**100**	**94**	**100**	**240**	**100**

Source: Field Survey. May, 2014

Table 5.7 shows that in Glefe, the most significant way in which people were affected by floods was the outbreak of diseases represented by 38%. The poor sanitary condition in the community compounded the problem. Community members complained of serious attacks from mosquitoes in the evenings. Due to the poor drainage system, there are many small pools of water which serve as breeding places for mosquitoes. Residents in Glefe also suffer from personal injuries when it floods. They further complained of disruption of activities like schooling for their kids since it is difficult to move around after floods occur. They explained that flood waters could take days, weeks or even a month to subside and this was a big problem in Glefe. Another way they are affected was the cut of electricity. Anytime there was

flooding, community members had to call the authorities of the Dansoman branch of Electricity Company of Ghana (ECG) to cut power supply to ensure safety. There had been cases where some residents suffered electric shocks after floods. One other effect of flooding was the loss of homes by some residents. Residents who lost their homes resorted to reclaiming land by filling the Gbugbe and Dzatakpor lagoons and associated wetlands, leading to gradual loss of the lagoons. In Alajo, the major problem at the time of floods was loss of household items.

5.6 Flood Prevention and Management

Coping Strategies

The issue of how respondents were coping with flooding was discussed during the study. Respondents shared what they did when they suspected floods would occur, what they actually did during floods and what they did after the floods.

Table 5.8 Immediate action upon suspicion of flooding in community

		Community				Total	
		Glefe		Alajo			
		Freq	%	Freq	%	Freq	%
Immediate action upon suspicion of flooding	Dig trenches to drain water away	12	10	2	2	14	6
	Ensure safety of children	2	2	7	7	9	4
	Fill compound with sand bags	34	27	5	5	39	18
	Inform household members	2	2	2	2	4	2
	Leave house and go to a safe place	0	0	9	10	9	4
	Lock doors and stay inside	2	2	2	2	4	2
	Do nothing	54	44	13	14	67	31
	Pack things and leave	12	10	19	20	31	14
	Pack valuables and keep at a safe place	0	0	32	34	32	15
	Pray to God that rain does not fall heavily	6	5	0	0	6	3
	Raise an alarm	0	0	3	3	3	1
Total		124	100	94	100	218	100

Source: Field Survey. May, 2014

Table 5.8 shows the immediate actions that respondents took any time they suspected that floods would occur. A large majority (44%) in Glefe actually did nothing when

they suspected floods would occur. Others were proactive to fill their compounds with sand bags. Some also decided to dig trenches before the floods started while others just packed valuables and left for safer places. In Glefe, some actually resorted to prayers and pleaded with God to spare them the heavy rains. In Alajo, when they suspected heavy rains, the majority of them packed their valuables and moved to safer havens.

Table 5.9 Action during flood in communities

		Community				**Total**	
		Glefe		Alajo			
		Freq	%	Freq	**%**	Freq	**%**
Action during flood	Collect water with buckets	12	10	5	5	17	8
	Dig trenches	26	21	5	5	31	14
	Ensure safety of children	8	6	3	3	11	5
	Fill compound with charcoal	2	2	2	2	4	2
	Fill compound with sand bags	16	13	8	9	24	11
	Lock myself in my room	4	3	4	4	8	4
	Move to a safe place	12	10	11	12	23	11
	Do Nothing	28	23	40	43	68	31
	Pack stones and use as path	2	2	0	0	2	1
	Pack valuables and keep at a safe place	10	8	8	9	18	8
	Stay above the ground	4	3	8	9	12	6
Total		**124**	**100**	**94**	**100**	**218**	**100**

Source: Field Survey, May 2014

Table 5.9 also shows that a large majority of respondents just did nothing during the actually flooding while others filled their compounds with sand bags. A small proportion also ensured the safety of their children first before anything else. During the time that floods happen, some respondents just lock themselves in their rooms.

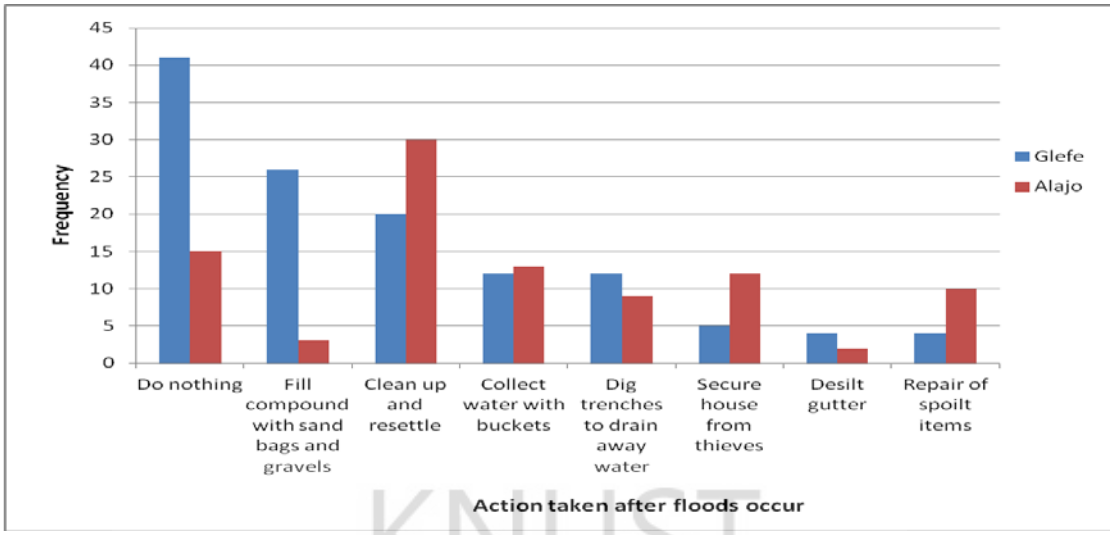

Figure 5.14 Action taken after the floods occur.
Source: Field Survey. May, 2014.

In Glefe, after floods occurred most residents did nothing and just waited patiently for the water to subside gradually. Figure 5.14 shows the various actions taken after the floods in both communities. Respondents in Glefe who currently suffer from floods due to many causes where asked about their thoughts concerning flood prevention and management. This is important because it helps explain why there are some actions and inactions on the part of the community members.

5.6.1 Belief in Flood prevention

In Glefe, where flooding is still prevalent, 88% believed that flooding could be prevented. The remaining percentage gave various reasons as to why they thought nothing could be done concerning flooding. Furthermore, respondents in Glefe were asked about what they perceived could be done to prevent or mitigate floods in their community.

Table 5.10 Respondents view of how flooding can be prevented in Glefe.

Intervention	**Percentage**
Construction of sea defence	15
Cessation of sand mining	3
Improvement of drainage system	49
Prevention of building in waterway	6
Fencing of houses	2
Filling floodable areas with stones	3
Reduction in heavy rain stops	4
Improved waste management	5
Informing agencies for help	2
No idea	5
Proper planning	5
Total	**100**

Source: Field Survey. May, 2014

From Table 5.10, a great percentage advocated for improved drainage in the community and the construction of a sea wall. Five percent had no idea of what should be done but still believed that flooding could be prevented. Twelve percent of the respondents in Glefe also did not think the flooding in the community could be dealt with.

Table 5.11 Reason respondents think flooding cannot be prevented in Glefe.

Reason	Percentage
No idea	30
Increasing population and poor sanitation	11
Indiscipline	11
Natural disaster	14
No assistance to prevent	11
No capacity	6
Sea is stronger than sea defence	17
Total	**100**

Source: Field Survey. May, 2014

Table 5.11 shows that 30% of the respondents had no idea yet they still believed flooding could not be prevented. About 14% agreed that it was a natural disaster and it would be difficult for man to do anything to significantly reduce it. Six percent (6%) agreed that they did not have the capacity to prevent flooding so would rather not think of trying to prevent it. These perceptions explain why some residents think their situation concerning flood prevention is hopeless.

5.6.2 Flood Mitigation by Households

Some residents in Glefe who were quite proactive had actually put in mitigation measures to reduce the effect of floods. About 40% of the respondents had put in some measures to protect their household members as well as their properties from the devastating effect of floods. The remaining 60% had not put in any concrete measures to safeguard themselves from floods. The ones who did not put in any mitigation measures gave various reasons. Thirty six percent explained they could not afford the cost associated with mitigating floods. Others had plans to relocate from the community so did not want to invest any money into flood mitigation. Six percent of respondents mentioned that the flood did not affect them so severely so they were not troubled. Twenty four percent also were of the view that flood mitigation was the responsibility of the government and the assembly.

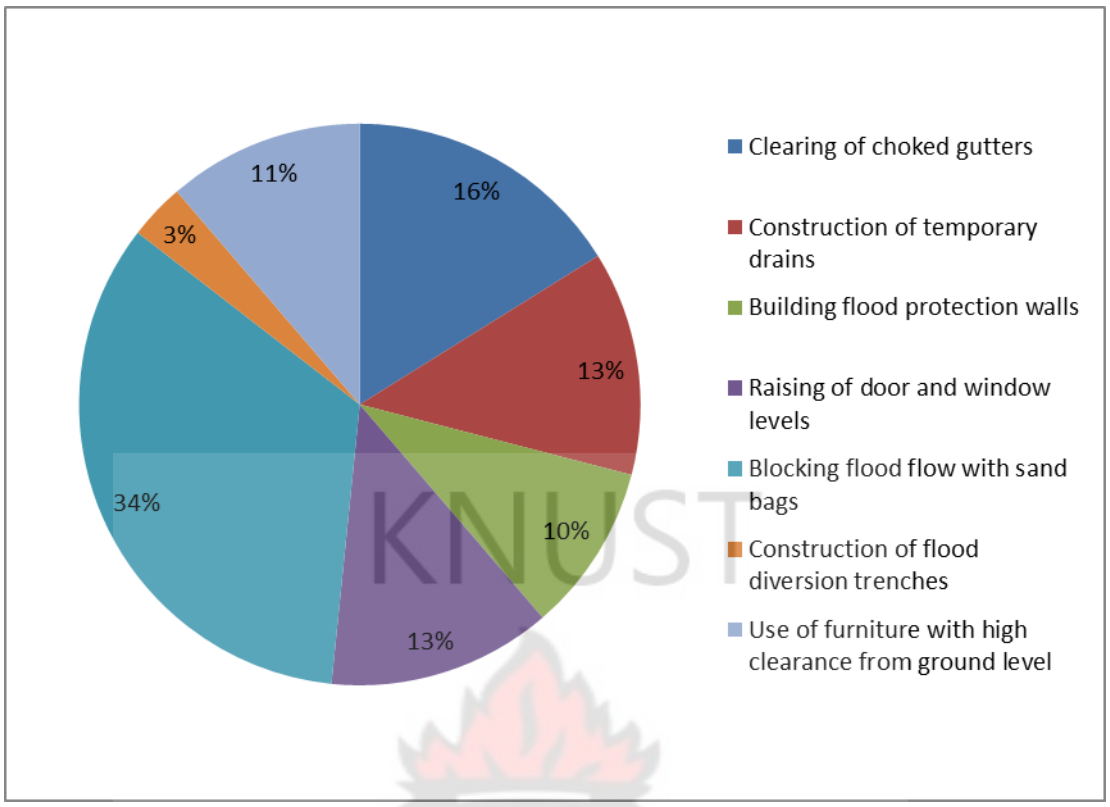

Figure 5.15 Flood mitigation measures by households in Glefe.

Source: Field Survey. May, 2014.

In Glefe, majority of about 34% used sand bags to block the flood waters as shown in Figure 5.15. A minority of three percent (3%) actually constructed flood diversion trenches to safeguard their properties. Other means by which they mitigated floods were by constructing temporary drains, clearing choked gutters, building flood protection walls, raising door and window levels as well as using furniture with high clearance from the ground. These measures put in place were useful in some situations but no quite effective in others. The success of the measures used is shown in a later section.

5.6.3 Flood Mitigation by Responsible institutions

In both communities, respondents were asked to identify mitigation measures that government or other agencies had implemented to reduce the effect of floods. In Alajo, it was very clear and obvious that storm drains had been constructed on both sides of the town. The Onyasia River and Odaw River had been lined with concrete and this project was done purposefully to redeem Alajo from the perennial flooding they used to experience. Figure 5.16 shows a section of the Odaw drain.

Aside the main storm drains that had been constructed to save the bad situation, smaller drains that run through the community had been constructed to improve the drainage in the community. Aside the main construction, public education was done to ensure that the drains were maintained and not used as refuse dumps. Desilting of the drains was also embarked on periodically by the Hydrological Services Department. In brief, Alajo had seen a major intervention from the government in the form of drain construction to mitigate the effect of floods.

Figure 5.16 Storm drain in Alajo (Odaw).

Source: Field Survey. May, 2014.

In Glefe, it was a totally different situation since the government had not implemented any major intervention to save the situation. NADMO officials had done some public education on flooding on how to protect themselves when floods occurred. Residents intimated that many people had come to the community to study the flooding situation but had not helped them in any significant way. The residents of Glefe were really suffering and lamented bitterly about the non-response of the government after numerous complaints. The situation in Glefe was being compounded by activities of residents. The various deleterious activities of some residents in Glefe like reclaiming the lagoons for building construction as well as using it as a refuse dump were making the problem worse. A detailed study of the beach topography at Glefe revealed a relatively low elevation beach with elevation between 1.5 metres and 2 metres (Appeaning Addo and Adeyemi, 2013). There is no sea defence to protect the coast.

High tidal waves easily cause sea water to enter the homes of residents and flood them.

Residents complained that, when the sea water enters the community, it does not have any outlets so upon observation, it is seen that the communtiy is dotted with so many ponds and pools of water (see Figure 5.17). Such pools of water serve as breeding places for mosquitoes. Most houses have beach sand in their compounds.

Figure 5.17 Stagnant water from sea in Glefe.
Source: Field Survey. May, 2014.

Figure 5.28 Choked drain in Glefe.
Source: Field Survey. May, 2014.

The poor state of drainage in the community had also not received any attention from the government or any institution. There are no well designed and properly constructed drains within the community. The few drains or trenches that have been made are either not well networked or are choked with rubbish (see Figure 5.18). This lack of proper drains also inhibits the easy disposal of waste water. Many homes dispose of black and grey water on open surfaces.

5.6.4 Mitigation efforts by community members in Glefe

Community members were asked about efforts they had made to mitigate floods as a community. Much effort had not been made since about 38% said some effort had been made. Some attempts had been made by community members to get rid of the filth in the community but this was not regular. The state of sanitation in the community was very bad. The lagoons had been used as refuse dumps, rubbish was all over the place and members were not making frantic efforts to change the situation. One major thing that the youth of the Glefe community did was to excavate the tunnel under the embankment to create an outlet for the lagoon anytime it got full in order to reduce the effect of the flood. Some community members also dug trenches to serves as temporary drains within the community.

5.7 Impact of interventions

After all efforts made by both institutions and household, respondents were asked to evaluate the interventions and give their opinion as to whether there has been a success or a failure.

5.7.1 Impact of intervention in Glefe

In Glefe, about 20% of respondents who had tried to mitigate floods at the household level said there was some success. They explained that the mitigation measures put in place by the household was able to reduce the effect of floods on their lives and properties. The remainder of about 80% said the mitigation measures they put in place were not successful. They gave some reasons why they thought they had failed. Some explained that the floods were too severe and they needed proper engineering solutions to the problems.

When asked about the mitigation measures that were put in place by city authorities or other agencies, Alajo enjoyed a far higher success rate than Glefe. From the perspectives of Glefe respondents, no major intervention was made thus; a very small

degree of success in terms of mitigation was realized. From Table 5.12, about only six percent (6%) of respondents in Glefe thought that the public education and some other activities embarked on by the city authorities had helped reduced flooding in the community. The remainder thought that the government had failed and needed to come to their aid with better solutions. The degree of success according to respondents is shown in Table 5.13.

Table 5.12 Success of mitigation measures by the government

		Community				Total	
		Glefe		Alajo			
		Freq	%	Freq	%	Freq	%
Success of mitigation measures by the government	Yes	2	6	94	94	130	96
	No	34	94	6	6	6	4
Total		36	100	100	100	136	100

Source: Field Survey. May, 2014

Table 5.13 Degree of success of government mitigation measures

		Community				Total	
		Glefe		Alajo			
		Freq	%	Freq	%	Freq	%
Degree of success of government mitigation measures	Average	2	100	3	3	5	5
	Successful	0	0	20	21	20	21
	Very successful	0	0	71	76	71	74
Total		2	100	94	100	96	100

Source: Field Survey. May, 2014

5.7.2 Impact of intervention in Alajo

From Table 5.12 Alajo had a totally different story where about 94% of the respondents thought that the construction of the storm drains and the general drainage improvement within the community was a big success. Alajo used to be a very high risk flood prone area, but after the intervention, the community has been free from floods. The six percent (6%) who still had issues were those at a section of the Onyasia drain where the construction ended. Residents there complained that the place easily got flooded when there was heavy rainfall. Figure 5.19 shows the area at the end of the drain that still floods.

Figure 5.19 Floodable area at a section of Onyasia River.

Source: Field Survey. May, 2014.

This success notwithstanding, residents of Alajo would have to put a stop to certain activities. Many residents in Alajo living close to the drains have turned them into refuse dumps where they shamelessly expel their waste. Some wait for the rains to fall and intentionally dump during the rains so the refuse would be carried away. Figure 5.20 shows the drain used as a refuse dump. This continuous practice would cause siltation of the drain and it may overflow in case of any heavy downpour. If regular maintenance by way of dredging is not done it may result in Alajo having problems again. Residents would have to desist from dumping refuse into the drain.

Figure 5.20Alajo drain used as refuse dump.
Source: Field Survey. May, 2014.

5.8 Roles of Institutions in Flood Mitigation.

As part of the survey, some institutions were visited to know the roles they play as well as efforts they have made in the prevention or mitigation of floods in Accra. Some institutions visited were Hydrological Services Department, Town and Country Planning Department, Environmental Protection Agency, National Disaster Management Organisation and Planning Department of Accra Metropolitan Assembly.

Hydrological Services Department (HSL)

As part of its role in flood mitigation, HSL offers engineering services by identifying flood prone areas and doing hydrological and hydraulic analysis for those areas. HSL also designs storm water drainage systems, award them on contract and supervise their construction. In the execution of this role, they encounter some difficulties. The encroachment on drainage channels makes their work difficult because some encroachers have proper documentation to their land. Therefore, when a building needs to be pulled down, there has to be a lot of litigation because some encroachers have title to the land. Their work is also made difficult because some residents dump refuse into drains and choke them. One challenge they also face is funding which hardly is available for drainage projects. The issue of encroachers as well as funding problems also played a role in stalling many drainage projects. As an institution, HSL collaborates with other institutions like Department of Urban Roads, AMA, NADMO, EPA, Ghana Meteorological Agency and Ministry of Local Government and Regional Development.

Town and Country Planning Department (TCPD)

The TCPD plays its role in flood mitigation by preparing layouts taking into consideration the principle of safety. It is ensured that the layouts prepared take cognizance of areas that are not buildable and need to be preserved for other uses. Land uses are allocated with safety in mind; therefore, a flood prone area would not be allocated for residential purposes. One difficulty is the non-compliance with the layouts prepared. Many developers in Accra build without permits and flout so many planning regulations with impunity. After completion of their building when they start getting threats of demolition, they apply for permits and seek regularization. To ensure that development control is adhered to, TCPD collaborates with the

Metropolitan Works Department. TCPD explained that enforcement of development control was a big hurdle. Many developers actually build without regard for any scheme. They collaborate with HSD and NADMO.

Environmental Protection Agency (EPA)

EPA plays its role in flood prevention when it comes to big developmental projects like construction of residential estates. EPA does its studies and gives permit before such developments can take place. Therefore, apart from giving permits to developers who do large scale projects, they do not play any major role in flood prevention in Accra. When there are cases of encroachment on wetlands, EPA does its assessment and the appropriate action is taken.

National Disaster Management Organisation (NADMO)

NADMO is an institution that coordinates the activities of other institutions to help prevent floods and respond to emergencies related to floods. NADMO embarks on public education on causes of floods within flood prone communities. Appendix 8 shows the list of issues that the public education features. They also set up Disaster Volunteer Groups to advise residents not to build on flood prone land. It collaborates with the 48 Engineers Regiment, ECG, HSD and Ministry of Water Resources, Works and Housing.

Planning Department (AMA)

The Planning Department of AMA also contributes its quota in helping prevent floods. They are engaged in public education on flood prevention through the use of public address systems, radio and television announcements. Contractors are also engaged to desilt drains in floodable areas in the metropolis. Some difficulties are encountered in the execution of these tasks. Some residents in flood prone areas tend to dispose of their refuse into drains especially during rainy seasons. Funding for education exercises and desilting of drains is not always available thus, such activities are not done regularly. The department collaborates with NADMO, EPA and Department of Urban Roads (DUR).

Ghana Meteorological Agency (GMA)

GMA plays its role by observing the weather, compilation of meteorological information observed and analysis of data. Based on this, forecasting is done and the

general public is served by providing information/data to all who need it. For example, farmers, contractors and shippers make use of meteorological information. GMA had no special schemes or regulation for flood prevention in flood prone areas. GMA intimated that giving early warning of heavy rainfall alerted people in such flood prone areas as well as NADMO to prepare for the floods. This is done so people are not taken unawares, thereby not exposing them more directly to the danger of the floods. GMA collaborates with NADMO and they meet periodically to discuss issues concerning flooding to give their input towards education.

5.9 Summary of Results and Discussions

This chapter has taken a close look at the existing situation concerning flooding in the study areas located in Accra. One community had received a major intervention by the government and the other had not seen any major intervention from the government. The particular causes of floods were examined in both communities. Glefe still suffers severely from flooding due to several reasons and Alajo no more suffers from flooding. The experiences that residents have had with flooding were also discussed. Mitigation measures by both households and government were identified and assessed to know how well they have saved the situation. The next chapter summarizes the findings, makes recommendations based on them and also presents a conclusion.

CHAPTER SIX

SUMMARY OF FINDINGS, RECOMMENDATIONS AND CONCLUSION

6.1 Introduction

This chapter summarizes the findings of the research. Based on the findings, flood management interventions have been recommended. This chapter ends with a general conclusion. The causes of flooding are summarized as follows:

6.2 Causes of flooding

In Glefe, flooding has become a part of the daily lives of the people. It happens so often due to the various contributing factors that come together to make the community a high risk flood prone area. One main cause of flooding in Glefe is the low lying nature of the land and the shoreline keeps receding. The coast is so vulnerable to erosion and the community gets flooded easily when the tides on the sea are strong and very high. This is a common phenomenon in the community. The assemblyman for the area even mentioned that most of the community was already under the sea due to the vast erosion that has occurred over the years.

To compound the problem, massive sand mining occurs at the shore of the community. Community members use the sand in construction projects like building of houses on reclaimed land. There is also an increase in population which requires more houses to be built. The increasing population may also be attributed to the low rental values in the area.

Another reason for flooding in the community was the encroachment on the Gbugbe and Dzatakpor lagoons. Due to loss of houses and land to the floods, many residents reclaim the lagoons by filling with refuse and building on them later. The low cost of rent in the community also made it attractive to very low income earners. This encroachment is gradually reducing the capacity of the lagoons and they easily get full and overflow with a short spell of rain. The overflowing lagoon waters easily got into the homes and flooded the community.

Another related cause is the embankment created by Panbros Industries Ltd. The embankment prevents excess water from the lagoons from contaminating their water used for salt production. The lagoon waters are contaminated with rubbish and all kinds of waste. There are conflicts between community youth and Panbros staff when the lagoons get full. This happens because the community youth have to excavate the

sand from the tunnel for the excess water to flow while the Panbros workers also want to protect their waters from contamination.

Poor sanitation is one problem that needs immediate attention. Apart from the effect that the bad sanitation practices have on flooding, it also puts the health of the community members at risk. The community is engulfed in so much filth. Refuse is dumped carelessly into the lagoons and the few existing drains are all choked with rubbish.

The absence of proper drainage in the community also contributes to flooding in the community. There are few poorly designed drains in the community and they are not networked, thus they always have stagnant water and rubbish in them.

Furthermore, spillage from the Weija Dam also causes flooding in Glefe as recorded in June, 2014. The spillage makes flooding of the community inevitable since there is no protection from the excess water spilled from the dam.

In Alajo, flooding had not occurred after the drain conctruction. This intervention was praised by majority of the respondents who said it had saved them greatly. Therefore, Alajo no longer experiences flooding and is safe.

6.3 Mitigation measures

In Glefe, various measures had been used by residents to mitigate floods. The HSL had not intervened in a major way to protect the community from floods. The households and community had to cater for themselves. The only intervention by NADMO identified was public education on risks associated with floods which did not resolve the problem at all. About 40% of residents in Glefe had adopted their own ways of tackling the flooding problem. To reduce the effect of floods, some residents had to resort to building of flood protection walls, digging trenches to drain away flood water, raising door and window levels, filling places with sand bags to block flood waters, clearing of choked drains and use of furniture with high clearance from the ground. These methods yielded poor results though some were quite helpful. In short, the mitigation measures used in the community were not enough to save them from floods and the residents appealed to government for help.

Alajo had a different story to tell since they had benefitted from a major intervention by way of drain construction. A drain lined with concrete had been constructed and

this had saved the situation to a great extent. The general drainage in the community had also been improved and this helped prevent floods.

6.4 Recommendations

After careful examination of the findings, the following recommendations can be considered to ensure that the problem of flooding is something of the past. The solution to the problem cannot be implemented in a day or week so the recommendations have been categorized into short term and long term.

6.4.1 Short term mitigation measures

For Glefe, in the short term, the community needs to improve the sanitation situation. It is necessary to get rid of all the filth in the community. The community can do this in partnership with the AMA's waste management department and other private waste management companies. This would help deal with the problem of mosquitoes and other diseases in the interim. Sanitation by-laws must also be strictly enforced. The attitudinal problem of haphazard disposal of refuse needs to be tackled by all stakeholders in the community. Special involvement of traditional leaders of the community would be helpful. Public education on the hazards of poor environmental and sanitation practices must be done to Public Health Department to help improve the situation. The attitude of waiting for the assembly to come and clear rubbish must be stopped. Residents would have to be encouraged to embark on self-help projects and regular clean up exercises. The residents would also have to be educated by the EPA on the adverse effects of reclaiming the lagoons and building on them. The EPA would have to ensure that the areas very close to the lagoons are protected. The lagoons can be dredged by HSD to increase their capacities to accommodate more water.

In addition, sand mining at the shore of the community would have to be stopped. Though climate change may be a factor in sea level rise (Appeaning Addo and Adeyemi, 2013), the cessation of sand mining can help safeguard the coast and reduce the erosion happening there. Since traditional leaders are very revered in the community, they can serve as a mouth piece against sand mining. Those caught mining sand should be punished appropriately to serve as a deterrent to others who may engage in similar activities.

Poor drain conditions is a major issue that needs to be tackled. It would be imperative for the HSL and DUR to improve on the drain construction in the community. A well designed drain system needs to be drawn and implemented to help save the situation. More engineering solutions must be embarked on to help reduce the effects of flooding. The temporal drains made by residents are not properly designed, hence would have to be designed and constructed well. Glefe does not have a prepared planning scheme which makes it difficult to regulate physical development in the community. Considering the current situation, urban upgrading can be done to ensure that infrastructure like road, water and sanitation are improved.

For Alajo, the community is not in a dire situation. There is a problem of waste management and this must be tackled immediately. Public education must be done to promote environmental cleanliness and proper waste disposal methods. Many residents along the drain dump refuse into the drains and this is gradually piling up and silting the drain. In the long term, if this is not stopped, the capacity of the drain may be reduced and a heavy downpour may cause a flood. Volunteer groups must be formed to campaign against dumping of refuse into the drains.

6.4.2 Long term mitigation measures

In Glefe, the major intervention that can be done in the long term would be to construct a sea defence mechanism in the form of a sea wall along the shore of Glefe. Walls of concrete or rock should be built to protect the community from erosion and flooding. Seawalls are massive structures designed to protect the land behind them from direct wave attack. They are generally built along reaches of coast that contain some type of critical infrastructure such as an evacuation route, water or sewer main, utility easement or rail line. Figure 6.1 shows an example of a sea wall at Sea Bright in New Jersey. This will go a long way to stop the flooding caused by the sea.

Figurer 6.1 Waves breaking over seawall at Sea Bright, New Jersey.

Source: Halsey, 1986

Other mechanisms have been tried and tested in other parts of the world in a bid to control coastal erosion. New Jersey (in United States of America) has employed some measures to mitigate coastal hazards which have achieved great success. They may also be considered by AMA for coastal protection in Glefe.

- **Beach nourishment**: It is the process of extending a beach seaward along designed contours both above and below the tide line. Newly placed sand protects property and infrastructure from wave attack, inundation, undermining, and increased vulnerability due to long-term shoreline erosion/recession. Beach nourishment is often referred to as beach fill as these projects are designed to mitigate long-term shoreline erosion through "filling" large quantities of sand into the coastal zone.
- **Elevation of buildings**: In coastal flood zones in New Jersey, elevating structures is an effective way to mitigate potential damage from flooding, wave action and debris. In New Jersey communities participating in the National Flood Insurance Program (NFIP), ordinances and laws require buildings to be sited at an elevation above the Base Flood Elevation (BFE);

that is, the flood elevation that has a one percent probability of being equaled or exceeded in any given year (determined on an individual community basis). Also in Florida, a retrofit measure that is increasingly being used is to elevate flood prone structures so that the living or working area is above the 100-year base flood elevation.

Figure 6.2 House on pilings in Holgate, New Jersey.
Source: Halsey, 1986

- **Shore perpendicular protection structures**: Shore perpendicular protection structures are designed to either reduce the rate of transport of sand along a specific reach of shoreline or to completely block the alongshore movement of sand beyond a certain point. Groins are often constructed in series (called a groin field) forcing the sand to fill in to a specified level on one beach before allowing sand to be transported to the next beach in the field. Groins are constructed perpendicular to the shore to trap and reduce the alongshore transport of sand.

- **Shore parallel structures**: Shore parallel protection structures are built both onshore and offshore of the coast. Viewed as the last line of defense against coastal storms, onshore structures, (e.g., bulkheads and revetments) limit the landward extent of erosion or retain land behind the structure. Offshore structures, or breakwaters, are designed to limit the magnitude of wave energy

in their lee. Breakwaters can be built either above or below the water's surface depending on the desired level of wave protection.

Another option may be to relocate the whole community and transform the area into a water park or recreational park. The lagoons can be cleaned up and they can be transformed into attractive areas for visitors. All this would need huge sums of money and commitment from the private and public sectors. Alajo may not be experiencing flooding at the moment but it would be important to secure funds to complete the drain on the Onyasia stretch so the people at that end of the drain can be relieved.

6.5 Impact of mitigation measures

The mitigation measures used by both the households and government yielded positive and negative results. In Glefe, the only major intervention from government was public education according to the respondents. There was no visible project implemented to prevent floods in the community. Therefore, the public education had yielded virtually nothing in terms of reducing the effect of floods in the community. The mitigation measures used by households too did not yield positive results. The success rate of reducing the effect of floods was very low since the people did not have adequate capacity to mitigate floods.

Alajo had benefitted from a major drain construction project. According to respondents, the project was indeed very helpful. About 94% of respondents acknowledged that the drain construction was successful in mitigating floods in the community. Despite that, about six percent (6%) who were mainly at the section where the drain was not completed complained that they still suffered from flooding.

6.6 Conclusion

Flooding is quite difficult to deal with. It is caused by various factors, both natural and artificial. Glefe, the eroded coast make the community liable to flooding and some activities like sand mining also compounds the problem. No major intervention has been done by the HSD to save the people of Glefe. Though residents have made efforts to mitigate the effects of floods, they have not made much success. Glefe community needs a lot of help from the government and international development partners to transform the lives of the residents. Alajo on the other hand has benefitted from the construction of drains and this has been successful in preventing floods in the community. The drains need to be extended to ensure the area at the end of the

Onyasia drain is protected from floods. Considering the various causes, effect, mitigation measures examined, it would be important that an intervention is made towards the prevention of floods in Accra especially Glefe which is in a dire situation. Funds must be secured by the AMA to ensure that projects to prevent flooding in the communities are implemented successfully.

REFERENCES

Accra Metropolitan Assembly (AMA) (2009). "Integrated Solid Waste Management Strategy." Hifab-SIPU-Colan Consultants. Urban Environmental Sanitation Project; Accra, Ghana.

Accra Metropolitan Assembly (AMA) (2010), 2010-2013 Medium Term Development Plan.

Accra Metropolitan Assembly (AMA) (2011): "Accra, Millennium City". Summary Profile of Policy Initiatives Programmes and Projects and Achievements, AMA, Accra.

ActionAid, (2006): "Climate Change, Urban Flooding and the Rights of the Urban Poor in Africa: Key Findings from Six African Cities". A Report by ActionAid International

Adams A. G., (2010) Perennial Flooding in the Accra Metropolis: The Human Factor. Accra.

ADRC Data Book 2002. *Data Book on Asian Natural Disasters in the 20th Century, Natural Disasters in India*. Kobe, Japan.

Alhassan, A. R., Gabbay, O., Arguello, J. E. M. and Boakye-Boaten, N. A., (2010), Report to the Accra Metropolitan Assembly on Solid Waste Composition in Aryee Diki Electoral Area, Ayawaso Central Submetro, Accra New Town.

Amoani, K.Y., Appeaning-Addo, K., & Laryea, W.S., (2012), 'Short-term shoreline evolution trend assessment: A case study in Glefe, Ghana', *Jàmbá: Journal of Disaster Risk Studies* 4(1), Art. #45, 7 pages. Available at http://dx.doi.org/10.4102/jamba.v4i1.45 (viewed on 22nd June, 2014)

Anokwa, Y., Martin, N. & Muff, R., (2005), 'Coastal stability map of Greater Accra Metropolitan Area', Environmental and engineering geology map of Greater Accra Metropolitan Area, Accra, Ghana.

Appeaning Addo, K., Walkden, M. & Mills, J.P., (2008), 'Detection, measurement and prediction of shoreline recession in Accra, Ghana', ISPRS Journal of Photogrammetry and Remote Sensing 63(5), 543–558.

Appeaning Addo, K., 2009, Detection, measurement and prediction of shoreline change in Accra, Ghana, Lambert Academic Publishing, Saarbrücken.

Appeaning Addo, K., Lloyd, L., Amisigo, B. & Ofori-Danson, P.K., (2011), 'Impacts of coastal inundation due to climate change in a cluster of urban coastal communities in Ghana, West Africa', Remote Sensing 3(5), 2029–2050.

Appeaning Addo, K. & Adeyemi, M. (2013), 'Assessing the impact of sea-level rise on a vulnerable coastal community in Accra, Ghana', *Jàmbá: Journal of Disaster Risk Studies* 5(1), Art. #60, 8 pages.

Askew, A.J. (1999), Water in the International Decade for Natural Disaster Reduction. In: Leavesley et al (Eds) *Destructive Water: Water-caused Natural Disaster, their Abatement and Control.* IAHS Publication No.239.

Atuguba, R.and Amuzu, T. (2006) Report on Climate Change and Flooding in Alajo, Accra. ActionAid (International) Ghana.

Bowden, C. M. (1987). The Biochemistry of Nitrogen in freshwater Wetlands. Biochemistry (4)

Breen, C.M., Quinn N.W and Mander J. J. (eds) (1997). Wetland Conservation and Management in Southern Africa. Challenges and Opportunities IUCN-ROSA, Harare

Campbell, M.O., 2006, 'The sustainability of coconut palm, Cocos nucifera (Linnaeus, 1753), in coastal Ghana', Journal of Coastal Research 22(5), 1118–1124.

CECI 2004. *Capacity building for adaptation to Climate Change, Vulnerability assessment report*, CECI, Hue.

Cernohous, L. (1979) The Role of Wetlands in Providing Flood Control Benefits. U.S. Fish and Wildlife Service, Bismarck Area Office, Bismarck, North Dakota.

Darteh B, (2010). Flooding in the City: The Blame Game. Accra Learning Alliance Blog

Dasgupta, S., Laplante, B., Meisner, C., Wheeler, D. & Yan, J., (2007), 'The impact of sea-level rise on developing countries: A comparative analysis', World Bank Policy Research Working Paper 4136, 1(1), viewed 19 August 2014,

De-Graft, S.J., 2011, 'Environmental issues', radio broadcast, Joy FM,

Dhar, O. N. and Nandargi, S. (2002): "Hydrometeorological Aspects of Floods in India" *Natural Hazards*, Volume 28 Number 1, p. 1 – 33

Ditsa, G., (2004), A Research Design and a Methodological Approach to an Explanatory User Behaviour Testing Lessons Learnt.

Dixon, A.B. and Wood, P. A. (2003). Wetland Cultivation and Hydrological Management in Eastern Africa: Matching Community and Hydrological needs through Sustainable Wetland use. Natural Resources Forum 27 (2) 117-129

Dow, K. (1992), Exploring differences in our common future(s): The meaning of vulnerability to global environmental change. Geoforum 23: 417–436.

Dow, K. (1993), Unpublished literature review on the 'concept of vulnerability' and the 'factors contributing to vulnerability'. Worcester: George Perkins Marsh Institute, Clark University.

DuToit, R.F. (1994). Mid-Zambezi and Manna Pools: Ecology and Conservation Status. In : Matiza, T and Crafter (eds) Proceedings of a seminar on Wetland, Ecology and priorities for Conservation in Zimbabwe, Kentucky Airport Hotel,13-15 January 1992, IUCN, Harare

Flooding in Urban Areas: (Urban Flooding) 2013 http://www.floodsite.net/juniorfloodsite/html/en/teacher/thingstoknow/hydrology/urbanfloods.html. Accessed on 12th September, 2013

Haines, A., Kovats, R.S., Campbell-Lendrum, D. and Corvalan, C. (2006) Climate change and human health: impacts, vulnerability, and public health. Lancet, 367, pp. 2101-2109.

Halsey, S.D. (1986). Proposed classification scale for major northeast storms: East coast, USA based on extent of damage. Geological Society of America, Abstracts with Programs (Northeastern Section). 18, 21.

Hofmann N, Mortsch L, Donner S, Duncan K, Kreutzwiser R, Kulshreshtha S, Piggot A, Schellenberg S, Schertzer B, Slivitzky M. (1998). Climate change and variability: impacts on Canadian water. In Canada Country Study: Climate Impacts and Adaptation, Vol. VII, National Sectoral Volume. Environment Canada: Ottawa; 1–127.

Hove C. And Chapungu L (2013). Human Perceptions on Degradation of Wetland Ecosustems: The Case of Magwenzi Wetland in Chivi District, Zimbabwe. Greener Journal of Geology and Earth Sciences. Vol. 1 (1)

Hualou, L (2011). Disaster Prevention and Management: A Geographical Perspective. Disaster Advances 4(1)

Institute of Local Government Studies (ILGS), International Water Management Institute (IWMI) (2012): Community Adaptation to Flooding Risk and Vulnerability

Intergovernmental Panel on Climate Change (IPCC) (2007): "Climate Change 2007: Impacts, Adaptation and Vulnerability" In: Parry ML, Canziani O. F., Palutikof J. P., van der Linden P. J., and Hanson C. E. (eds) Contribution of Working group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge UK

Karley, N. K., (2009) Flooding and Physical Planning in Urban Areas in West Africa: Situational Analysis of Accra, Ghana. Theoretical and Empirical Researches in Urban Management, 4 (13)

Lawford, R. G., Prowse, T. D., Hogg, W. D., Warkentin, A. A., Pilon, P. J. (1995): "Hydrometeorological Aspects of Flood Hazards in Canada". *Atmospheric-Ocean Vol.* 33 Issue 2 Canadian Meteorological and Océanographie Society p.

30 – 320

Ly, C.K., (1980), 'The role of the Akosombo Dam on the Volta River in causing erosion in central and eastern Ghana (West Africa)', Marine. Geology 37, 323–332.

Mathur, V. (2006). Sustainable Development through Integrated Flood Management. WMO Bulletin 55 (3)

Maskrey, A.1989. Disaster Mitigation: A Community-based Approach. Oxfam, Oxford

McGuire, Bill; Burton, Paul; Kilburn, Christopher and Willets Oliver: World Atlas of Natural Hazards, Arnold Publishers, Great Britain, 2004.

Mugenda O. M. And Mugenda A. G., (1999). Research Methods: Quantitative and Qualitative Approaches. African Centre for Technology Studies (ACTS), Nairobi, Kenya. Acts Press.

Musa, D. and Usman, M. (2013) An evaluation of the physical planning flood control measures adopted in Kubwa Town, Federal Capital Territory, Abuja. Elixir International Journal. (www.elixirpublishers.com)

Munich Re Topics (2002): Natural Catastrophies in 2002. Review of the Year 2002

National Research Council, (2000). Beach Nourishment and Protection. Marine Board, Commission on Engineering and Technical Systems. Washington, D.C.: National Academy Press.

Nelson, S. A. (2013) Natural Disasters and Assessing Hazards and Risk. EENS 3050 Natural Disasters Lecture Notes, Tulane University. Accessed on 20th February, 2014. www.tulane.edu/~sanelson/natual_disasters/introduction.htm

Nelson S. A. (2012) Flooding Hazards, Prediction and Human Intervention, EENS 3050, Natural Disasters Lecture Notes, Tulane University

Nyarko, K. B. (2000). Application of a Rational Model in GIS Flood Risk Assessment in Accra, Ghana. Journal of Spatial Hydrology, Vol. 2 No. 1

Odemerho, F.O. (1988). Benin City: A Case Study of Urban Flood Problems. In: Sada, P.O. and Odemerho F.O. (Eds). Environmental Issues and Management in Nigerian Development, Evans Brothers, Ibadan.

Oludare, H., O. Bashir and H. Olusegun (2012), Building Capabilities for Flood Disaster and Hazard Preparedness and Risk Reduction in Nigeria: Need for Spatial Planning and Land Management. Journal of Sustainable Development in Africa (Volume 14, No. 1)

Oppong, B. (2011) Environmental Hazards in Ghanaian Cities: The Incidence of Annual Floods along the Aboabo River in the Kumasi Metropolitan Area (KMA) of the Ashanti (Unpublished Postgraduate thesis)

Sam, P. (2009) Flooding in Accra Research Report. http://www.modernghana.com/news/223780/1/flooding-in-accra-research-report.html (Accessed on 12th September, 2013)

Schanze J., Evzen, Z. and Jiri, M. (2006): "Flood Risk Management: Hazards, Vulnerability and Mitigation Measures" Earth and Environmental Sciences. Vol. 67, Nato Science Series: IV: Springer, Dordrecht

Shaw, R., (2006), Critical Issues of Community Based Flood Mitigation: Examples from Bangladesh and Vietnam. Journal of Science and Culture Special Issue on "Flood Disaster Risk Reduction in Asia" Volume 72, Number 1-2

Smith, N. (2013). The contributions of the United States to Global Warming and Change. http//www.articlemyriad.com

Tapiwa, U. N., Lubna, R., Asfaw, K. K., Thi T. X. N., and Forba, I. N., (2010) From Vulnerability to Resilience in Disaster Risk Management: Process of Assessing Vulnerability to Flood. PhD Block course presentation, Institute of Environment and Human Security, United Nations University.

Thompson P. M. and Sultana P. (1996). Distributional and Social Impacts of Flood Control in Bangladesh. The Geographical Journal, Vol. 162, No. 1. The Royal Geographical Society (with the Institute of British Geographers)

United Nations Framework Convention on Climate Change (UNFCC) (2007): Climate Change: Impacts, Vulnerabilities and Adaptation in Developing Countries www.unfcc.int/resource/docs/publications/impacts.pdf

UN-International Strategy for Disaster Reduction (UN-ISDR) (2008) "Disaster Risk Reduction Strategies and Risk Management Practices: Critical Elements for Adaptation to Climate Change" Submission to the UNFCCC Adhoc Working Group on Long Term Cooperative Action.

UN-International Strategy for Disaster Reduction (UN-ISDR) (2009). "Reducing Disaster Risks through Science: Issues and Actions, the Full Report of the ISDR Scientific and Technical Committee 2009".

United Nations Human Settlement Programme (UN-Habitat) (2009). Global Report on Human Settlements- Planning Sustainable Cities. Earthscan, London.

United States Environmental Protection Agency (EPA) (2006). Wetlands: Protecting Life and Property from Flooding

WaterAid and European Union (2008). Urban Sector Assessment Report. Accra, Ghana.

Wetlands, Functions and uses, 2014 http://forestandrange.org/new_wetlands/flood_control.htm. Accessed on 26th February, 2014

World Bank, (1989). Bangladesh action plan for flood control. Dhaka: World Bank Asia Region Country Department

World Bank, (2004), Project Appraisal Document on a Proposed Credit in the Amount of SDR 41.6 Million (USD 62.0 Million Equivalent) to the Republic of Ghana for a Second Urban Environmental Sanitation Project.

Yeasmin, S. and Rahman, K. F., (2012), 'Triangulation' Research Method as the tool of Social Science Research. BUP Journal, Volume 1, Issue 1, ISSN: 2219-4851 p 156

APPENDIX 1: HOUSEHOLD QUESTIONNAIRE

NAME OF INTERVIEWER: **.....**

DATE OF INTERVIEW: **.....**

1. Community.....
2. Name of respondent .....
3. Sex: Male □ Female □
4. Age:.....
5. Ethnicity.....
6. Religion……
   a. Christian □ b. Islam □ c. Traditionalist □ d. No religion □
7. Activity Status
   a. Employed □ b. Unemployed □ c. Homemaker □ d. Student □ e. Retired/Pensioner □ f. Person with Disability/Too weak to work □ g. Other (please specify).....
8. Occupation.....
9. Educational level attained
   a. None □ b. Primary □ c. JHS □ d. SHS □ e. Tertiary □
   b. f. Others (please specify) □.....
10. Monthly income.....
11. Length of stay in community
    a. 0–5 yrs □ b. 6–10 yrs □ c.11–15 yrs □ d.16–20 yrs □ e.21–25 yrs □ f. 26+yrs □
12. Residential Status
    a. Free occupant □ b. Tenant □ c. Relative to owner □ d. Caretaker □ e. Owner occupant □
13. Type of house
    a. Detached □ b. Semi-detached □ c. Storey (no)..... □ d. Other □
14. Type of building material (wall)
    a. Sandcrete□ b. □ Landcrete c. Wattle and daub □ d. Bricks □ e. Wood □ f. Others (please specify)....
15. Has your household experienced flooding before? (If No, skip to question 27)
    a. Yes □ b. No □
16. If yes, when was the last time you experienced flooding? Month.....Year.....
17. If yes, why do you still live here? (respondent should pick the single most important reason)
    a. Proximity to work □ b. Born in the community □ c. Affordability/Low cost of housing and land□ d. Free housing □ e. Cheap rent □ f. Social/family ties□ g. Access to social amenities □
    h. Livelihood opportunities □ i. No permit required to settle □ j. Other (please specify) □.....
18. Are you willing to move out of this area if you get a better place (free from flood)?
    a. Yes □ b. No □
19. If yes, please explain why.....

    .....

    .....

20. If no, please explain why.....

    .....

21. What do you think is the major cause of flooding in your community?

a. Building in water course/ water way□ b. Bad refuse disposal methods□
c. Building on reclaimed land□ d. High tidal waves□ e. Improper planning□
f. Indiscriminate granting of permits□ g. Poor design of drains□ h. Poor construction of drains□
i. Choked drains□ j. Low lying nature of land□ k. Hard landscaping/impervious surfaces□ l. Caused by God□ m. No idea□ n. Other (specify) □
……..

22. How often do floods occur in this community?
    a. Once a yr□ b. Twice a yr□ c. Thrice a yr□ d. Four times a yr□ e. More than four times a yr□
23. Which month in particular does flooding occur in your community?.....
24. How long do the floods last when they occur?
    a. Hours□ b. Days□ c. Weeks□ d. Months□ e. Other (please specify).....
25. Which agency (ies) or organisation(s) come(s) to your aid during floods?
    a. NADMO□ b. AMA □ c. Sub-metro office□ d. None (If none skip to question 27) □
    b. Other, (please Specify)□.....
26. What help are offered to you?
    a. Provision of relief items (e.g. food, building materials, blankets, medicine, mattresses) □
    b. Rescue effort□ c. Other, Specify.....
27. How do you dispose of waste?
    a. Public damp site□ b. Door to door□ c. Dumping in drains/gutters□ d. Burning□
    e. Burying□ f. Dumping in nearby water body□ g. Dumping in drain/gutter□
    h. Other, (please specify).....
28. Do you pay money to dispose of your waste? (If No skip to question 31)
    a. Yes□ b. No□
29. If yes, how much do you pay per month?
    a. 0 - 0.99 Gh¢□ b. 1 – 1.99 Gh¢□ c. 2 – 2.99 Gh¢□ d. 3 – 3.99 Gh¢□ e.4 – 4.99 Gh¢□ f. 5 – 5.99 Gh¢□ g. 6 – 6.99 Gh¢□ h. 7 – 7.99 Gh¢□ i. 8 – 8.99 Gh¢□ j. 9 – 9.99 Gh¢□ k. 10 Gh¢ and above□
30. In what ways are you affected by floods when they occur?
    a. Outbreak of disease□ b. Personal Injuries□ c. Collapse of building□
    d.Disruption of activities (e.g. schooling for children) □ e. Hunger□
    f. Loss of household items (e.g. TV, fridge, furniture, etc.) □
    g. Loss of livelihood/income generating activities (e.g. home-based industry) □
    h. Loss of human lives (family, neighbours) □
    i. Disruption of services (e.g. electricity, water, etc.) □
    j. Loss of livestock□
    k. Other, (please specify)□.....
31. Do you think floods can be prevented in your community?
    a. Yes □ b. No □
32. If yes, how do you think this can be achieved?

    .....

    .....

    .....
33. If No, why can't they be prevented?

    .....

    .....

34. Has your household put in any flood mitigation measures? (If No, skip to question 40)
    a. Yes □ b. No □
35. If yes, what flood mitigation measure(s) has your household put in place?
    a. Clearing of choked gutters□ b. Construction of temporary drains□
    c. Building flood protection walls□ d. Raising of door and window levels□

e. Blocking flood flow with sand bags□ f. Construction of flood diversion trenches□

g.Use of furniture with high clearance from ground level□

36. If no, why hasn't your household put in place any flood mitigation measure?
    a. We cannot afford the cost associated with flood mitigation measures□
    b. We intend to relocate to another community□
    c. Flood mitigation measures should be the responsibility of the hose owner/caretaker □
    d. Other (please specify)□.....
37. What intangible measures does your household put in place in case of floods?
    a. Pack valuables and send them to a place not at risk□ b. Leave the house□
    c.Ensure safety of children□ d. Nothing□
38. Have the mitigation measures put in place by the household been successful?
    a. Yes □ b. No □
39. If yes, what is the degree of success?
    a. Average□ b. Successful □ c. Very successful□
40. If no, why?

.....

.....

.....

41. What mitigation measure(s) has the government or any organisation put in place?
    a. Drain construction□ b. Public education□ c. De-silting of drains□
    d.Clearing of waterways□ e. Enforcement of planning laws□ f. No idea□ g. None□
42. Have the mitigation measures put in place by the government or any organisation been successful?
    a. Yes □ b. No □
43. If yes, what is the degree of success?
    a. Average□ b. Successful □ c. Very successful□
44. If no, why?

.....

.....

.....

45. Have community members made any efforts as a group to prevent floods?
    a. Yes □ b. No □
46. If yes, what efforts have been made?

.....

.....

.....

47. If No, why hasn't the community organised itself to prevent floods?

.....

.....

.....

48. What do you do whenever you suspect that floods are likely to occur on a particular day?

.....

.....

49. What do you do during the time that floods actually occur?

.....

.....

50. What do you do after the floods occur?

.....

.....

51. Do you report incidences of floods to any authorities?
    a. Yes □ b. No □
52. If yes, which authorities do you report to?
    a. NADMO□ b. AMA □ c. Sub-metro office□ d. Other (please specify) □.....
53. If No, why don't you report to the authorities?

.....

.....

54. Do city authorities or any other organisation make any efforts to solve the problems of flooding in your community?
    a. Yes □ b. No □
55. If yes, what particular efforts have been made?

.....

.....

56. What do you think the following should do to help solve the problem of flooding in your community (recommendations)?
    Households in community

.....

.....

AMA

.....

.....

Hydrological Services Department

.....

.....

Central Government

.....

57. Any other comment.

.....

.....

THANK YOU FOR YOUR TIME

APPENDIX 2: QUESTIONNAIRE FOR HYDROLOGICAL SERVICES DEPARTMENT

KWAME NKRUMAH UNIVERSITY OF SCIENCE AND TECHNOLOGY

COLLEGE OF ARCHITECTURE AND PLANNING

DEPARTMENT OF PLANNING

MSc. DEVELOPMENT PLANNING AND MANAGEMENT

This research instrument is designed to seek relevant primary data for the conduct of an academic exercise. This will aid me complete my final year thesis. Your support is very much anticipated and please be assured that your responses will be treated with utmost privacy.

AN ASSESSMENT OF FLOOD MITIGATION IN ACCRA

HYDROLOGICAL SERVICES DEPARTMENT

NAME OF RESPONDENT: .....

NAME OF INTERVIEWER: .....

DATE OF INTERVIEW: .....

CONTACT NUMBER: .....

1. Which areas in Accra have suffered severely from flooding in the past ten years?

   .....

   .....

   .....

2. What role does Hydrological Services Department (HSD) play in flood prevention in Accra?

   .....

   .....

   .....

3. What difficulties does Hydrological Services Department (HSD) have in executing this role?

   .....

   .....

   .....

4. What do you think are the major causes of floods in Accra?

   .....

   .....

   .....

   .....

5. Which floodable areas have received interventions and which have not received any intervention?

Areas **with** intervention/mitigation measures	Areas **without** intervention/mitigation measures

6. What mitigation measures have been put in place to reduce the effects of floods in Accra?

No.	Floodable Area	Intervention/Mitigation measures	Effect/Outcome
1.			
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			

7. What has caused the stalling of engineering measures (drain construction/lining and dredging) put in place to address flooding?

   .....

   .....

   .....

   .....

8. Which institutions does HSD collaborate with in flood management in Accra?

   .....

   .....

   .....

9. Is HSD satisfied with the level of collaboration?

   Yes [ ] No [ ]

10. If no, why?

    .....

    .....

11. Is the HSD adequately resourced to carry out its responsibilities when flooding is concerned?

    Yes [ ] No [ ]

12. If no, what are your challenges?

i. Human

.....

.....

ii. Financial

.....

.....

iii. Logistics and equipment

.....

.....

iv. Others

.....

.....

13. What recommendations would you make to reduce the effects or occurrence of floods in Accra?

.....

.....

.....

.....

.....

.....

.....

THANK YOU FOR YOUR TIME

APPENDIX 3: QUESTIONNAIRE FOR NADMO

KWAME NKRUMAH UNIVERSITY OF SCIENCE AND TECHNOLOGY

COLLEGE OF ARCHITECTURE AND PLANNING

DEPARTMENT OF PLANNING

MSc. DEVELOPMENT PLANNING AND MANAGEMENT

This research instrument is designed to seek relevant primary data for the conduct of an academic exercise. This will aid me complete my final year thesis. Your support is very much anticipated and please be assured that your responses will be treated with utmost privacy.

AN ASSESSMENT OF FLOOD MITIGATION IN ACCRA

NATIONAL DISASTER MANAGEMENT ORGANISATION (NADMO)

NAME OF RESPONDENT: .....

NAME OF INTERVIEWER: .....

DATE OF INTERVIEW: .....

CONTACT NUMBER: .....

1. Which areas in Accra have suffered severely from flooding in the past ten years?

   .....

   .....

2. What are some of the diseases associated with the incidence of floods in Accra?

   .....

   .....

3. What do you think are the major causes of flooding in Accra?

   .....

   .....

4. Do you have any special regulations to control activities in floodable areas of Accra?
   Yes [ ] No [ ]
5. If yes, are they being enforced?
   Yes [ ] No [ ]
6. If no, why?

   .....

   .....

   .....

   .....

7. Is NADMO aware of any AMA-initiated projects/programmes aimed at reducing the incidence or mitigating the effects of flooding in Accra?
   Yes [ ] No [ ]

8. If yes, what programmes are they and do you think they have been effective?

   .....

   .....

   .....

   .....

9. What specific actions does NADMO take in flood prevention in Accra?

   .....

   .....

10. Is the NADMO adequately resourced to carry out its responsibilities when flooding is concerned?

    Yes [ ] No [ ]

11. If no, what are your challenges?

    i. Human

    .....

    .....

    ii. Financial

    .....

    .....

    iii. Logistics and equipment

    .....

    .....

    iv. Others

    .....

    .....

12. Which institutions does NADMO collaborate with in flood management in Accra?

    .....

    .....

13. Is NADMO satisfied with the level of collaboration?

    Yes [ ] No [ ]

14. If no, why?

    .....

    .....

15. What recommendations would you make to reduce the effects of floods in Accra?

    .....

    .....

THANK YOU FOR YOUR TIME

APPENDIX 4: QUESTIONNAIRE FOR ACCRA METROPOLITAN ASSEMBLY PLANNING DEPARTMENT

KWAME NKRUMAH UNIVERSITY OF SCIENCE AND TECHNOLOGY

COLLEGE OF ARCHITECTURE AND PLANNING

DEPARTMENT OF PLANNING

MSc. DEVELOPMENT PLANNING AND MANAGEMENT

This research instrument is designed to seek relevant primary data for the conduct of an academic exercise. This will aid me complete my final year thesis. Your support is very much anticipated and please be assured that your responses will be treated with utmost privacy.

AN ASSESSMENT OF FLOOD MITIGATION IN ACCRA

ACCRA METROPOLITAN ASSEMBLY

NAME OF RESPONDENT: .....

NAME OF INTERVIEWER: .....

DATE OF INTERVIEW: .....

CONTACT NUMBER: .....

1. What role does AMA play in flood prevention in Accra?

   .....

   .....

   .....

2. What difficulties does AMA have in executing this role?

   .....

   .....

   .....

   .....

3. What do you think are the major causes of floods in Accra?

   .....

   .....

   .....

   .....

   .....

4. Which floodable areas have received interventions and which have not received any intervention?

Areas **with** intervention/mitigation measures	Areas **without** intervention/mitigation measures

5. What mitigation measures have been put in place to reduce the effects of floods in Accra?

No.	Floodable Area	Intervention/Mitigation measures	Effect/Outcome
1.			
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			

6. Is development control (zoning laws and by-laws) enforced properly in AMA?
   Yes [ ] No [ ]
7. If no, why?

   .....

   .....

   .....

   .....

8. Which institutions does AMA collaborate with in flood management in Accra?

   .....

   .....

   .....

   .....

9. Is AMA satisfied with the level of collaboration?

   Yes [ ] No [ ]

10. If no, why?

    .....

    .....

11. Does AMA embark of educational campaigns concerning floods?

    Yes [ ] No [ ]

12. Is the AMA adequately resourced to carry out its responsibilities when flooding is concerned?

    Yes [ ] No [ ]

13. If no, what are your challenges?

i. Human

.....

.....

ii. Financial

.....

.....

iii. Logistics and equipment

.....

.....

iv. Others

.....

.....

14. Do you think climate change has had an impact on flood occurrences in Accra?

Yes [ ] No [ ]

15. Please explain why yes or no.

.....

.....

.....

.....

16. What recommendations would you make to reduce the effects or occurrence of floods in Accra?

.....

.....

.....

THANK YOU FOR YOUR TIME

APPENDIX 5: QUESTIONNAIRE FOR EPA

KWAME NKRUMAH UNIVERSITY OF SCIENCE AND TECHNOLOGY

COLLEGE OF ARCHITECTURE AND PLANNING

DEPARTMENT OF PLANNING

MSc. DEVELOPMENT PLANNING AND MANAGEMENT

This research instrument is designed to seek relevant primary data for the conduct of an academic exercise. This will aid me complete my final year thesis. Your support is very much anticipated and please be assured that your responses will be treated with utmost privacy.

AN ASSESSMENT OF FLOOD MITIGATION IN ACCRA

ENVIRONMENTAL PROTECTION AGENCY (EPA)

NAME OF RESPONDENT: .....

NAME OF INTERVIEWER: .....

DATE OF INTERVIEW: .....

CONTACT NUMBER: .....

1. What role does EPA play in flood prevention in Accra?

   .....

   .....

   .....

   .....

2. What are the difficulties that it faces in executing this role?

   .....

   .....

   .....

   .....

3. What do you think are the major causes of flooding in Accra?

   .....

   .....

   .....

   .....

   .....

4. Have wetlands in Accra been encroached on?
   Yes [ ] No [ ]
5. If yes, which areas?

   .....

   .....

   .....

6. Which activities are encroachers on wetlands usually involved in?

   .....

   .....

   .....

7. What action has EPA taken concerning encroachers on wetlands?

   .....

   .....

   .....

8. What action has EPA taken concerning development in high risk flood prone areas?

   .....

   .....

   .....

   .

9. Which institutions does EPA collaborate with in flood management in Accra?

.....

.....

.....

.....

10. Is EPA satisfied with the level of collaboration?

Yes [ ] No [ ]

11. If no, why?

.....

.....

.....

12. Are environmental laws related to flooding enforced properly in Accra?

Yes [ ] No [ ]

13. If no, why?

.....

.....

.....

.....

14. Is the EPA adequately resourced to carry out its responsibilities when flooding is concerned?

Yes [ ] No [ ]

15. If no, what are your challenges?

i. Human

.....

.....

ii. Financial

.....

.....

iii. Logistics and equipment

.....

.....

iv. Others

.....

.....

16. What recommendations would you make to reduce the effects of floods in Accra?

.....
.....
.....
.....

THANK YOU FOR YOUR TIME

APPENDIX 6: QUESTIONNAIRE FOR TCPD

KWAME NKRUMAH UNIVERSITY OF SCIENCE AND TECHNOLOGY

COLLEGE OF ARCHITECTURE AND PLANNING

DEPARTMENT OF PLANNING

MSc. DEVELOPMENT PLANNING AND MANAGEMENT

This research instrument is designed to seek relevant primary data for the conduct of an academic exercise. This will aid me complete my final year thesis. Your support is very much anticipated and please be assured that your responses will be treated with utmost privacy.

AN ASSESSMENT OF FLOOD MITIGATION IN ACCRA

TOWN AND COUNTRY PLANNING DEPARTMENT (TCPD)

NAME OF RESPONDENT: .....

NAME OF INTERVIEWER: .....

DATE OF INTERVIEW: .....

CONTACT NUMBER: .....

1. Which areas in Accra have suffered severely from flooding in the past ten years?

   .....

   .....

   .....

2. What role does TCPD play in flood prevention in Accra?

   .....

   .....

   .....

3. What difficulties does TCPD have in executing this role?

   .....

   .....

   .....

4. What do you think are the major causes of floods in Accra?

   .....

   .....

   .....

   .....

5. Which floodable areas have received interventions and which have not received any intervention?

Areas **with** intervention/mitigation measures	Areas **without** intervention/mitigation measures

6. What mitigation measures have been put in place to reduce the effects of floods in Accra?

No.	Floodable Area	Intervention/Mitigation measures	Effect/Outcome
1.			
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			

7. Is development control (zoning laws and by-laws) enforced properly in AMA?
   Yes [ ] No [ ]
8. If no, why?

   .....

   .....

   .....

   .....

9. What are the major land uses in the floodable areas in Accra?

No.	Floodable Area	Major land use
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		

10. Which institutions does TCPD collaborate with in flood management in Accra?

    .....

    .....

11. Is TCPD satisfied with the level of collaboration?

    Yes [ ] No [ ]

12. If no, why?

.....

.....

.....

13. Does TCPD embark of educational campaigns concerning floods?

Yes [ ] No [ ]

14. Is the TCPD adequately resourced to carry out its responsibilities when flooding is concerned?

Yes [ ] No [ ]

15. If no, what are your challenges?

i. Human

.....

.....

ii. Financial

.....

.....

iii. Logistics and equipment

.....

.....

iv. Others

.....

.....

16. What recommendations would you make to reduce the effects or occurrence of floods in Accra?

.....

.....

.....

THANK YOU FOR YOUR TIME

APPENDIX 7: QUESTIONNAIRE FOR GMA

KWAME NKRUMAH UNIVERSITY OF SCIENCE AND TECHNOLOGY

COLLEGE OF ARCHITECTURE AND PLANNING

DEPARTMENT OF PLANNING

MSc. DEVELOPMENT PLANNING AND MANAGEMENT

This research instrument is designed to seek relevant primary data for the conduct of an academic exercise. This will aid me complete my final year thesis. Your support is very much anticipated and please be assured that your responses will be treated with utmost privacy.

AN ASSESSMENT OF FLOOD MITIGATION IN ACCRA

GHANA METEOROLOGICAL AGENCY (GMA)

NAME OF RESPONDENT: .....

NAME OF INTERVIEWER: .....

DATE OF INTERVIEW: .....

CONTACT NUMBER: .....

1. Which areas in Accra have suffered severely from flooding in the past ten years?

   .....

   .....

   .....

   .....

2. What role does Ghana Meteorological Agency (GMA) play in flood prevention in Accra?

   .....

   .....

   .....

   .....

3. What difficulties does Ghana Meteorological Agency (GMA) have in executing this role?

   .....

   .....

   .....

   .....

4. What do you think are the major causes of floods in Accra?

   .....

   .....

   .....

   .....

5. What other warning systems are in place apart from radio and television for residents of flood prone areas?

   .....

   .....

   .....

   .....

6. Is Ghana Meteorological Agency (GMA) adequately resourced to carry out its responsibilities when flooding is concerned?

   Yes [ ] No [ ]

7. If no, what are your challenges?

i. Human

.....

.....

ii. Financial

.....

.....

iii. Logistics and equipment

.....

.....

iv. Others

.....

.....

8. Which institutions does GMA collaborate with in flood management in Accra?

.....

.....

.....

9. Is GMA satisfied with the level of collaboration?

Yes [ ] No [ ]

10. If no, why?

.....

.....

.....

11. What recommendations would you make to reduce the effects of floods in Accra?

.....

.....

THANK YOU FOR YOUR TIME

APPENDIX 8: NADMO PUBLIC EDUCATION MESSAGES

NATIONAL DISASTER MANAGEMENT ORGANISATION (NADMO) MESSAGES TO BE USED BY THOSE ON INFORMATION VANS TO MARKETS AND PUBLIC PLACES

1. Always find out if the area you are to build suffers from floods in order not to build on water ways.
2. Never put refuse or solid materials in drains and discourage others from doing so.
3. Always help to desilt or clean gutters or drains and encourage others to do same.
4. Always identify a higher place where you can run to during unexpected floods in your area.
5. If it will be safe to save animals during floods, do so. However if the situation is not good run to safety and leave the animals alone.
6. In getting out of flooded areas, do not carry heavy objects on or with you.
7. Do not drink flood water and do not eat food contaminated by the flood water.
8. After floods in your home disinfect your home/rooms.
9. Flood waters are contaminated with faecal matter and therefore cause water borne diseases. E.g. diarrhea, dysentery, cholera, typhoid, malaria, etc.
10. Always let your community clear water channels to improve drainage in and around your area.
11. Raise alarm to inform others of looming floods.
12. Do not try to swim in the flood waters. The current could be dangerous and you may hit some underwater obstructions.
13. Do not drive through the flood waters. The current could be dangerous and you and your vehicle could be swept away by the floods.
14. Do not sell contaminated water or food for consumption to the general public.
15. Cleanliness, our environment, our health.
16. Siting kiosks indiscriminately on water ways etc. must be avoided.
17. Clean your environment and save a life.
18. In case of a flood disaster, call the following numbers of NADMO
    - 0302772926
    - 0302785375
    - 0302982531

APPENDIX 9: SAMPLE SIZE CALCULATION FOR GLEFE

Population of Glefe according to 2000 census = 2,072

Projected population of Glefe (2014) = 3,177

Number of households in Glefe according to 2000 census= 292

Projection of households in 2014 is $Pt= Po (1+r)^n$

Where

Pt= Projected population (number of households in year 2014)

Po = Base population (number of households in year 2000)

r= intercensal growth rate (between year 2000 and 2014)

n= number of years

Therefore

$Pt= 429 (1+0.031)^{14}$

$Pt= 429 (1.031)^{14}$

Pt= 429 (1.533)

Pt= 657.77

The projected number of households in Glefe in 2014 is **658**

Number of households in Glefe to be sampled =

$$n = \frac{N}{1 + N (e)^2}$$

Where n = sample size
N = sample frame
e = error of margin

At 5% margin of error

$$n = \frac{658}{1 + 658 (0.05)^2}$$

n = **248**

Calculated sample size for Glefe is **248**