

**MASTER'S PROGRAMME IN
URBAN MANAGEMENT AND DEVELOPMENT**

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**“Empirical Assessment of Adaptive Capacity of Low-Income Communities to
the Impacts of Climate Change and Flooding: The Case of Ayigya in the
City of Kumasi, Ghana”**

**Aldrin B. Plaza
Philippines**

Supervisor: Aloysius Bongwa

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EXECUTIVE SUMMARY

Environmental studies on global climate have revealed that human-related activities have contributed greatly to the increase in greenhouse gases which has resulted to the increase in global temperature and thereafter the global climatic cycle. Although not all disasters are linked to climate change, the most devastating of all disasters and their effects and increase in magnitude have been proved to have a direct link with climate change, and that is flooding. In the case of the Ayigya community in Ghana, the lack of measures to adapt and mitigate the impacts of climate change and flooding was identified to be a problem the community is facing. Taking-off from this the study aimed at investigating the adaptation and mitigation strategies and measures that are existing in Kumasi and in Ayigya particularly, and whether there are mechanisms to operationalize them. In addition, the study also aimed at determining what socio-economic and ecological factors of Ayigya are potentially vulnerable to climate change and disaster impacts. The study's geographical scope was situated in the old traditional villages of Ayigya (Ahimbono and Zongo) which has an approximate land area of about 55 hectares. Ayigya was described here as a community whose haphazard development was dictated with the demand for low-income rental housing primarily because of the establishment of the Kwame Nkrumah University of Science and Technology (KNUST) campus right across its location.

The concepts and cases discussed in the study's literature review dealt with climate change as not just an environmental problem but as a development issue that has to be addressed up to the community level. The fact that climate change has now been identified to have social and economic impacts means that communities should be made aware of the activities and practices that add up to the magnitude of greenhouse gas emissions which causes climate change like for one, the use of firewood as fuel for lighting and cooking which not only emits carbon dioxide but also contributes to the reduction of carbon sinks. But more important are adapting to the impacts of climate change which at this point are considered irreversible – meaning climate change cannot be stopped but its impacts can only be delayed or reduced to a certain magnitude. Specifically, low-income communities which are the most susceptible to climate change impacts like flooding and erosion have to be capacitated and be involved pro-actively in making their communities resilient to these impacts.

The research methodology designed for this study was exploratory. For the primary data, the methods of data collection implied here consist of household interviews, in-depth and experts' interviews, transect survey as a field observation method, and peer discussions. The household surveys were done with 100 respondents selected from the estimated 6,000 households in Ayigya. Observation methods through transect surveys were done to get an initial idea about Ayigya's physical environment. The in-depth and experts' interviews were done to get specific information from selected respondents from the community, the government and academic and research institutions based in Kumasi. Quantitative analysis using the Erosion Potential Method (EPM) to determine the erosion category in Ayigya was also done to verify the results of the qualitative analysis.

The study also presented four international cases related to climate change and disaster impact adaptation and mitigation. These cases were taken from the Philippines, India, Mexico and Kenya. The first is the Philippine case which dealt with pro-active participation of low-income

communities in managing and mitigating disaster prevention and preparedness measures at the community level. The case of India showed how information and communication technology (ICT) tools such as geographic information systems (GIS) can improve planning and decision-making for government officials in order to address development issues such as climate change and disasters more effectively and accurately develop measures to mitigate them. The case of Mexico not only gave an example of a good disaster risk management (DRM) system but also showed the importance of involving and recognizing the valuable inputs of technical experts from academic and research institutions. Lastly the case of Kenya showed how protecting the local economic base, in this case agriculture, against the impacts of disasters can make communities less vulnerable to the effects of disaster in the social and economic aspects.

The findings of the study focused on three main things – the existing strategies and measures related to climate change adaptation and DRM; institutional mechanisms to operationalize disaster preparedness strategies; and the socio-economic and ecological characteristics of Ayigya. From these, the vulnerabilities and potential impacts to climate change and natural disaster were drawn and the analysis yielded among others, the following salient results – (i) erosion is the most severe environmental problem in Ayigya which is supported by qualitative data from field and secondary sources and also from the results of the quantitative analysis using the EPM method; (ii) Ayigya Zongo is the more socially and economically vulnerable to climate change and disaster impacts compared to Ayigya Ahimbono; and (iii) there are overlapping of functions existing between several government agencies and the governance tools being used are too outdated and are almost un-applicable to Ayigya’s existing conditions.

In conclusion, the research concluded first of all that the most severe problem in Ayigya related to climate change and disaster impacts is erosion which is an after-effect of torrential rains and flooding. However in relation to these phenomena, the strategies and measures on disaster management in Kumasi are more reactive in nature. On the institutional mechanisms, there are some overlaps in the functions of several agencies involved in disaster management and the common problem faced by all of them is the lack of financial resources and shortages in logistics for conducting field operations. The National Disaster Management Office (NADMO) also has a good organizational structure from the national down to the local level but this has fallen short in Ayigya where no disaster volunteer group has been established to assist NADMO in the on-site operations particularly in implementing emergency response measures. To address these concerns, several actions have to be done both at the level of the Kumasi Metropolitan Authority (KMA) and also at the community level to enhance their institutional capacity in disaster management. Among the things that need to be done are the establishment of the community-based disaster volunteer group (DVG), capacity-building, and establishment of partnerships with local and international institutions and organizations. In the concept of sustainable development, this study concluded that given the physical, social, economic, and governance issues existing in Ayigya and Kumasi, achieving sustainable development in this case still has a long way to go.

Key words: Sustainable Development, Climate Change and Disaster Impact Adaptation and Mitigation, Disaster Risk Management, Vulnerability, Flooding and Erosion

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LIST OF ABBREVIATIONS

AVBR	Academie van Bouwkunst Rotterdam
BRRRI	Building and Road Research Institute
CCCI	Cities in Climate Change Initiative
DRM	Disaster Risk Management
DVG	Disaster Volunteer Group
EMI	Earthquakes and Megacities Initiative
EPM	Erosion Potential Method
GAMA	Greater Accra Metropolitan Assembly
ICT	Information and Communication Technology
IEC	Information, Education and Communication
IFRC-RCC	International Federation of the Red Cross and Red Cross Crescents
IPCC	Intergovernmental Panel on Climate Change
ISDR	International Strategy for Disaster Reduction
KMA	Kumasi Metropolitan Assembly
KNUST	Kwame Nkrumah University of Science and Technology
MSE	Micro Small Enterprises
NADMO	National Disaster Management Organization
NDRC	National Disaster Relief Committee
UN	United Nations
UNDP	United Nations Development Programme
UNDRO	United Nations Disaster Relief Co-ordinator
UNESCO	United Nations Educational, Scientific and Cultural Organization

TABLE OF CONTENTS

	Page
Executive Summary.....	i
Acknowledgements.....	ii
List of Abbreviations.....	iii
List of Tables.....	vii
List of Figures.....	vii
List of Boxes.....	viii
Chapter 1: Introduction.....	1
1.1 Background of the Study.....	1
1.2 Statement of the Research Problem.....	4
1.3 Objectives of the Study and Research Questions.....	5
1.4 Scope and Limitations.....	6
1.5 Thesis Structure.....	6
1.6 Summary.....	8
Chapter 2: Literature Review.....	9
2.1 Sustainable Development, Globalization and the Changing Environment.....	9
2.2 Disasters and their Nature.....	11
2.3 Geographical Factors Involving Disasters.....	12
2.4 Climate Change Impact Adaptation.....	12
2.5 Disaster Risk Management Concepts.....	14
2.6 Planning for Disaster-Free Human Settlements.....	14
2.7 Framework for Integrating Disaster Risk Mitigation into Land Use Planning and Risk Management Practices, The Philippines’ Experience.....	15
2.8 Disaster Risk Management for Floods.....	16
2.9 Impacts of Urban Growth to the Urban Environment and Public Health with the Advent of Climate Change and Disasters.....	17
2.10 Economic and Financial Impacts of Disasters.....	20
2.11 The Relationship Between Climate Change Adaptation and Disaster Risk Management.....	21
2.12 Conceptual Framework.....	22
2.13 Summary.....	23
Chapter 3: Research Methodology.....	24
3.1 Description of the Study Area.....	24
3.2 Research Design.....	27
3.2.1 Research Type.....	27
3.2.2 Data Collection Methods.....	27
3.2.3 Data Processing and Analysis.....	29

3.3 Analytical Framework.....	30
3.4 Research Variables and Indicators.....	30
3.5 Summary.....	31
Chapter 4: Related Case Studies on Climate Change and Disaster Impact Adaptation	33
4.1 Community-Driven Disaster Prevention: The Case of the Homeless People’s Federation of the Philippines Experience.....	33
4.2 Enhancing Disaster Management Through GIS: The Case of Allahabad City, India...	34
4.3 Formulating and Implementing National Disaster Management Systems: The Case of Mexico.....	36
4.4 Disaster Preparedness, Prevention, Mitigation and Management in Kenya.....	36
4.5 Lessons from the Cases Presented.....	37
4.6 Summary.....	39
Chapter 5: Findings and Analysis of the Study.....	40
5.1 On the disaster preparedness strategies in Kumasi and in Ayigya.....	40
5.2 On existing mechanisms to operationalize disaster preparedness strategies.....	43
5.3 On the socio-economic and ecological conditions in Ayigya.....	46
5.4 Vulnerabilities, Potential Impacts and Institutional Gaps.....	53
5.4.1 Physical and Environmental Vulnerabilities and Potential Impacts.....	53
5.4.2 Social Development Vulnerabilities and Potential Impacts.....	57
5.4.3 Economic Development Vulnerabilities and Potential Impacts.....	58
5.4.4 Governance/Institutional Gaps.....	59
5.5 Application of Lessons from Related Cases.....	62
5.6 Summary.....	63
Chapter 6: Conclusions and Recommendations.....	64
6.1 Conclusions.....	64
6.2 Recommendations.....	66
6.2.1 Potential Areas/Mechanisms for Enhancing Institutional Capacity.....	66
6.2.2 Options for Adaptation and Institutional Interventions.....	67
6.2.3 Potential Areas for Further Research.....	69
6.3 Summary.....	70
Bibliography.....	71
Annexes.....	74

LIST OF TABLES

	Page
Table 2.1: Examples of Multi-level Adaptation Measures for some Anticipated Health Outcomes of Global Climate Change.....	13
Table 2.2: Summary of Some of the Likely Impacts of Climate Change.....	19
Table 3.1: Research Variables and Indicators.....	31
Table 4.1: Summary of Key Lessons from Related Cases on Climate Change and Disaster Impact Adaptation.....	39
Table 5.1: Coefficient Values for Y, X, and \square	55
Table 5.2: Erosion Coefficient, Z.....	56
Table 6.1: Timing of Inputs of Mechanisms for Enhancing Institutional Capacity.....	67
Table 6.2: Options for Adaptation and Institutional Interventions to Vulnerabilities and Potential Impacts of Climate Change and Flooding.....	68

LIST OF FIGURES

Figure 1.1: Location of Metropolitan Kumasi Area, Ashanti Region.....	3
Figure 1.2: Location Map of Study Area.....	6
Figure 2.1: Illustration of Adaptation and Mitigation Using Problem Tree Analysis Model.....	13
Figure 2.2: Disaster Management Framework.....	14
Figure 2.3: Model for Mainstreaming DRM into Land Use Planning.....	15
Figure 2.4: Conceptual Framework.....	22
Figure 3.1: Kumasi Soil Classification Map.....	25
Figure 3.2: Topographic Map of Ayigya.....	26
Figure 4.1: Allahabad Flood-Affected Areas Map.....	35
Figure 4.2: Allahabad Route of Relief Map.....	35
Figure 4.3: Allahabad Paved and Mud Road Connectivity Map.....	35
Figure 4.4: Allahabad Map of Location of Hospitals in Flood Affected Areas.....	35
Figure 5.1: Road Network and Drainage of Ayigya Ahimbono and Zongo.....	40
Figure 5.2: Map showing roads, paths and alleys with gully formations and drainage pattern.....	42
Figure 5.3: NADMO Organizational Structure.....	43
Figure 5.4: HH Survey Responses on the Perception on Top Priority Problems Encountered in Ayigya.....	46
Figure 5.5: Slope and Topographic Projection at HH Survey Respondent 17, 31, and 32 in Ayigya Zongo.....	47
Figure 5.6: Slope and Topographic Projection of the Ayigya Zongo Section on the East Side.....	47
Figure 5.7: HH Survey Responses on Age of Houses.....	51
Figure 5.8: HH Survey Responses on Educational Level.....	52
Figure 5.9: HH Survey Responses on the Source of Income.....	52
Figure 5.10: The 1978 Scheme of Ayigya showing the line of gully formations and its line of extension based on the 2004 survey map.....	54

LIST OF BOXES

Box No. 1: Floods in Ghana, 2009	45
Box No. 2: The Stages of the Davision Cycle of Erosion with Climatic Interventions	50

*“We cannot stop natural calamities, but we can and must better equip
individuals and communities to withstand them”*

KOFI ANAN

Former UN Secretary General
Chancellor, University of Ghana, Legon

CHAPTER 1: INTRODUCTION

The first chapter provides the background information and rationale for the chosen topic of this thesis. Also in this chapter are the study's research problem, objectives and research questions which are meant to ensure that the whole research process will be focused in the topic presented. The scope and limitations define the areas of study mainly in the geographical aspect as well as the expected and encountered constraints in the conduct of the fieldwork activities. The last section of this chapter presents an overview of the structure of this thesis briefly describing the contents of each of the six chapters.

1.1 Background of the Study

Discussions of environmental problems involving cities would not be complete without considering the impacts of its activities on what we call as the "global commons" which include the depletion of non-renewable resources and emissions of greenhouse gases which contribute significantly to the depletion of the stratospheric ozone layer and has caused the global phenomenon which is climate change (Hardoy, Mitlin and Satterthwaite, 2001). The main contribution of city-based consumption to greenhouse gases are carbon dioxide emissions from the combustion of fossil fuels for power generation using coal and oil as fuel, industrial operations, motor vehicles and other domestic and commercial energy uses as well as city-based demand for fuel wood consumption like in the case of many peri-urban areas of African Cities (Ibid).

The effects and impacts brought about by climate change to the global commons have now become the preeminent development challenge of different countries. The most obvious effect of climate change that is most felt are changing weather conditions in a global scale which have brought extended periods of extreme precipitation and in some cases altering with severe droughts. Climate-induced changes in the frequency and magnitude of precipitation have increased flooding, landslides and erosions most of which have affected settlement areas (Hardoy, Mitlin and Satterthwaite, 2001). The most severely affected of this are small urban villages are located on or close to rivers and other surface waters and which have been affected by repeated incidents of flooding due mainly to inadequate investment on storm drainage network and flood control systems. These repeated incidents of flooding have put inhabitants of cities, especially the small urban villages at risk of loss on life and property.

The resilience of settlements, especially slums with the advent of changing climactic conditions has made them more and more vulnerable to the impacts of disasters. Effects of climate change like extended rainy seasons has caused settlements, especially slums, susceptible to the impacts of possibly increasing incidents of flooding which could lead either to soil erosion and thereafter loss on life and property, or water stagnation as a result of poor drainage which could lead to the outbreak of diseases such as malaria and dengue fever. **Rajenda Pakuari**¹, chairman of the Intergovernmental Panel on Climate Change (IPCC) states that "*while the prime responsibility*

¹ Rajenda Pakuari is a Nobel Prize Winner and chairman of the Intergovernmental Panel on Climate Change. He is also the Director-General of the Energy and Resources Institute of India.

for climate change lies with developed nations, the poor are those who suffer the most when climate disasters strike – whether in developed or developing countries”.

In the UN Habitat State of World Cities Report (2007), a slum household is defined as a group of individuals living under the same roof in an urban area who lack one or more of the following:

1. Durable housing of a permanent nature that protects against extreme climate conditions.
2. Sufficient living space which means not more than three (3) people sharing a room.
3. Easy access to safe water in sufficient amounts at an affordable price.
4. Access to adequate sanitation in the form of public or private toilet shared by a reasonable number of people.
5. Security of tenure that prevents forced evictions.

The first of these five conditions for determining a slum area emphasizes that settlements should also be safe from disasters especially those caused by nature such as floods, landslides and earthquakes. Another definition of slums are that they are neglected parts of cities where housing and living conditions are appallingly poor ranging from high density, squalid central city tenements to spontaneous squatter settlements without legal recognition or rights (Working on Cities Reader, AVBR, 2009)

Ghana in West Africa has been susceptible to different kinds of disasters including plague and disease outbreak and floods caused by excessive rains. In 2007, the International Federation of the Red Cross and Red Cross Crescents reported the occurrence of torrential rains which lasted for three weeks in the Upper East Region of Ghana causing the death of twenty-two persons and the displacement of 200,000 more individuals most of whom are farmers (IFRC-RCC, 2007). Although disaster preparedness strategies have been formulated by the national government of Ghana with the creation of the National Disaster Relief Committee (NDRC) in 1992 not much success has been done on the actual operations due to lack of financial resources and weak institutional structure from the national going to the local level of government. That is why in 1996 through Act 517, the national government of Ghana created the National Disaster Management Organization (NADMO), an autonomous body created by the national government to prepare disaster preparedness plans for Ghana. The NADMO is composed of seven (7) committees that handle disaster planning and mitigation for seven (7) areas namely:

1. Geological disasters
2. Pest and insect infestation disasters
3. Relief and reconstruction
4. Hydrometeorological disasters
5. Bushfires/areas affected by lightning
6. Epidemics
7. Man-made disasters

Under Act 517 of 1996, it requires each district in Ghana to formulate District Disaster Management Plans which is to form an internal part of their district and local development planning processes. Along with these plans, other agencies and non-government groups such as

the Ghana Red Cross Society are also conducting outreach and education campaigns particularly on school children and community groups about disaster response plans. Among the topics that they teach are those about fire safety, flooding, first aid and also conducting trainings for fire fighters on disaster response. However despite all these new efforts, allegations of mismanagement and lack of productivity have always been associated with NADMO since it was established and was pointed out as a vehicle used by some political leaders to pursue their political interests particularly that of being re-elected to their position which has led to the ineffectivity of disaster plans prepared by the respective metropolitan and district areas of Ghana. One such case of failure to implement disaster preparedness plans is in the case of Ghana's capital city Accra. A disaster preparedness strategy was developed by the Greater Accra Metropolitan Assembly (GAMA) in 1991. However based on feedbacks and surveys conducted by GAMA and NDRC, the situation in terms of responding to post disaster impacts has not improved. It was learned that factors such as inadequate manpower and logistics, poor communication systems, ad hoc planning, and inadequate public education and support has caused the failure of the disaster preparedness strategy of Accra. Moreover at the national level, the NDRC was given limited funding which could only cover relief activities. Because of this other post disaster activities such as rehabilitation of affected areas could not be implemented.

The problem of implementing disaster preparedness plans is further aggravated by rapid population growth and urbanization which has lead to increased slums as a result of the government's failure to address these phenomena. In Africa, urbanization of cities has given rise to other problems involving land use, especially settlement areas. In the case of Ghana, the population increased by about 50% between the years 1994 to 2000 with an annual population growth rate of 2.7%. Of the country's population, 30% live below the poverty line with about 50% having no access to potable water, and a vast majority of them living in slums with a portion still with no access to formal housing (Human Settlements Ghana, 2003).

In the City of Kumasi, the growth of peri-urban communities depends very much on their proximity to the city center and also to their adjoining areas and the activities therein. Kumasi is located in a transitional forest zone located about 270 km. north of Accra (see Figure 1.1). The location of the city is almost at the center of Ghana and is traversed by a number of major road networks making it an area susceptible to migration. For the City of Kumasi, a peri-urban interface area defined as places "with presence of bush/fallow agricultural land, but with competition for land from non-agricultural uses" and is

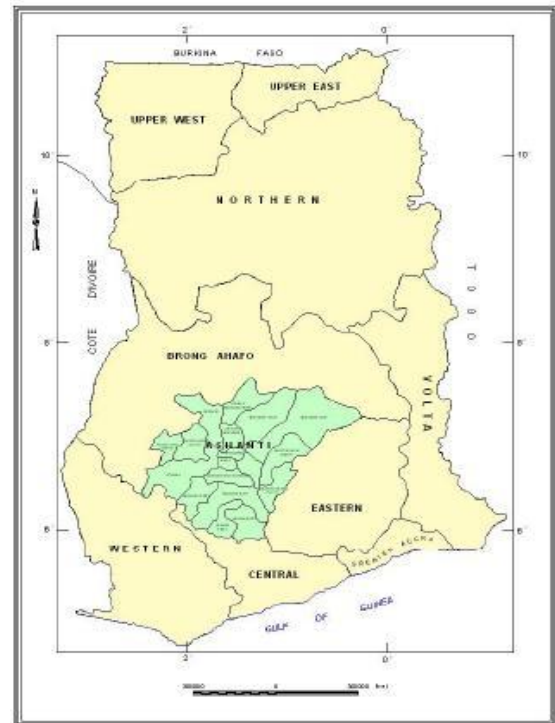


Figure 1.1: Location of Metropolitan Kumasi Area, Ashanti Region (Source: Mwinlanaah Yuonavel Ghana Atelier Workshop Presentation)

determined as areas from 4 to 47 km from the center of Kumasi (Brook and Davilla, 2000). For areas closer to the city center, newcomers are attracted to these areas due to the high cost of housing in the city center where rental housing is still considered expensive for the poor. They choose to settle in these peri-urban areas as their day-to-day activities are dependent to the activities at the city center. Rental houses in Kumasi are made up of large compound houses accommodating several households. Many of these dwellers use their houses for income-generating activities as well such as food production, shops and services like hairdressing and day care.

One of these peri-urban villages in Kumasi is the community of Ayigya, a suburb of Kumasi under the Ofiokorm sub metro located about 5 km. from the Kumasi City Center. It is bounded by Asokre Mampong to the north, Kwameh Nkrumah University of Science and Technology (KNUST) campus to the south, Kentinkronu to the east and Maxima to the west. The major Accra-Kumasi road separates the suburb and the KNUST campus.

1.2 Statement of the Research Problem

In the African region, enhancement of adaptive capacities especially of local governments to formulate and implement adaptation measures with broad sustainable development strategies is seen as a critical factor to address the impacts of climate change in African cities (Smit and Pilifosova, 2007; Moser and Satterthwaite, 2008). If these initiatives on enhancing adaptive capacities would not be done, the vulnerability of African cities to the effect of climate change would cause more devastating effects to low-income communities as a result of droughts or excessive rains which cause flooding.

In the case of Ayigya, the subsiding level of topsoil along the streets and dwelling units are clear evidences of flooding and erosion in the area. Although there has been no properly documented history of the events of flooding in the area, there is an indication that flooding and erosion has repeatedly occurred in the area for quite some time without putting up sustainable measures to mitigate its possible future impacts like weakening of house structures. The situation gets worse each year as Ayigya also lacks the necessary drainage infrastructure to convey rain water into the proper catchment areas.

Based on this first-hand information the problem therefore is *the lack of appropriate measures in Ayigya to mitigate and adapt to the impacts of climate change and flooding.*

Given the poor physical conditions of the community of Ayigya plus its natural physical characteristics, the need for upgrading the settlement to make it more livable is deemed necessary. Initial activities for slum upgrading have already been being conducted by several academic institutions with the aim of assisting the Kumasi Government in preparing the appropriate plans for the area to improve the living conditions of the Ayigya settlers. And because of the previous events of natural disasters in the area, primarily flooding, the need for structural and non-structural means of mitigating future impacts of disasters in the areas should also be done as part of planning the area for slum-upgrading.

1.3 Objectives of the Study and Research Questions

This study investigated whether there are adaptation strategies/measures that are in place in the City of Kumasi and whether the community of Ayigya has the capacity to implement these strategies.

Specifically, the objectives of this research are to:

- i. Determine if adaptation strategies and mitigation measures are in place in the city of Kumasi;
- ii. Determine the implementation mechanisms of the City of Kumasi with regards to disaster preparedness and whether these respond to the needs of the community, particularly Ayigya, in mitigating the potential impacts and in responding to events of disasters, specifically flooding;
- iii. Investigate the vulnerability of the Ayigya community to the impacts of climate change and flooding and the preparedness/capacity not only of the local government but the inhabitants of the community to mitigate them;
- iv. Present similar or related cases on climate change impact adaptation in other cities and/or countries which they can learn from; and
- v. Determine which structural and non-structural measures for adapting and addressing the future impacts of flooding can be integrated into the planning of Ayigya for slum-upgrading based on its existing assets.

With these objectives at hand, the main research question for this study is:

- i. Are disaster preparedness strategies for climate change and flooding in place in the City of Kumasi, particularly in Ayigya?

To respond more elaborately to the question, the following questions were also looked into:

- ii. If there are such strategies, what are the existing implementation mechanisms to operationalize disaster preparedness strategies for climate change and disaster impacts in Ayigya?
 - Are financial resources available for implementation?
- iii. What are the vulnerable socio-economic and ecological characteristics of the Ayigya community with regards to climate change and disaster impacts?
- iv. What lessons can be learned from the related cases on disaster management presented in this study?

- v. What adaptation strategies and measures specifically appropriate for Ayigya can be done/proposed based on its existing assets?

1.4 Scope and Limitations

The scope of this study in terms of geographical coverage is within the community of Ayigya, specifically the low-income communities located in the Old Ayigya (the traditional village and the “Zongo” areas) (see Figure 1.2), and will focus strictly on the incidents of flooding and erosion. The study focused mainly on finding appropriate strategies to mitigate the impacts of future event of flooding and erosion in Ayigya through structural and non-structural means.

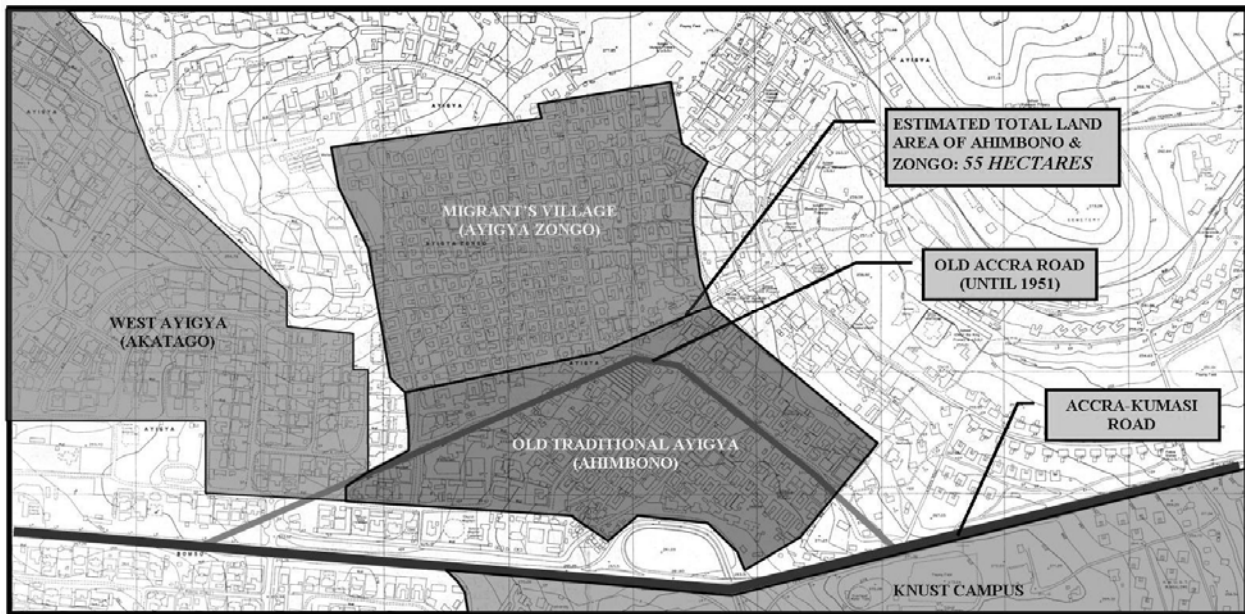


Figure 1.2: Map of the study area

There are a number of limitations and constraints for this study. The first is the unfamiliarity of the study area plus the short time allotted to conduct actual fieldwork. Language translation to English was thought of earlier as a constraint, but this was hardly encountered as students from the Architecture Department of KNUST who are Twi dialect native speakers accompanied the researcher during the household survey.

1.5 Thesis Structure

This thesis shall be composed of six chapters with the structure to be arranged as follows:

Chapter 1: Introduction.

Chapter 1 provides the background information and rationale for the chosen topic of this thesis. Also in this chapter are the study’s research problem, objectives and research questions which

are meant to ensure that the whole research process will be focused in the topic presented. The scope and limitations define the areas of study mainly in the geographical aspect as well as the expected and encountered constraints in the conduct of the fieldwork activities. The last section of this chapter presents an overview of the structure of this thesis briefly describing the contents of each of the six chapters.

Chapter 2: Literature Review

Chapter 2 lays out the theoretical foundations and concepts related to the chosen thesis topic. This chapter starts with the discussion on sustainable development which will serve as the overarching concept of this whole study. The succeeding sections then dealt with other related concepts and cases on the nature of disasters and its geographical context, a thorough discussion about the difference between climate change adaptation and mitigation, urbanization, the relevance of environmental planning to climate change and DRM, socio-economic impacts of disasters, and the relationship between climate change and disasters. A case on integrating disaster management into land use planning is also presented in one of the sections of this chapter.

The last part of this chapter presents the conceptual framework of the study which illustrates the relationship between sustainable development and climate change and disaster impacts.

Chapter 3: Research Methodology

Chapter 3 gives a description of the research area including its physical characteristics – geomorphology, slope and topography. Also discussed in this chapter are the research design and the different methodologies used to gather data and other information needed to come up expected results of the study based on the objectives and research questions in Chapter 1.

The other sections of this chapter deals with the detailed discussion of the analytical process to be used illustrated through an analytical framework, and the respective variables and indicators based on the first three research questions of the study. The data sources of for each of the variables and indicators are also presented. The variables and indicators were based on the first three of the five research questions of the study as the fourth research questions has to do with the lessons learned from different international cases while the fifth is for the conclusions and recommendations of the study.

Chapter 4: Related Case Studies on Climate Change and Disaster Impact Adaptation

Chapter 4 presents four related international cases studies on climate change and disaster impact adaptation from Asia, Latin America and Africa. From these cases, relevant lessons will be drawn that will serve as a benchmark for the subject of this study in formulating doable recommendations to address the identified hazards and risks in Ayigya as well as the institutional gaps on the aspect of governance in relation to DRM.

Chapter 5: Analysis and Results

Chapter 5 presents the analysis of the findings of the study based on the first three research questions. The results of these analyses would be the identification of the socio-economic vulnerabilities and potential risks of Ayigya to climate change and disaster impacts as well as the institutional gaps that need to be addressed in relation to climate change adaptation and disaster impact mitigation. To answer the fourth research question, the last part of this chapter gives the applicable interventions culled out from the lessons from the international cases presented in the previous chapter.

Chapter 6: Conclusions and Recommendations

Chapter 6 answers the fifth and last research question of this study. Based on the findings from the primary and secondary sources and the analysis of the data gathered, conclusions were drawn regarding Ayigya's collective vulnerability to the impacts of climate change and disasters and the capacity of the community and the government to address these vulnerabilities and potential impacts. Also tackled in this chapter is the linkage of the results of this study to the concept of sustainable development discussed in Chapter 2. The last part of this chapter consists of indicative frameworks for timing of cooperation and collaboration mechanisms to bridge the identified institutional gaps, the assessment of climate change adaptation options based on the identified vulnerabilities and potential impacts, and the areas for further research.

1.6 Summary

In this chapter, the study's background described how human-related activities have contributed to the increase in GHGs which has resulted to the increase in global temperature and thereafter the global climatic cycle. Although not all disasters are linked to climate change, but one, if not, the most devastating of all disasters and their effects and increase in magnitude have been proved to have a direct link with climate change, and that is flooding and erosion. In the case of the Ayigya community in Ghana, adapting and mitigating the impacts of climate change and flooding was identified as the problem to be investigated in this research. The objectives and research problems are therefore aimed in: investigating the adaptation and mitigation strategies and measures that are possibly been existing in Kumasi and in Ayigya particularly, and whether there are mechanisms to operationalize them; determining what socio-economic and ecological factors of Ayigya that are potentially vulnerable to climate change and disaster impacts, and the institutional gaps in implementing adaptation strategies and mitigation measures; finding related international cases from which lessons can be drawn; and recommending appropriate structural and non-structural strategies and measures based on the analysis of the results of the study and the related international cases. The study's geographical scope was situated in the old traditional villages of Ayigya (Ahimbono and Zongo) which has an approximate land area of about 55 hectares.

CHAPTER 2: LITERATURE REVIEW

This chapter lays out the theoretical foundations and concepts related to the chosen thesis topic. This chapter starts with the discussion on sustainable development which will serve as the overarching concept of this whole study. The succeeding sections then dealt with other related concepts and cases on the nature of disasters and its geographical context, a thorough discussion about the difference between climate change adaptation and mitigation, urbanization, the relevance of environmental planning to climate change and DRM, socio-economic impacts of disasters, and the relationship between climate change and disasters. A case on integrating disaster management into land use planning is also presented in one of the sections of this chapter.

The last part of this chapter presents the conceptual framework of the study which illustrates the relationship between sustainable development and climate change and disaster impacts.

2.1 Sustainable Development, Globalization, and the Changing Environment

The most well-known definition of *sustainable development* is the one by the Brundtland Commission which is “*meeting the needs of the present generation without compromising the needs of the future generation to meet their own.*” Another definition of sustainable development according to Blewitt (2008) is that it is also about protecting and conserving the planet’s natural environment. The core concept of sustainable development is about reconciling ‘development’ (which implies the finite use of resources and the generation of wastes) with the ‘environment’ (which implies finite limits on the use of many resources and on the capacity to absorb or break down wastes or render them harmless) at local, regional and global scales (Hardoy, Mitlin and Satterthwaite, 2001). From this concept, development driven by an excessive or worse abusive use of resources would result to generation of enormous amount waste products thereby resulting to: (i) the depletion of resources for future use which could possibly lead to a decline on socio-economic conditions; and (ii) decreasing capacity of ecosystems to absorb development and its impacts. More specifically, this concept implies that human activities determine the state of the environment and the world’s resources, including our lifestyles and consumption patterns, and thus will leave a lasting impact not only at present but in the future as well. One practical illustration of this is how cities manage their waste – i.e. are wastes managed in such a way that it would minimize the environmental costs in the future like costs that it would imply to eliminate the impacts of accumulated toxic wastes brought about by poor waste management practices of industries resulting to the polluting of rivers and waterways. Maybe the present generation would not be able to feel the adverse impacts of these activities, but the costs of these activities could impact in 20 to 30 years at a time when a new generation of communities has evolved.

One of the development trends that have engulfed urban areas is *globalization*. It is often said that for cities to be sustainable they must be globally competitive. Globalization may be thought of initially as the widening, deepening and speeding up of worldwide interconnectedness in all aspects of contemporary social life, from the cultural to the criminal, the financial to the spiritual (Blewitt, 2008). The pressures for some cities to be globally competitive has somewhat put them in a struggle to balance this with the concept of sustainable development. Since the industrial

revolution, globalization impacts on the environment has taken its toll in different forms like the exploitation of common resources such as air and marine thereby affecting the hydrological cycles and meteorological conditions in a world-wide scale. The US Environmental Protection Agency has reported that world temperature has increased by about 1.7 deg F for the past 100 years. This phenomenon only implies that globalization has also brought about negative impacts that have now become key issues among which are climate change, water shortage and resource depletion which has occurred due to: the exploitation of global commons – the atmospheric, marine environment and hydrological cycles; demographic expansion that leads to increase in pollution and consumption of global materials; and trans-boundary pollution involving the transmission of pollutants through air, soil and water across political borders (Ibid).

For the African Region, the 2009 State of the World Report by the Worldwatch Institute has identified the following impacts of climate change:

- i. Heavily populated delta regions at risk from flooding;
- ii. Severe reductions in crop yields and fisheries production; and
- iii. 75 to 250 million people without access to fresh water by the year 2020.

These changes in meteorological conditions has caused excessive rains (El Niño) and droughts (La Niña) in different regions especially in Asia and Africa thereby negatively affecting people's socio-economic activities, especially those living in low-income level conditions. In addition, with low and middle income countries having most of the world's urban population, this means that they also have most urban population at greatest risk from the increased intensity and frequency of storms, flooding, landslides and heatwaves and constraints on fresh water that climate change brings (Moser and Satterthwaite, 2008).

According to the IPCC, there two things that are certain in relation to climate change:

- i. There is a natural greenhouse effect which already keeps the earth warmer than it would other wise be (Owen and Unwin, 1997).
- ii. Emissions resulting from human activities that are substantially increasing the atmospheric concentrations of the greenhouse gases: carbon dioxide, methane, chlorofluorocarbons (CFCs), and nitrous oxide. These increases will enhance the greenhouse effect, resulting on average in an additional warming of the earth's surface, and in effect the main greenhouse gas, water vapour, will increase in response to global warming and further enhance it (Owen and Unwin, 1997).

From statement number 2, the question many would ask maybe – *“Just how does human activities change global climate?”* Greenhouse gases are what keep the earth warm enough to be inhabitable by living creatures. However, there are human activities that introduce other greenhouses gases which could cause the rising of global temperature and therefore cause changes in global climate cycles. Among the use of aerosols and burning of fossil fuels for energy production which causes the changes in the ultra-violet shield ozone in the stratosphere

and changes in cloud formation cycles as they may form in lower atmospheric temperatures thereby causing increased incidents of extreme rainfall.

In the case of small urban communities located in flood plains or along river banks, the increased incidents of extreme rainfall coupled by extended rainy seasons have put them at risk of the damages of flooding which could negatively affect their economic and social activities. Add to this are erosions which could occur in at least two possible ways – one is washing away of surface topsoil on settlements with poor drainage networks which will cause foundation structures to be exposed and slowly cause physical damage to settlement structures; and the other are flashfloods brought about by washing away of topsoil from steep areas where deforestation has caused the depletion of tree cover which used to make the soil intact.

2.2 Disasters and their Nature

The United Nations Disaster Relief Co-ordinator (UNDRO, 1976) defined disasters as the consequence of two (2) different kinds of phenomena. These are: (i) events induced by natural physical process such as earthquakes and volcanic eruptions; and (ii) events induced by human activities such as fire and contamination.

The nature of disasters is that they usually occur in “chains” which could be a series of either or both natural and man-made disasters. In most cases, disasters occur as chains of events with a final outcome that cause damage to both life and property. Examples of chains of events are as follows:

Rainstorm → **Flood** → Water Contamination → Disease Outbreak

Earthquake → Landslide → **Flood**

Earthquake → Tsunami → **Flood** → Water Contamination → Disease Outbreak

Cyclone → **Flood** → Water Contamination → Disease Outbreak

From the examples given above, we can see that most disasters results to one common phenomenon along the chain which is flood. Floods are identified as the most devastating of all disasters, its nature and devastating effects as well as measures to mitigate them shall be discussed in the succeeding literatures.

Disasters are also defined as any occurrence that causes damage, economic disruption, loss or damage to human beings and other beings, deterioration in health systems and other system one scale sufficient to warrant an extra-ordinary response from the outside affected area (Ahmad and Qureshi, 1995). This definition of disasters simply describes them as events that negatively affect the socio-economic conditions of a given territory, be it a city or a small village. Events of disasters could within a few minutes shut down plant operations, prohibit access to transport network, or even leave a family homeless. These and many others are the devastating nature of

disasters which when not addressed with appropriate mitigating measures would result to huge losses in life and property.

2.3 Geographical Factors Involving Disasters

Disasters are also referred to as the disruption and unravelling of spatial or geographic order (Hewitt, 1997). There are four identified geographical factors that influence the extent of the effects of disasters. These are: hazards; vulnerability and adaptability; intervening conditions of danger; and human coping and adjustments. These geographical factors are important considerations in planning for making a territory safe and resilient to disasters as this would provide the basis in coming up with sound and appropriate disaster mitigation measures to ensure a safer community.

Hazards refer to the extent of the threat that disasters pose that we wish to avoid. Like in the case of flooding, it is not the flood itself that creates the risk but the effects of flood like drowning (damage to life) or losing a house (damage to property).

Vulnerability and *adaptability* refers to the characteristics of a community (people and their activities) that can serve to either increase or decrease the negative effects of disasters. Specifically, vulnerability is the proximity of a community to dangerous agents and environments whereas adaptability is their capability to avoid, withstand and recover from disasters, as well as influence safety conditions or acquire means of protection and relief. Intervening conditions of danger refers to the characteristics of the physical environment such as topography, soil type and vegetation cover which can have a significant influence on the magnitude of the impact of disasters.

Lastly *human coping and adjustments* refers to the people's capacity to respond to the challenges of life after the damaging effects of disasters.

2.4 Climate Change Impact Adaptation

Adaptation refers to the adjustment in ecological, social or economic systems to actual or expected climatic stimuli and their effects or impacts. This term refers to changes in processes, or structures to moderate or offset potential damages or to take advantage of opportunities associated with changes in climate (Smit and Pilifosova, 2007). The measures for adaptation are often interchanged with those of mitigation. However there is a difference between the two. In more simple terms, mitigation deals with measures to address the impacts of climate change so as to at least delay its damaging effects whereas mitigation deals with measure to address its causes in order to reduce global warming. Using the problem tree analytical model as an illustration, the difference between adaptation and mitigation using climate change as the core problem is illustrated in Figure 2.1.

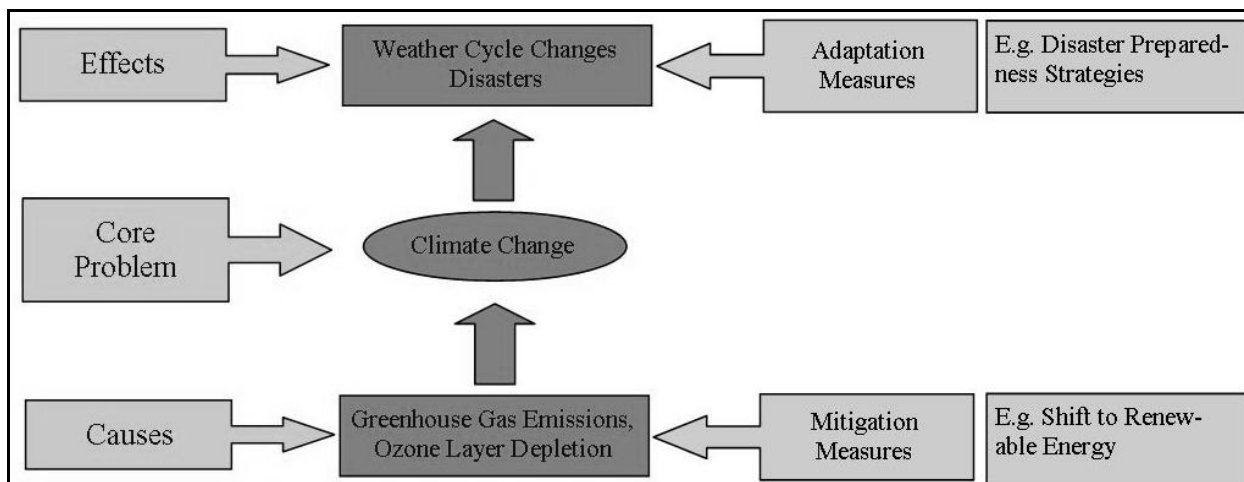


Figure 2.1: Illustration of Adaptation and Mitigation Using Problem Tree Analysis Model

Adaptive capacity refers to the potential or ability of a system, region, country, city or community to adapt to the effects or impact of climate change (Smit and Pilifosova, 2007). Adaptation measures may come in structural and none structural means but most importantly changes in personal behaviour and lifestyle (refer to Table 2.1 below for examples of adaptation measures). However most low and middle income countries and cities are least to implement adaptation measures, especially structural means as they lack the financial capacity to do so (Moser and Satterthwaite, 2008). Moreover, institutional capacity and knowledge on the impacts and causes of climate change is also weak among these cities.

Table 2.1: Examples of Multi-level Adaptation Measures for some Anticipated Health Outcomes of Global Climate Change

Adaptive Measure	Heat-Related Illness	Vector-Borne Disease	Health and Extreme Weather Events
Administrative/Legal	<ul style="list-style-type: none"> - Implement weather watch/warning systems - Plant trees in Urban Areas - Implement Education Campaigns 	<ul style="list-style-type: none"> - Implement vaccination programs - Enforce vaccination laws - Implement education campaigns to eliminate breeding sites of mosquitoes and flies 	<ul style="list-style-type: none"> - Create disaster preparedness programs - Employ land-use planning to reduce flash floods - Ban precarious residential placements
Engineering	<ul style="list-style-type: none"> - Insulate Buildings - Install high-albedo materials for roads 	<ul style="list-style-type: none"> - Install window screens - Release sterile male vectors 	<ul style="list-style-type: none"> - Construct strong seawalls - Fortify sanitation systems
Personal Behaviour	<ul style="list-style-type: none"> - Maintain Hydration - Schedule work breaks during peak daytime temperatures 	<ul style="list-style-type: none"> - Use tropical insect repellants - Use pyrethoid-impregnated bed nets 	<ul style="list-style-type: none"> - Heed weather advisories

Source: Adaptation to Climate Change in the Context of Sustainable Development and Equity, in the reader for Urban Environment and Infrastructure Management Specialization, IHS (2009)

2.5 Disaster Risk Management Concepts

Disaster Risk Management (DRM) is the systematic process of using administrative directives, organizations, and operational skills and capacities to implement strategies, policies and improved coping capacities in order to lessen the adverse impacts of hazards and the possibility of disaster (ISDR, 2009). Disaster risk management is actually a part of disaster management, focusing on the “before” (risk analysis, prevention, and preparedness) of the extreme natural event, and relating only to the “during” and “after” of the disaster only through risk analysis (GTZ, 2004).

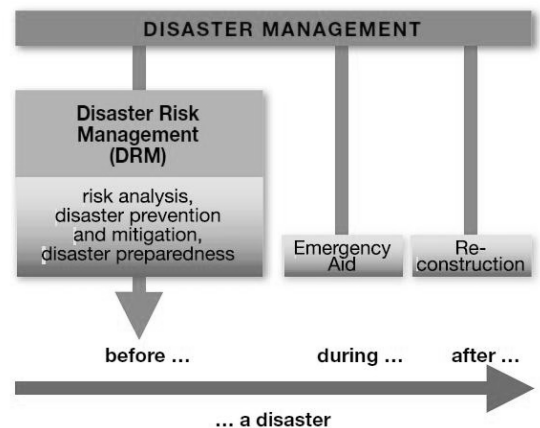


Figure 2.2: Disaster Management Framework
(Source: GTZ)

Formulating DRM strategies also takes into account the different socio-economic aspects typical to a local development plan – social, institutional, ecological, and in certain cases the cultural aspect as well. From this concept and taking off from the definition of ‘Adaptation’ in Section 2.4, DRM strategies then forms a critical part of formulating strategies for adapting to the impacts of climate change one of which are disasters such as flooding and erosion.

2.6 Planning for Disaster-Free Human Settlements

When planning for patterns of physical development especially for human settlements, there are several considerations that should be made starting from the policy-making level as follows:

- i. High Risk Areas which include: seismically active zones and seismic faults; river flood plains; tidal wave flood plains; zones presenting special risks of tropical storms; and vicinity of active volcanoes.
- ii. Kinds of High Vulnerability Development which include: high concentration of population; high concentration of economic activities especially manufacturing; key communication installations; major transportation junctions; and major defense installations.

In general, high risk areas should be closed to development of highly vulnerable activities. It is actually in the fields of construction and physical planning that many of the preventive measures on disaster impacts should be taken. Through engineering measures and special design methods, protection against disasters could be developed hence eliminating bad site selection, and other problems related to construction and development. These measures can be reinforced by non-engineering measures such as: (i) the public should be educated on disasters; (ii) various professions should be trained in prevention techniques; and (iii) the public should be informed about all the precautions taken and the results of research.

Also through the formulation and implementation of land use regulations (zoning maps and laws) undesirable urban development trends in a territory can be controlled with much less expenditure of public money. However, land use plans should be reinforced by subdivision regulations, and which should be legislated with that purpose as the anchor. This is so because subdivision regulations can contain provisions on use restrictions but still having the main purpose of mainly limiting further land subdivisions and consequent sales of lands in high-risk areas. Although many see that land use regulations and engineering measures to reduce risks of disasters may be considered as exclusive alternatives to each other, often a combination of both measures should be used. However, in places where density is high, like in the case of slum areas, engineering measures may be more justifiable, and on the other hand control of land use may be more difficult.

2.7 Framework for Integrating Disaster Risk Mitigation into Land Use Planning and Risk Management Practices, The Philippines' Experience

The Earthquakes and Megacities Initiative (EMI) Inc. is a non-government organization whose advocacy is to promote the design and implementation of disaster management plans for cities through a highly inclusive and participatory process that involves all interested parties and stakeholders. Through their Cross-Cutting Capacity Development (3CD) program, the organization together with its local and international network of partners was able to assist megacity governments in preparing and implementing sound disaster risk management practices.

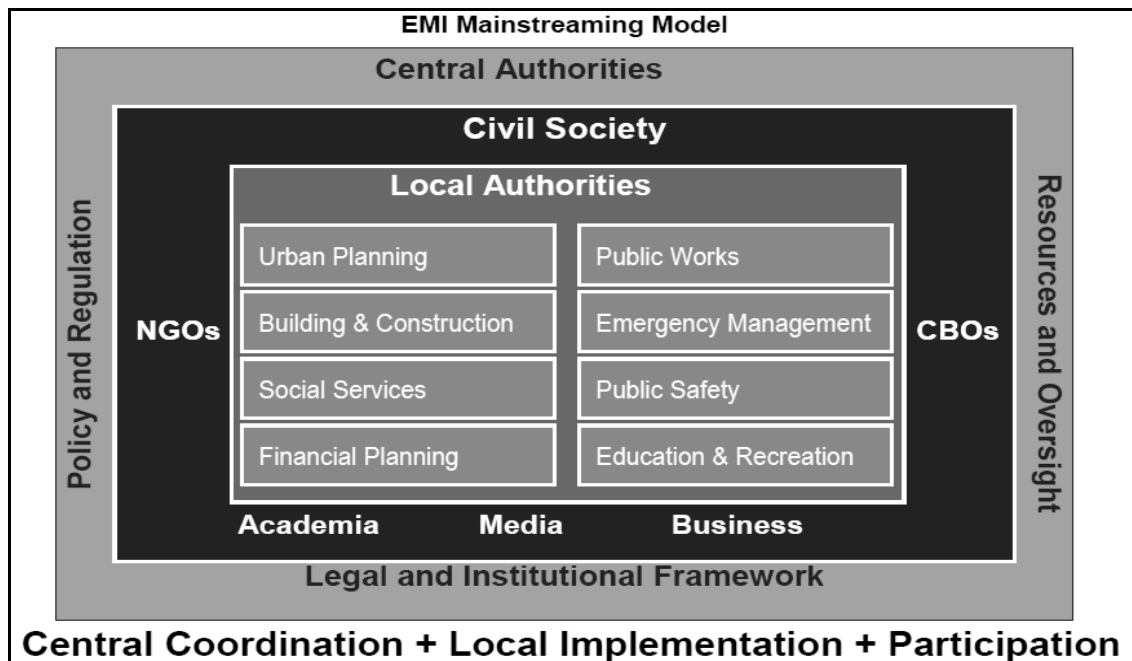


Figure 2.3: Model for Mainstreaming DRM into Land Use Planning (Source: Earthquakes and Megacities Initiative (EMI) Inc. 2005, *Mainstreaming Disaster Risk Reduction Through Land Use Planning and Risk Management Practices*)

One of the focus areas of the 3CD Program is to integrate disaster risk mitigation into land use planning. This they were able to do through the development of framework which suggests that local government should be able to utilize and operationalize the existing structure to promote risk reduction without the need for coming up with a re-structured organization (*Figure 2.3*). This model shows the ways in which how disaster risk measures and practices can be incorporated into their daily functions. This also shows that through the city government's interaction with organized civil society groups, concrete actions for creating awareness and initiating participatory processes can be effectively done also with the use of innovative tools such as the creation of focus groups in the formulation of a disaster management plans.

2.8 Disaster Risk Management for Floods

Floods are identified as the most devastating among all disasters with accounting to about 90% of damages caused by disasters (UNDRO, 1976). Flooding is actually an effect of other disasters such as rainwater, landslides and tsunamis. But the primary source of flooding is either rainfall or melting snow caps in the case of countries with winter season. Flash floods are defined by UNESCO as floods of short duration with a relatively high peak discharge and which are common in arid and semi-arid areas. They usually occur as an effect of mountain erosions, which have low forest cover, caused by heavy rainfall, and may also occur following thunderstorms in regions that are more humid. The severely affected areas of floods are those settlements which are located adjacent to river channels, often referred to as floodplains, and also those areas located along coast lines wherein flooding is caused either by tsunamis or sea water surges.

For areas located along flood plains, several management measures can be done to control if not prevent the extensive damages caused by floods. The first set of measures actually comprise of engineering solutions such as: construction of dikes, flood banks or levees to divert the flood waters; dams and reservoirs to retain flood waters upstream; and channel improvements to evacuate flood waters more rapidly. However, proper scheduling is needed to implement these measures as these have to be built in seasons of little or no rain but which has been getting difficult lately because of the changing weather patterns caused by climate change.

Apart from engineering measures, which entail a lot of cost, there are also non-structural means of flood management (Miller, 1997). Among these include:

- i. Land use planning and zoning to control the use of flood-prone areas – where through the land use regulations control of development along flood prone areas will be limited to uses such as open spaces, parks and play areas.
- ii. Flood-proofing of existing structures – where means of protecting individual structures from the effects of flooding will be done by: relocation of settlers from flood-prone areas, increasing elevation of buildings by piles; flood walling by concrete or steel walls to keep the flood out; dry flood-proofing which is simply making buildings water-tight; and wet flood-proofing which is applicable to buildings with 2 or more levels where the basement

or ground floor level of a building is allowed to flood while keeping the habitable portion of the building above flood level.

- iii. Soil and water conservation to reduce flood flows – which is aimed at preserving the soil and water resources by measures such as reforestation and terracing.
- iv. Forecasting and warning systems – where hydrological models are used for forecasting measurements of the rainfall over the catchment and produce estimates of future river flows.

2.9 Impacts of Urban Growth to the Urban Environment and Public Health with the Advent of Climate Change and Disasters

In general, there is no clear and definite definition of what an urban environment or areas are as they vary from country to country. For example in the Philippines, urban areas, particularly urban barangays, are defined as those having at least 1,000 inhabitants where the occupation of inhabitants is predominantly non-agricultural and where public structures such as school, hospital, health center, library, and a church or chapel where religious activities are carried out at least once a month, and where a market place or building where trading activities are carried out at least once a week are established (Serote, 2004).

In the **United Kingdom**², urban areas are defined as those urban lands which extend for at least 20 hectares, with a minimum population of 1,000 persons and which should satisfy the following conditions as lands comprising of: (i) permanent structures and on the land on which they are situated (built-up site), for this purpose, land is defined as the ground covered by a permanent structure and any ground enclosed by, or closely associated with, such a structure; (ii) transportation corridors (such as roads, railways and canals) which have built-up sites on one or both sides, or which link-up built sites 50 meters apart; (iii) transportation features such as airports and operational airfields, railway yards, motorway service areas and car parks; (iv) mine buildings; and (v) any area completely surrounded by built-up sites.

From these two definitions, we can say that urban areas are defined based on the available services and physical structures present in a country. But no matter how urban areas are defined, all are commonly susceptible to the impacts of urban growth as a result of growing urban population. In urban areas the growth of population affects the capacity of the city's environment to accommodate future growth as well as the capacity of the infrastructure services to provide efficient services to the people. Barrow (2005) described urban environments as having the following characteristics:

- i. Can provide healthy and stimulating environments for their dwellers, and can generate funds and funds to aid rural areas.

² Source: http://www.statistics.gov.uk/census2001/pdfs/urban_area_defn.pdf (Accessed: May 10, 2009)

- ii. Rapid population growth is not always a cause of urban problems; there are cities which have undergone rapid demographic expansion with limited ill effects. Rapid population growth with coupled poor governance is problematic.
- iii. While there are many very large cities, and most of these have appeared quite rapidly, much of the urban environment in developing countries consist of far smaller settlements.
- iv. Mega-cities are not necessarily prone to problems, but if problems do appear considerable resources may be required to solve them.
- v. There is a huge diversity of urban environments: cities can vary a lot and within a city there are often marked differences, notably between the rich and poor districts.
- vi. Statistics are incomplete and inaccurate, consequently there is too much generalism and false assumptions about problems. Problems vary from city to city and within a single city.
- vii. Ways in which developed countries have responded to rapid population growth and urban environmental problems in the past may not be appropriate for the future.

One phenomenon that has had impacts to the quality of urban environment is called *urban sprawl*. Urban sprawl is defined as low-density development beyond the edge of service and employment where people live from where they shop, work, recreate and educate – thus requiring cars to move between zones (Knaap, 2009). This definition however is based on the western context of urban sprawl. Nevertheless, urban sprawl is still brought about by the need to provide areas for settlements as a result of a growing population. As a result, the sprawling of new settlements in a horizontal development has caused the destruction of soil resources which led to significant losses in food production as agricultural lands are the most frequently affected by this phenomenon thereby affecting also the security of food supply to some urban areas. Another impact of urban sprawl is that it removes soil and vegetation sinks for carbon dioxide which could add to the problems caused by climate change, especially in poor and developing countries where urban forests and greens are none existent in urban areas.

The magnitude of urban growth of cities also has impacts on public health. Other urban growth related problems such as over-crowding, poor housing, lack of street lighting, un-surfaced paths, open gullies, unclear sewage and refuse as well as the use of dangerous cooking and lighting methods in poor areas put the inhabitants at risk of various diseases which include diarrheal diseases, malaria, tuberculosis, HIV/AIDS, bubonic plague, debilitation by parasites, respiratory problems, and accidents brought about by poor housing, alcoholism, and un-surfaced and unlit roads. With the advent of climate change and its impacts, these urban development related problems which resulted from urban sprawl lead further into other social-related impacts such as loss of mobility due to floods especially in settlements along riverbanks, and other health problems such as water contamination and even psychological stress as a result of loss of life and property. Table 2.2 below summarizes some of the likely impacts of climate change to urban and even non-urban areas.

Table 2.2: Summary of Some of the Likely Impacts of Climate Change

CHANGE	IMPACT ON NATURAL SYSTEMS, AGRICULTURE AND WATER	IMPACT ON URBAN AREAS	IMPACT ON HEALTH AND HOUSEHOLD COPING	IMPLICATION FOR CHILDREN
Warm spells and heatwaves frequency up on most land areas	Reduced crop yield in warmer regions, wildfire risk up, wider range for disease vectors	Heat islands with higher temperatures (up to 7 deg. C higher); often large concentrations of vulnerable people; air pollution worsened	Increased risk of heat related mortality and morbidity; more vector borne disease; impacts for those doing strenuous labor; increased respiratory disease where air pollution worsens; food shortages	Greatest vulnerability to heat stress for young children; high vulnerability to respiratory diseases, vector-borne diseases; highest vulnerability to malnutrition with long term implications
Heavy precipitation events, frequency up over most areas	Damage to crops, soil erosion, water-logging, water-quality problems	Floods and landslide risks up; disruption to livelihoods and city economies, damage to homes, possessions and to transport and infrastructure; loss of income and assets; often large displacements of population; with risks to social networks and assets	Deaths, injuries, increased food and both water-borne and water-washed diseases; more malaria from standing water; decreased mobility with implications for livelihoods; dislocations; food shortages; risks to mental health, especially associated with displacement	Higher risk of death and injury than adults; more vulnerable to water-borne/washed illness, and to malaria; risk of acute malnutrition; reduced options for play and social interaction; likelihood of being removed from school/put into work as income is lost; higher risk of neglect, abuse and maltreatment associated with household stress and/or displacement, long-term risks for development and future prospects
Intense tropical cyclone activity increases	Damage to crops, trees and coral reefs, disruption to water supplies			
Increased area affected by drought	Land degradation, lower crop yields, livestock deaths, wildfire risks and water stress up	Water shortages, distress migration into urban centers, hydro-electric constraints, lower rural demand for goods/services, higher food prices	Increased shortages of food and water, malnutrition and food and water-borne diseases up; risk of mental health problems up; respiratory problems with wildfires	Young children at highest health risk from inadequate water supplies; at highest risk of malnutrition, with long-term implications for overall development; risk of early entry into work, exploitation
Increased incidence of extreme high sea level	Salinization of water sources	Loss of property and enterprises; damage to tourism, damage to buildings from rising water table	Coastal flooding, increasing risk of death and injuries; loss of livelihoods; health problems from salinated water	Highest rates of death for children; highest health risks from salinization of water supplies, long-term developmental implications

Source: Moser, C. and Satterthwaite, D. (2008), *Towards Pro-Poor Adaptation to Climate Change in the Urban Centers of Low and Middle Income Countries, Climate Change and Cities Discussion Paper 3, International Institute for Environment and Development (IIED)*.

These are just some of the environment-related impacts of urban growth. However urban growth should not be seen as the mere cause of these problems, but also the way cities are being managed by the respective governments. Good city governance should include strong environmental management and the means to adopt forward-looking approaches to addressing these problems (Barrow, 2005). Among these approaches include: (i) developing adequate services to serve the growing population; (ii) passing and enforcing appropriate legislation especially for development controls; and (iii) implementing protective measures especially in high risk and vulnerable areas.

2.10 Economic and Financial Impacts of Disasters

The previous section discussed the impacts of disasters with regards to the impacts of climate change and disasters on an environmental and social perspective. The economic and financial impacts of disasters are also crucial in formulating climate change impact adaptation strategies especially structural measures that require huge investment costs. In another view, failing to invest on disaster preparedness measures will also result to economic losses among the people as a result of disruption of services and means for them to go about their economic-related activities.

In a report published by the World Bank (Benson and Clay, 2004) on the economic and financial impacts of disasters, it is stated that natural hazards potentially have significant adverse macroeconomic consequences and thus it requires serious consideration by policy and decision makers. In addition, the same report also states that based on a number of researches on the financial and economic impacts of disasters, major disasters have both short and long term impacts for economic growth and development and that these have broad policy implications. Among these are:

- i. Impact on government expenditures and services provision because of reallocation of resources for disaster relief and rehabilitation activities which could possibly lead to budget deficit.
- ii. Impact on government revenues due to changes in timing of taxations caused by the disruption of the influx of flow of revenues and at certain periods would force governments to resort to short-term borrowing.

These impacts on government expenditure budget and revenues generation could be minimized if not avoided if resource allocations for disaster preparedness strategies which are anticipatory in nature (apart from post-disaster relief and rehabilitation) have been in place. However this is not usually the case especially in developing countries even if some strategy elements for disaster preparedness do not require substantial financial requirements. This is because even if only modest funds are required, there are many government services that compete for budgeting plus add the fact that governments and even some donors suggest that spending on such disaster preparedness strategies has low political priority (Benson and Clay, 2004). Most of them fail to realize that small measures like for example ensuring the safety of school buildings from the devastating effects of cyclones could prevent these buildings from being damaged or worse even

collapse which in turn would prevent re-allocation of budget to build a new school building to replace the collapsed one and also the disruption of classes thereby affecting the learning progress of school children as they would in the coming school months resort to extended class hours on weekends.

Therefore to prevent these negative economic and financial impacts of disasters, sound policy making should be done by decision makers. It should be imperative for governments to explore the financial aspects of disaster preparedness which includes both anticipative and responsive measures to minimize if not eliminate its negative impacts on expenditures and revenue generation activities of the government as well as the socio-economic activities of the people.

2.11 The Relationship Between Climate Change Adaptation and Disaster Risk Management

Before climate change and disaster risk concerns are viewed as separate and distinct from each other. However as climate change experts began to expand their studies on the problems of global climate from just addressing its effects through mitigation measures to anticipating its potential effects and devising measures on how to adapt to these effects, among which are disasters. The United Nations Development Programme (UNDP) stated that with this ‘gradual turn to adaptation considerations and an increase in its salience, the climate change adaptation community has clearly commenced to take up on a topic that is very close and complimentary to the traditional preoccupations of the risk and disaster community. How to live with and adapt to climatic extremes and how to promote more resilient and secure communities are questions that are at the center of concerns of both communities’. Because of this development, measures of adaptation and disaster risk management can, today, for the most part be seen as synonymous to each other (Wamsler, 2008).

In the international community, the aforementioned view was taken into full consideration during the Stockholm Plan of Action for Integrating Disaster Risks and Climate Change Impacts to Poverty Reduction convention held in Stockholm, Sweden in October, 2007 and was participated by 200 participants from national governments, bilateral and multilateral agencies, civil society organizations, experts and researchers. The results of the plan of action was a result of the Global Platform for Disaster Risk Reduction and the findings of the IPCC that climate change is likely to increase the frequency and intensity of weather events and climate variability. The Plan of Action, as an output of the convention, contains the following priority actions to address the potential impacts of climate change and disasters:

1. Disaster risk reduction and climate change adaptation cannot be dealt with in separation.
2. Risks due to disasters and climate change must be known and measured.
3. Disaster and climate change risk analysis must be integrated into the national planning process, including the poverty reduction process in each country.

4. Disaster risk reduction and climate change adaptation are not sectors but need to be factors in all sectors.
5. Capacity building is required a local, national, regional and global levels with a focus on Global Facility priority countries that are particularly prone to natural hazards.

The aim of these priority actions is to integrate natural hazard and climate change risks in a more effective way into national development strategies including poverty reduction strategies with reference to the Hyogo and Kyoto community³ agreements.

2.12 Conceptual Framework

The conceptual framework aided the process of conducting this research. It served as the guide on approaching the research problem and solving it, and in determining the needed information for the research. The conceptual framework of this research is presented in Figure 2.4 below.

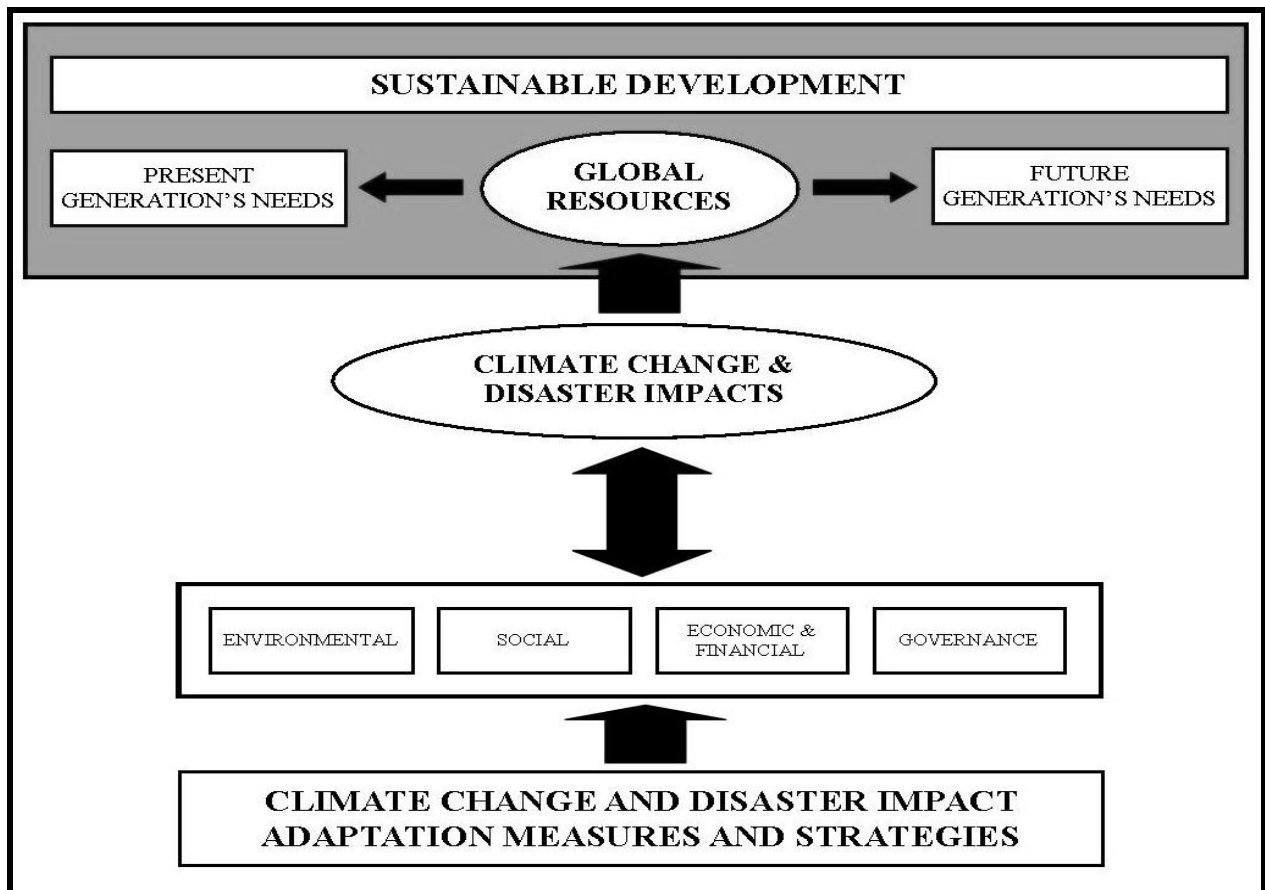


Figure 2.4: Conceptual Framework

³ Wamsler (2008) in her research entitled, *Managing Urban Disaster Risks*, defined the 'Hyogo Community' as the disaster risk management community that committed itself to the Hyogo Framework for Action 2005-2015, while the 'Kyoto Community' refers to the climate change community that committed itself to the Kyoto Protocol.

Sustainable Development is the overarching concept of this research. From the review of the related literature of this research, sustainable development depends on how humans utilize the available global resources and this affects the lives of people not only in the present but in the future as well. It is also human activities that cause the changes in the global environment and its impacts directly and in some cases indirectly affect the global resources (i.e. natural, human capital, etc.). As also presented in the literature review, climate change and disasters have environmental (i.e. land degradation), social (i.e. loss of life, displacement), governance (i.e. policy making), and financial and economic impacts (i.e. government expenditure and revenue generation, disruption of economic activities). For each of these impacts, structural and non-structural means of adaptation could be formulated to at least minimize the impacts of climate change and disasters, which in turn if implemented effectively could reduce the negative impacts of climate change and disasters and would in turn lead to the sustainability of the world's resources that would benefit both the present and future generations.

For this research, the focus of the study shall be on one major impact of climate change in the form of a disaster which has affected many African cities like Kumasi – flooding and erosion.

2.13 Summary

The concepts discussed in this chapter dealt with climate change as not just an environmental problem but as a development issue that has to be addressed up to the community level. The fact that climate change has now been identified to have social and economic impacts means that communities should be made aware of the activities and practices that add up to the magnitude of greenhouse gas emissions which causes climate change like for one, the use of firewood as fuel for lighting and cooking which not only emits carbon dioxide but also contributes to the reduction of carbon sinks. But more important are adapting to the impacts of climate change which at this point are considered irreversible – meaning climate change cannot be stopped but its impacts can only be delayed or reduced to a certain magnitude. Specifically, low-income communities which are the most susceptible to climate change impacts like flooding have to be capacitated and be involved pro-actively in making their communities resilient to these impacts and avoid its further “*indirect impacts*” which mostly are related with problems on public health like disease outbreaks.

CHAPTER 3: RESEARCH METHODOLOGY

This chapter gives a description of the research area including its physical characteristics – geomorphology, slope and topography. Also discussed in this chapter are the research design and the different methodologies used to gather data and other information needed to come up expected results of the study based on the objectives and research questions in Chapter 1.

The other sections of this chapter deals with the detailed discussion of the analytical process to be used illustrated through an analytical framework, and the respective variables and indicators based on the first three research questions of the study. The data sources of for each of the variables and indicators are also presented. The variables and indicators were based on the first three of the five research questions of the study as the fourth research questions has to do with the lessons learned from different international cases while the fifth is for the conclusions and recommendations of the study.

3.1 Description of the Research Area

Although plans to develop the suburb community of Ayigya have been made by the Town and Country Planning Department (TCPD) in 1967 and 1978, its development was dictated by the traditional rulers and the demand for low-cost rental housing with the establishment of the Kwameh Nkrumah University of Science and Technology (KNUST) opposite of its location. The buildings are made of only few multiple storey buildings, with a lot of single-storey compound houses which are rented out to multiple tenants. Infrastructure is also poor as there are no properly constructed drainage canals that control the flow of storm water in the area.

Flooding and erosion is frequent in the events of heavy rain in Kumasi as storm water is drained naturally. In Ayigya, there are only two main roads connecting it to the Kumasi-Accra road. Aside from this, the access roads are unpaved and could get muddy in the event of rains which make accessing the inner areas of Ayigya even more difficult to do, especially cases of emergency. Although no natural physical hazards like earthquake faults are found in the area of Ayigya, the physical development pattern that the community underwent plus its natural physical features mainly soil type and topography have made it vulnerable to impacts of disasters namely flooding and erosion.



One of the small alleys in Ayigya which has experienced topsoil erosion as a result of repeated incidents of extreme precipitation (Photo by John De Groot, AVBR)

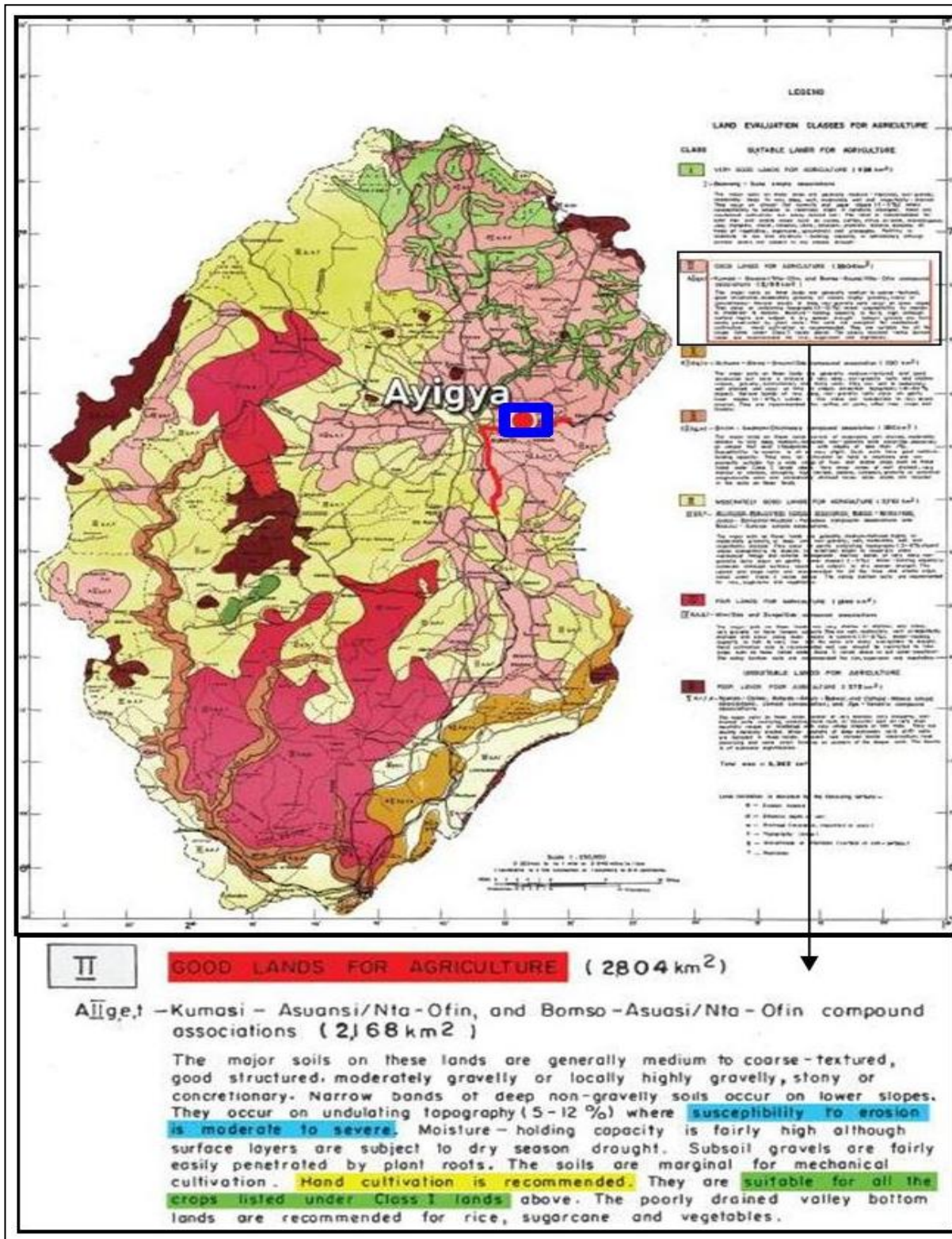


Figure 3.1 Kumasi Soil Classification Map (Source: AVBR)

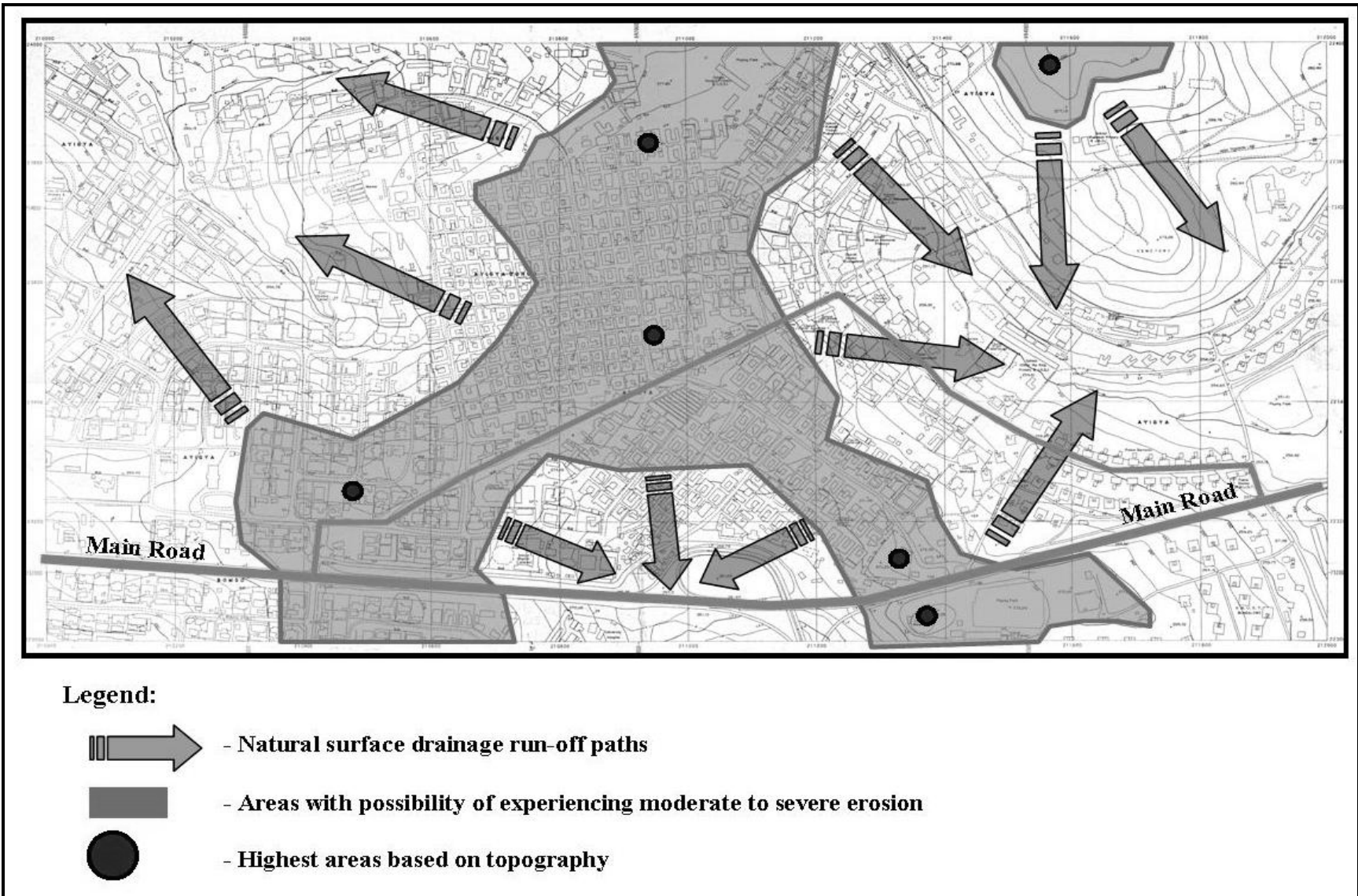


Figure 3.2: Topographic Map of Ayigya (Topographic Map courtesy of AVBR)

Soil Type

According to the soil classification map of Kumasi (see Figure 3.1), the soil in Ayigya is classified as Type II – Good Lands for Agriculture. This soil type is generally medium to coarse-textured, moderately to highly gravelly, stoney or concretionary where narrow bands of deep gravelly soils occur in lower slopes. This soil type also has a fairly high moisture absorptive capacity with surface layers susceptible to dry season drought. Moreover Class II soils are located in areas with undulating topography (5-12% slope, such as Ayigya) where susceptibility to erosion is moderate to high.

Topography and Slope

Ayigya's topography is characterized as undulating having slopes between 5 to 12% (see Figure 3.2). Although not too steep, the type of soil on which the community is situated makes it prone to erosion with the low-lying areas in being exposed to more risks posed by floods due to surface water run-offs from the high areas of Ayigya.

3.2 Research Design

This section described the approach and type of research used which include the methods of data collection, the reason for their use and the type of information or data needed to be obtained, and the methods by which these data will be analysed to meet the objectives of this research.

3.2.1 Research Type

Based on the objectives of this research, the type of research implied in this study is exploratory as it investigated the factors behind the capacity or incapacity of the Community of Ayigya in adapting to the impacts of flooding. Being exploratory in nature, this research could in the future actually serve as a reference for carrying out more detailed strategies to address the problems of climate change and disaster impacts adaptation for the whole city of Kumasi and possibly in other West African countries and cities.

3.2.2 Data Collection Methods

The following methods of data collection were used for this study.

a. Primary Data Collection

The primary data collection was done through a household survey. Since this research was carried out with a team of IHS students, a single questionnaire was used incorporating all the survey questions of the 11-member IHS team. The number of households surveyed as jointly determined by the group was 100 using simple random sampling, which is about 1.7%⁴ of the

⁴ Chapter 2 of *Recording and Using Indigenous Knowledge (International Development Research Centre, 1995)* on Sampling Methods recommends a minimum of 1% sample for a research population of between 5,000 to 10,000 with a 90% confidence level. This sample size is to be multiplied by 4 if a confidence level of 95% is to be desired.

total number of households in Ayigya. The purpose of this household survey specifically for this study is to determine the representative percentage of the population that has experienced flooding and also to get an overview of the community's perception on the capacity of the government to respond to emergencies based on what they have experienced in the previous events of flooding in Ayigya. In addition, the HH survey will also be used to determine and analyse: the existing assets of the community (i.e. livelihood knowledge and skills and possible alternatives) that could be at risk with the future events of flooding; and the assets that could be used or enhanced to enable them to adapt to the impacts of flooding.

Direct observation methods on the physical features of the Ayigya community were also done in order to validate the initial assumptions which served as the baseline information for this study. Direct observation methods were also undertaken to assess in what capacity the community can participate in the implementation of adaptation measures to the impacts of flooding based on their exact geographic location (i.e. whether on slopes or on foothills).

b. Secondary Data Collection

This included the review of existing (and available) land use and zoning regulations as well as building codes and subdivision development regulations of Kumasi. Other critical secondary data sources used for the analysis are thematic maps that describe the land use, topography and soil characteristics of Kumasi particularly in the area of Ayigya.

Other secondary data that were critical for this study are information on expenditures and budget allocation report/s of the city government in relation to disaster preparedness activities and existing documentations in relation to disaster preparedness and other strategies for adaptation which are needed to assess the capacity of the city government to formulate and/or implement strategies for flood (and disaster) impact adaptation. Previous studies and books from the KNUST Architecture and Planning Library as well as the West Ayigya Unit Committee also provided rich information on the process of development of Ayigya as a community.

Related case studies in other cities and countries were also researched in order to determine other flood impact adaptation and mitigation strategies that could be applicable to the case of Ayigya and the Kumasi government.

c. In-Depth and Experts' Interviews

In-Depth and experts' interviews were done with key informants from the city government of Kumasi, the KNUST, and the community leaders of Ayigya. The purpose of these interviews was to see at what points can cooperation and collaboration efforts be done in formulating and implementing adaptation measures to address the impacts of flooding not only in Ayigya but possibly for the whole city of Kumasi. Existing assets (i.e. availability of special committees) were also be determined in order to make stronger institutional ties together with the community in implementing adaptation measures for future impacts of flooding.

d. Peer Discussions

The fieldwork activities were conducted along with ten (10) other IHS students who were also working on their respective thesis topics which include housing finance (Martha D.S. and Nercua C.), community participation in spatial planning (Maha Putra N.), alternative building materials (Siek, L.T.) among others. Occasional discussions about the interviews and data collected by each individual are shared and discussed in group meetings held during the fieldwork in Kumasi. From these meetings, important information related to this study were also gathered and used in the analysis and recommendations.

3.2.3 Data Processing and Analysis

The data gathered from the direct observation methods, household surveys and secondary data review served as the basis for validating the assumptions on the physical environment conditions and establishing the baseline information needed for determining the presence or absence of climate change and disaster impact adaptation measures and strategies of the community of Ayigya to these impacts. The vulnerable areas to flooding and erosion in Ayigya were identified through a combination of field observations and analysis through the available maps on the assumptions on the physical environment conditions of Ayigya. Together with the results of the HH survey, the potential hazards and risks on the physical, social, economic, and also governance aspects were identified and analyzed.

After the potential hazard and risks have been identified and lessons have been drawn from the related case studies, the following 4-step process of vulnerability and adaptation assessment developed by UN-Habitat for their Cities in Climate Change Initiative (CCCI) Project was used to properly identify the relationship between the potential impacts and proposed adaptation measures. It is in this process where the information on possible points of cooperation and collaboration from the in-depth interviews from the city government, the KNUST, and the organizations operating in Kumasi were used. This method however was slightly modified in this study as the researcher opted to add an additional column which is the identification of institutional interventions to operationalize the options for adaptation.

Step 1: Validation/identification of vulnerabilities and potential impacts

Step 2: Identification of vulnerable sectors of society and/or physical assets

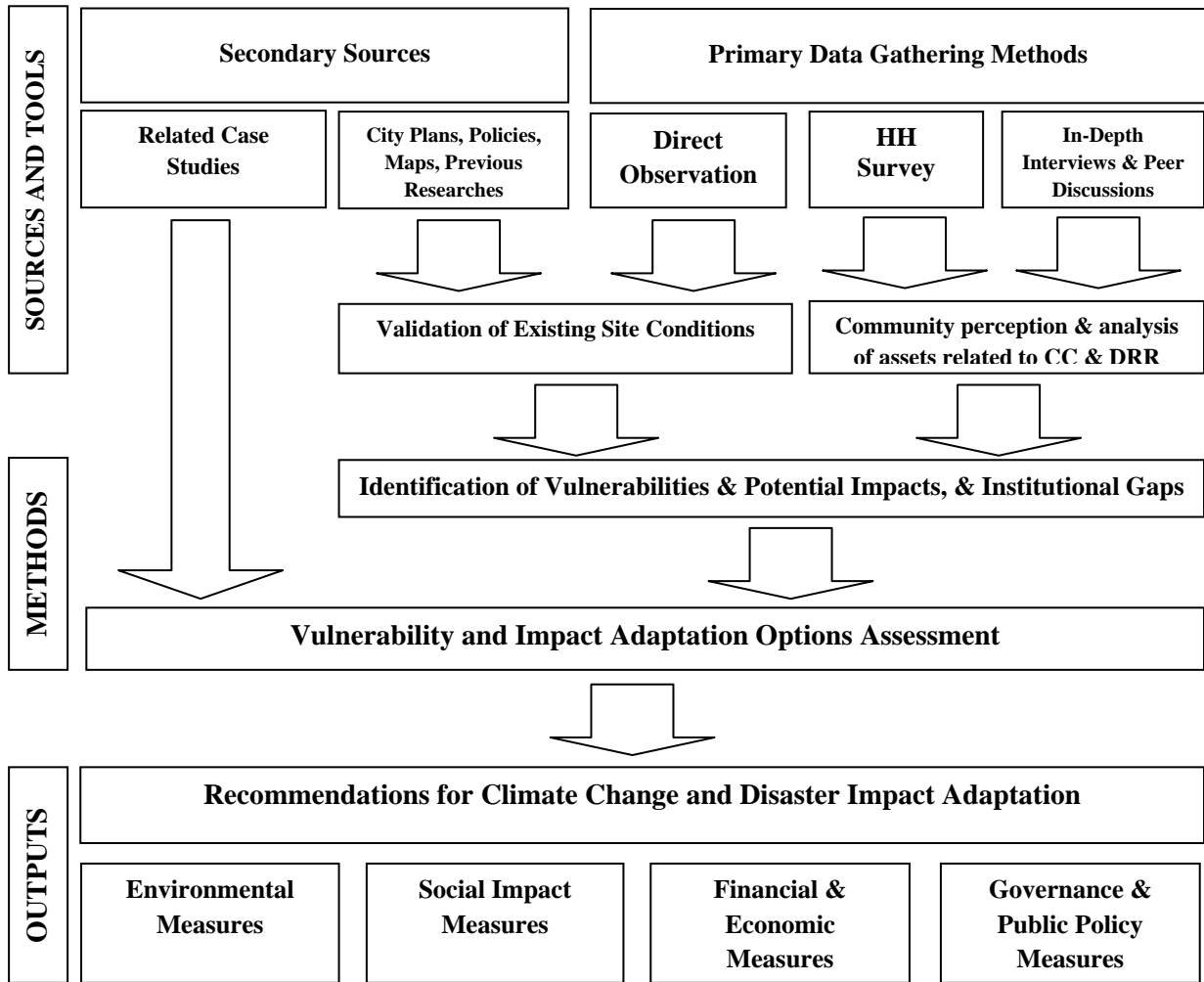
Step 3: Triggers and/or agents of potential impacts

Step 4: Options for adaptation

Step 5: Institutional intervention

3.3 Analytical Framework

The analytical framework of this research illustrates the research process of this study described in the previous section. It graphically shows how the data collection methods and analysis were done in order to come up with the results needed to achieve the objectives of this research.



3.4 Research Variables and Indicators

From the three of the five research questions in Chapter 1, variables and indicators were formulated to come up with the appropriate questions to be asked primarily for the household survey and also to guide the formulation of appropriated questions for the in-depth and experts' interviews.

Table 3.1: Research Variables and Indicators

Research Question	Variables	Indicators	Data Sources
Are disaster preparedness strategies for climate change and flooding in place in the City of Kumasi, particularly in Ayigya?	Structural Measures	Road length with drainage network lines	Field observations by transect walk method
	Non-Structural Measures	Road length with tree plantations	Field observations by transect walk method
		Easement provision, proximity of settlements from surface water ways	Field observations by transect walk method
		Disaster management plans, zoning regulations	Town and Country Planning Office, NADMO
		Emergency response mechanisms	Interview with respondents from city government, community and HH survey
What are the existing implementation mechanisms to operationalize preparedness and adaptation strategies for climate change and flooding in Ayigya?	Governance Instruments	Partnership agreements	Interview with respondents from city government
		Investment program for infrastructure improvement	Town and Country Planning Office
		Special committee on disaster preparedness	Interview with respondents from the city government
	Financial and Economic Instruments	Calamity fund allocation	Interview with respondents from the city government
		Alternative livelihood schemes	Interview with respondents from city government and HH survey
What are the vulnerable socio-economic and ecological characteristics of the Ayigya community in relation to climate change and disaster impacts?	Physical Environment Conditions	Identified hazard areas	Field observations by transect walk method, desk review and Expert's Interviews
	Housing Conditions	Type of building materials used	Field observations by transect walk method and Peer Discussion
	Social and Economic Capital	Other skills and knowledge aside from primary skill and knowledge used to generate income	HH survey and Peer Discussion

3.5 Summary

The study area Ayigya was described here as a community whose haphazard development was dictated with the demand for low-income rental housing because of the establishment of KNUST campus right across its location. First hand information on the physical characteristics of Ayigya also described it as an area susceptible to moderate to severe erosion.

The research methodology designed for this study was exploratory in nature and consists of primary and secondary data collections methods. For the primary data, the methods of data collection implied here consist of household interviews, in-depth and experts' interviews, transect survey as a field observation method, and peer discussion. For the household survey, 100 respondents were selected from the estimated 6,000 households in Ayigya or a sample size of 1.7%. This survey was used to get a picture of the socio-economic characteristics of the community's inhabitants. Observation methods through transect surveys were done to get an initial idea about Ayigya's physical environment. In-depth and experts' interviews were done to get specific information from selected respondents from the community, the government and academic and research institutions based in Kumasi. All of the information gathered from the previous three methods were supplemented by information from the peer discussions held during informal meetings at the hostel where the IHS student-researchers were billeted. All information gathered will now be used in the processing of the data for analysis as outlined in the study's conceptual framework and using the list of variables and indicators to properly identify the necessary data which will be used in the analysis of this study.

CHAPTER 4: RELATED CASE STUDIES ON CLIMATE CHANGE AND DISASTER IMPACT ADAPTATION

This chapter presents four related international cases studies on climate change and disaster impact adaptation from Asia, Latin America and Africa. From these cases, relevant lessons will be drawn that will serve as a benchmark for the subject of this study in formulating doable recommendations to address the identified hazards and risks in Ayigya as well as the institutional gaps on the aspect of governance in relation to DRM.

4.1 Community-Driven Disaster Prevention: The Homeless People’s Federation of the Philippines (HPFP) Experience⁵

Being located in the so-called “*Pacific Ring of Fire*” the Philippines is prone to a number of natural disasters and hazards. This coupled with its position being located along the typhoon belt of the North Pacific Basin and being susceptible to El Nino phenomenon would mean that hydrologic-triggered disasters would be commonly expected to occur. According to the statistics of the Philippine Atmospheric Geophysical and Astronomical Services Administration (PAGASA) the country is often visited by an average of 20 tropical cyclones a year, and has often experienced different kinds of natural disasters like earthquakes, volcanic eruptions, and landslides to name a few.

Despite having a disaster risk management strategy and institutional framework, the set-up is being criticized as being reactive, focusing more on disaster response than being proactive or preventive having emphasis on short-term, post-disaster relief and preparedness rather than on the strategic option of mitigation or post-disaster support measures such as reconstruction and alternative livelihood generation.

The Homeless People’s Federation of the Philippines (HPFP) is a social movement that mobilizes and builds the capacities of low-income communities living in high risk areas by helping them to realize their needs and aspirations for secure tenure, decent housing, basic services provision and livelihood through savings and other community-led process. To date, the HPFP is implementing a national programme involving the following activities with funding support from different donor agencies and international organizations:

- *Organization and mobilization of low income communities in high-risk areas.* This activity involves promoting and scaling-up community-led processes for security tenure, decent housing, relocation, basic services and disaster-risk management.
- *City-wide action.* Transforming a “micro” perspective of development into a multi-stakeholder environment that addresses secure tenure at the city scale.

⁵ This case is taken from a draft documentation of the same title currently being prepared by Dr. David Satterthwaite of the International Institute for Environment and Development (IIED) with support from the Asian Coalition of Housing Rights (ACHR).

- *Information Management.* Community-managed enumerations aimed at building comprehensive database of information about slum dwellers that can be take part on specific urban planning and community-led development initiatives.
- *Forging and maintaining productive partnerships.* This involves establishing partnerships with the government at the community, city-wide and national levels to ensure greater participation by the urban poor in policy formulation, city-wide planning, relocation policies, and implementation plans, development finance and *in-situ* slum upgrading.
- *Policy Advocacy.* This activity is aimed at ensuring that the existing legal frameworks related to housing at the national level by “*actively exploiting*” the space that these legal frameworks provide for participation in governance in order to lobby for pro-poor policy frameworks at all levels of government.
- *Designing innovative strategies for scaling-up community-led slum-upgrading city-wide.* This activity’s objective is to create city-wide Urban Poor Development Fund (UPDF) to mobilize development funds for injecting into communities to match savings collected for investing in land, services and housing.
- *Building alliances for learning communities.* In order to ensure that the initiatives of HPFP would provide a model for community-driven interventions in DRM, the lessons learned from the implementation of projects are documented, along with key disciplines, processes and procedures.

Among the beneficiaries of the HPFP’s initiatives which are affected by natural and man-made disasters include the communities of Payatas in Quezon City (dumps-site trash slide incident), Barangay Ginsaugon in Leyte (mountain landslide), Mount Mayon (barangays affected by mudflow and floods), and the Lower Tipolo Homeowner’s Association in Cebu (devastated by fire).

4.2 Enhancing Disaster Management Through GIS: The Case of Allahabad City, India⁶

This case is an example of how Geographic Information Systems (GIS) can be used as a tool for making early response systems and emergency preparedness plans for disaster management. This case also presents how GIS can be used to analyze the impacts of flood disasters within a certain defined area or territory.

The National Aeronautics and Space Administration (NASA) defines GIS as a computer-based system capable of assembling, storing, manipulating, and displaying geographically referenced information. Disaster management is a multi-disciplinary undertaking that requires many types of spatial data that should be available for administrators in the right and proper format for decision-making. The area of Allahabad City is traversed by the Ganga and Yamuna rivers and is

⁶ The Case of Allahabad City is one of the cases on the applications of GIS for natural hazard management specifically for floods and cyclones that could be accessed at www.gisdevelopment.net.

frequently affected by flooding with major floods occurring in the years 1948, 1956, 1967, 1978 and 1983. Floods in Allahabad is caused by the rise in level of river waters from Tehsil Sadar, Meja, Soraun, Phoolpur, Handia, Karchana, Bara due which is due to Meja Dam water release at Meja Urva, Manda, Koraune blocks of Meja Tehsil and due to heavy rains over low lying areas of nine localities in Allahabad City.

In order for the situation in Allahabad City to be carefully analyzed, various maps are generated in the GIS platform. Some of the maps generated are: flood affected areas of Sadar Tehsil, population density distribution in flood prone areas, villages having road connectivity, hospital facility in flood affected areas, and route of relief map.

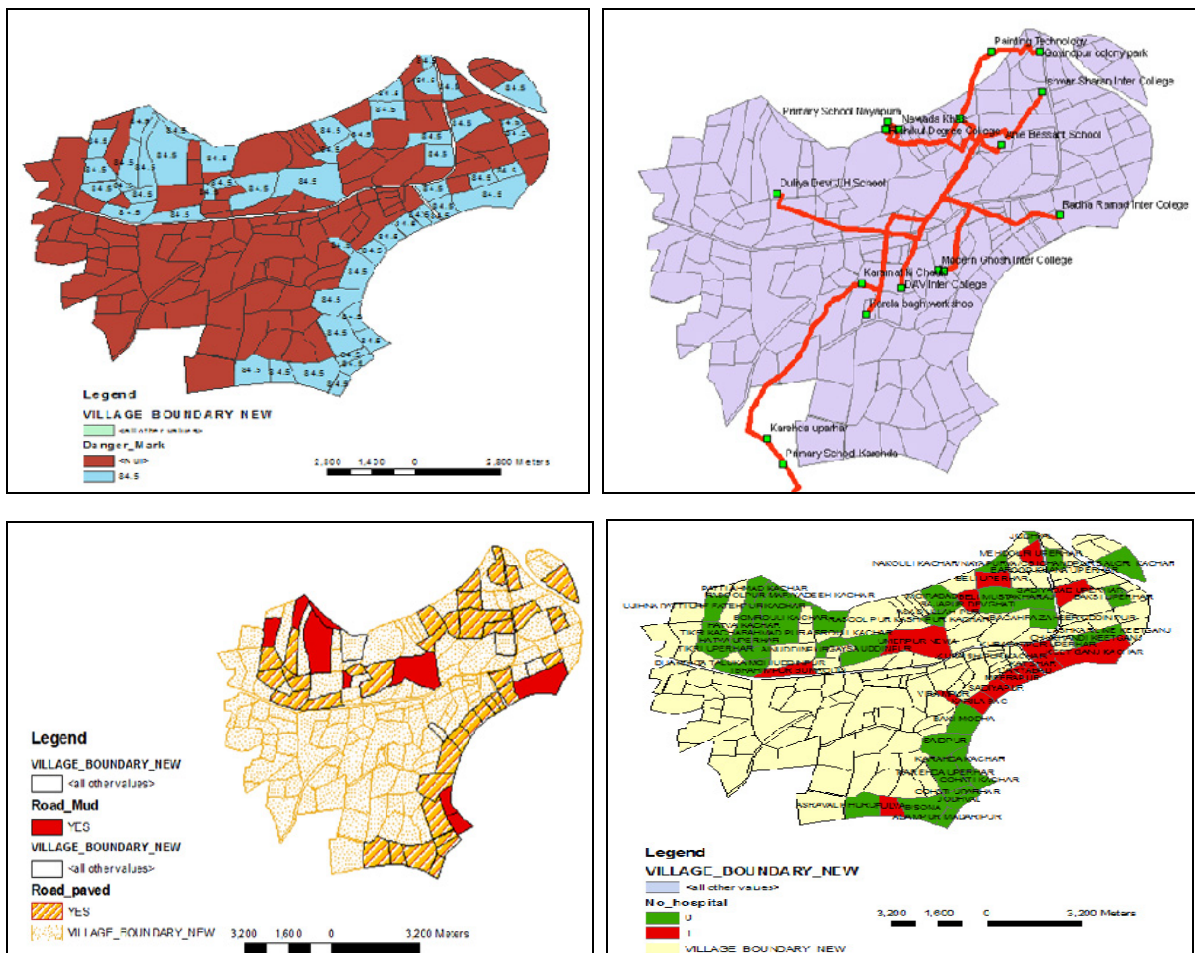


Figure 4.1, Top Left: Flood-Affected Areas Map; Figure 4.2, Top Right: Route of Relief Map; Figure 4.3 Lower Left: Paved and Mud Road Connectivity Map; Figure 4.4, Lower Right: Map of Location of Hospitals in Flood Affected Areas (Source: www.gisdevelopment.net)

The results of the analysis show that 54 villages are surrounded by water when river water reaches up to 84.50 meters which the level set as the danger mark for this analysis. With the aid of GIS based generated maps, requirements for food, camps, water, and relief shelter can be decided in the areas that can be classified as “safe zones”. The results also show that 33 villages

are affected by Ganga river in Sadar Tehsil and that only 7 villages out of the 54 have mud road. In planning for disaster preparedness villages with mud roads require more attention than paved road as there are other hazards and factors that should be anticipated in implementing disaster management measures. With these results, GIS as a tool for disaster management planning can be beneficial for getting all the relevant information at the time of occurrence of disasters.

4.3 Formulating and Implementing National Disaster Management Systems: The Case of Mexico⁷

In the case of Mexico, the public sector's role in disaster risk management was increased through a network approach. This started with the government's establishment of the National Civil Protection System (*Sistema Nacional de Protección Civil*, SINAPROC) in 1986 as the main mechanism for inter-agency coordination of disaster efforts. Specifically, SINAPROC is responsible for minimizing the loss of lives and property and the interruption of essential social services caused by disasters. Responsibility for the implementation of the system lies with the General Coordinating Body for Civil Protection in the Ministry of the Interior, and is networked in that the coordinating body synchronizes the technical work of the various ministries like for example, the Ministry of Social Development for Geologic Hazards.

In 1990, the National Council for Civil Protection was added to SINAPROC. The council is an advisory, planning, and coordinating committee and is headed by the president of Mexico and made up of 12 ministers plus the mayor of the Federal District of Mexico City. The network also includes the National Center for Disaster Prevention (CENAPRED), a unique institution located on the campus of the National Autonomous University of Mexico that reports directly to the Directorate of Civil Protection of the Ministry of the Interior. CENAPRED serves as a link between research work on natural disasters and policymakers and is involved in both research and information dissemination. The Mexican government allocates budgetary funds for disaster relief and reconstruction efforts by placing them in the Fund for Natural Disasters (FONDEN), which provides for the repair of uninsured infrastructure, immediate assistance to restore the productivity of subsistence farmers, and relief to low-income victims of disasters.

4.4 Disaster Preparedness, Prevention, Mitigation and Management in Kenya⁸

Although Kenya has been experiencing rain failure since the 1970s, particularly in its arid and semi arid lands, the country has not been spared from floods in the short periods of rainy season that come by like the ones that occurred in 1970, 1974, 1984, 1991, 1992, 1997 and 1998. According to meteorological records, four to five times a decade, Kenya experiences alternating

⁷ Presented as one of the case examples on Country Experiences on Disaster Management Systems published by the Inter-American Development Bank (IADB) in its publication entitled, "*Disaster Risk Management: National Systems for the Comprehensive Management of Disaster Risks and Financial Strategies for Natural Disaster Reconstruction*".

⁸ Implemented in 1999, the disaster management, prevention, mitigation and management, and flood emergency response projects in Kenya are initiatives funded by the UNDP focusing on disaster preparedness, prevention, capacity-building through training and community-based disaster mitigation, and risk zoning and vulnerability assessment of weather conditions.

events of drought and flooding which have had negative adverse impacts on the socio-economic conditions of the people, most especially those that depend on agriculture for their subsistence.

The Disaster Preparedness, Prevention, Mitigation and Management project focuses on strengthening national capacity to establish a proactive and comprehensive disaster management strategy targeting vulnerable people and communities. The project covers mitigation and prevention, preparedness, response, and recovery, and is integrated into initiatives aimed at poverty reduction and growth. The outcomes of the project are:

- Reduction in losses from disasters, in terms of lives, property, economy and environment
- Greater and sustainable development achievements, including a reduction in vulnerability of communities and infrastructure
- Reduction in overall risk of disasters, both natural and man-made

One of the major outputs in 2002 was the development of a National Disaster Policy. Considering that disasters of all types may occur, UNDP, working in close collaboration with the government, is committed to reducing exposure to risk and vulnerability through a coherent and comprehensive policy on disaster management. In this regard, a preventive strategy that encompasses preparedness, institutional framework, appropriate legislation, and coordination mechanisms have been proposed and will be pursued vigorously. The government is therefore developing a sustainable disaster management policy whose implementation will be through the concerted effort of all stakeholders. Separately, the Flood Emergency Response project aims to ensure a coordinated response to flood emergencies, particularly by providing assistance to government priority needs regarding humanitarian emergency operations to 175,000 affected Kenyans, including 65,000 displaced persons. This involves:

- Constructing water supply purification systems in response to community needs
- Strengthening post-flood recovery through seed and farm implement distribution
- Supporting food-for-work programmes for rehabilitation of damaged dykes and de-silting of dams
- Working in close collaboration with UNICEF and WHO on management of a malaria epidemic, ensuring continuous monitoring of the situation and subsequent evaluation of the performance of the emergency response

4.5 Lessons Learned from the Cases Presented

- *The Homeless People's Federation of the Philippines Case*

One of the difficulties being faced by many governments in the implementation of any program or project is the backing and involvement of the people at the community level. In the preparation and implementation of disaster management plans, these are often seen as

reactive due mainly to the non-involvement of the community in the implementation of the strategies embedded in the plan.

The case of the HPFP in the Philippines provides a paradigm shift on the view that low-income communities are powerless and are often just being left out in terms of services provision from the government. The HPFP case shows that low-income communities can be effective partners in implementation of initiatives in this case disaster risk management, to help develop vibrant and safer communities through pro-active people participation and support from the government, and in building partnerships with local and international organizations for capacity building and resource generation which empowers the communities to perform their tasks and responsibilities in managing disaster risks in their respective communities.

- ***The Case of Allahabad City, India***

The use of information and communication technology (ICT) tools in governance functions has been one of the backlogs in most developing countries due to a combination of factors like lack of financial capacity and manpower skilled in ICT. The case of Allahabad City in India realized that investing in ICT tools such as GIS would be able to save them more public money if this could aid them in making the right decisions such as investing in expensive infrastructure projects to prevent future events of severe flooding which would inflict damage to life and property. Moreover, the use of GIS tools in the case of Allahabad guided planners and decision makers in identifying the appropriate response measures which made their disaster management strategies anticipative, and which is expected to result to the reduction of casualties in the occurrence of future disasters.

- ***The Case of Mexico***

The lack of competent and technically equipped personnel in disaster management is a common dilemma faced by most developing countries. The case of Mexico was able to overcome this by including in their national disaster management system a “think-tank” organization, the National Center for Disaster Prevention (CENAPRED) at the National Autonomous University of Mexico. The role of the academe and experts has somewhat been overlooked most of the times by decision-makers as they see them as a threat to their decision-making authority. In this case, the academe and experts worked together with the government in mapping-out solutions to the country’s problems related to managing natural disasters and also strengthened the link in disseminating information and knowledge to the public about the do’s and don’ts, and other relevant information needed in times of disasters.

- ***The Case of Kenya***

The problem in many African countries and cities is that they are more economically vulnerable to the impacts of disasters due to socio-economic factors like educational attainment and source of livelihood. The case of Kenya was able to address this through the assistance of international organizations primarily the UNDP, by focusing on enhancing water supply provision, support programs and projects to agriculture which is the main

economic activity of the people affected by the series of flooding, and measures to combat the possible outbreak of epidemics like malaria which would also hamper the economic activities of the people.

Table 4.1 below presents a summary of the key lessons learned from these cases.

Table 4.1: Summary of Key Lessons from Related Cases on Climate Change and Disaster Impact Adaptation

Country	Case	Key Lessons
Philippines	Community-Driven Disaster Prevention: The Homeless People’s Federation of the Philippines (HPFP) Experience	<ul style="list-style-type: none"> • Community organizing and capacity-building on community-based DRM • Savings mobilization scheme • Networking with external organizations for resource generation (financial and non-financial)
India	Enhancing Disaster Management Through GIS: The Case of Allahabad City	<ul style="list-style-type: none"> • Use of GIS as a planning and decision-making tool • Use of GIS in enhancing emergency response measures
Mexico	Formulating and Implementing National Disaster Management Systems	<ul style="list-style-type: none"> • Involvement of “think-tanks” in planning and implementing DRM systems
Kenya	Disaster Preparedness, Prevention, Mitigation and Management in Kenya	<ul style="list-style-type: none"> • Enhancement of local economic base by incorporating measures to protect economic activities from potential disaster impacts

4.6 Summary

Four different cases on climate change and disaster impact adaptation and mitigation were presented in this chapter. The first is the Philippine case which dealt with pro-active participation of low-income communities in managing and mitigating disaster prevention and preparedness measures at the community level. This initiative proved that partnering with communities in disaster management is possible through networking and partnerships, and training and capacity building. The case of India showed how ICT tools such as GIS can improve planning and decision-making for government officials in order to address development issues such as climate change and disasters more effectively and accurately develop measures to mitigate them. The case of Mexico not only gave an example of a good DRM system but also showed the importance of involving and recognizing the valuable inputs of technical experts from academic and research institutions. Lastly the case of Kenya showed how protecting the local economic base, in this case agriculture, against the impacts of disasters can make communities less vulnerable to the effects of disaster in the social and economic aspects.

CHAPTER 5: ANALYSIS AND RESULTS OF THE STUDY

This chapter presents the analysis of the findings of the study based on the first three research questions. The results of these analyses would be the identification of the socio-economic vulnerabilities and potential risks of Ayigya to climate change and disaster impacts as well as the institutional gaps that need to be addressed in relation to climate change adaptation and disaster impact mitigation. To answer the fourth research question, the last part of this chapter gives the applicable interventions culled out from the lessons from the international cases presented in the previous chapter.

5.1 On the disaster preparedness strategies in Kumasi and in Ayigya

- *Structural Measures*

The study area is being serviced by an estimated total road length of 8.07 km, based on the transect walk and data from available maps (see Figure 5.1). Of this, only an estimated 2.575 km, or 31.9% has constructed open drainage canals that convey rainwater to the nearby rivers and streams. Most of these constructed drainage networks are located on the main road of Ayigya going to the government's affordable housing project located on the north side of the area. Aside from this network of open concrete drainage, there are no other structural means that could control flooding and prevent erosion.

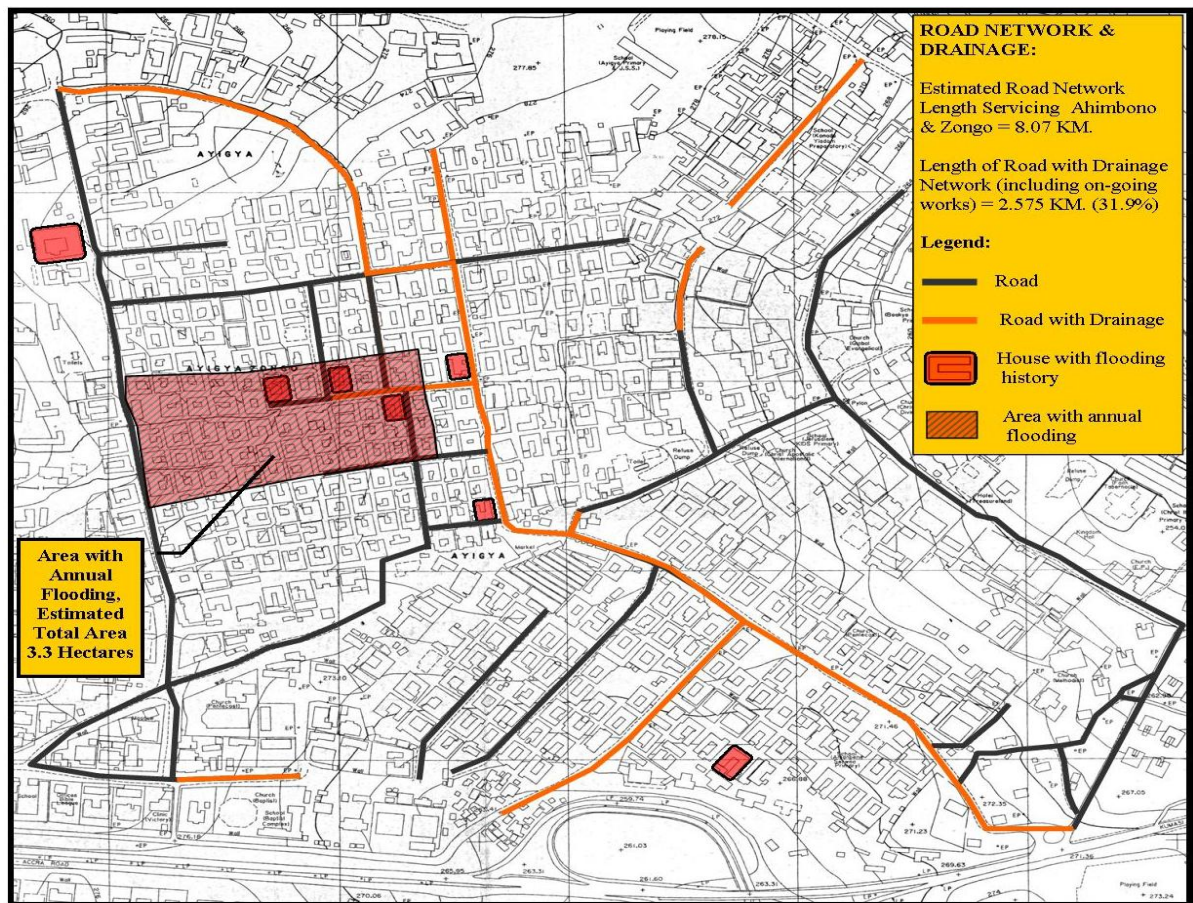


Figure 5.1: Road network and drainage of the Ayigya Ahimbono and Ayigya Zongo

The area that experience annual flooding in Ayigya Ahimbono and Ayigya Zongo is relatively small (estimated to be 3.3 hectares) compared to the total its estimated total land area of 55 hectares which is only about 6% of the land area located right in the middle of the Ayigya Zongo community (refer to Figure 5.1). Compared to Ayigya Ahimbono which has several networks of internal concrete drainage canals in between houses, none were seen constructed in Ayigya Zongo. From the household survey results, only 7 out of the 100 households (7%) that were interviewed have experienced previous incidents of flooding (refer again to Figure 5.1 for the location of these houses). Of these 7 households, 4 are located within or adjacent to the area where the repeated incidents of flooding and torrential rains have caused the roads to erode and some houses to collapse. The residents in this area have put up temporary measures such as the use of old rubber tires to hold the soil intact at one point. The analysis of these physical factors will be discussed more in detail in Section 5.3.



Upper Photo: Portion of the main road in Ayigya with constructed drainage; Lower Photo: Rubber tires used to temporarily hold the soil intact to prevent it from further eroding

- *Non-Structural Measures*

A number of non-structural measures can be done *in-situ* with the structural measures which could both enhance the sturdiness of the soil against erosion and control surface water run-offs from flooding the low-lying areas. Among the most common of these *in situ* non-structural measures are the provision of vegetation like trees and grass plant varieties, and provision of easements or open spaces especially in floodplains and other hazardous areas like cliffs and steep riverbanks.

The presence of vegetation and easement provisions in Ayigya were the ones that were assessed by ocular observations during the transect walk surveys in both Ayigya Ahimbono and Ayigya Zongo. From the ocular surveys, it was observed that gully formations abound and there was no presence of any vegetation and easements to protect the settlements from erosion. From the road length computations done on the map, it was estimated that about 5 km. or almost all of the roads outside the main roads of Ayigya have gully formations carved by surface water run-off (see Figure 5.2).

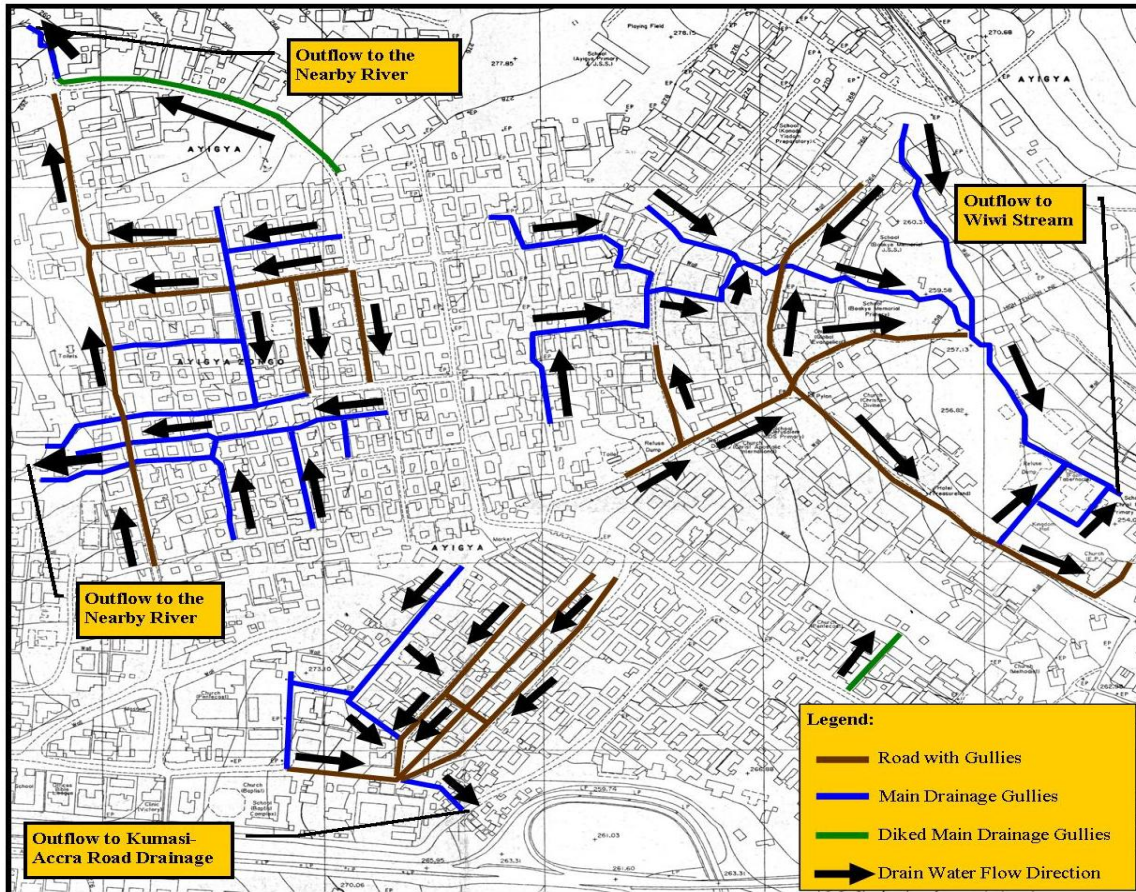


Figure 5.2: Map showing roads, paths and alleys with gully formations and drainage pattern

Other non-structural measures that were investigated in this study pertain to existing strategies and policies namely disaster management and land use plans, and zoning regulations. From the interviews conducted with the respondents from the Town and Country Planning Department (TCPD) of KMA, and the Ashanti Region and KMA offices of the National Disaster Management Organization (NADMO), these strategies and policies exist in principle. The reason behind the researcher stated this as “in principle” is because: (i) the land use plan that KMA is till using is the 1963 plan and the latest land development scheme for Ayigya which they use as basis for issuing development permit was the 1978 plan; and (ii) the one and only copy of the Disaster Management Plan (DMP) of Kumasi is “missing” during the time that the interviews were conducted.

In the 1963 land use plan of Kumasi, the Ayigya community is classified as residential. But the actual land use has a mixture of residential and commercial use with the presence of trading and small businesses plus the fact that most of the compound houses in both Ayugya Ahimbono and Ayigya Zongo are being rented out to tenants. This gives Ayigya a sort of a mixed-use characteristic. Aside from this, comparing the 1978 plan of Ayigya as against the actual development, the layout of the plots doesn’t match the structures and some roads have already been built up with houses as well. With regards to the DMP of Kumasi, the researcher solicited information from the NADMO-KMA Coordinator to briefly describe the

contents of the “missing” DMP. According to the NADMO-KMA Coordinator, they have pre, during, and post disaster strategies and measures. The pre-disaster strategies and measures include the education campaigns in schools and in the community, training of disaster volunteer groups (DVGs). The strategies and measures during disasters are mostly on rescue operations whereas the post-disaster activities focus on relief distribution operations.

5.2 On the existing implementation mechanisms to operationalize disaster preparedness strategies

- *Institutional Organization*

In terms of system and organization, the government of Ghana has established such a system for disaster preparedness as explained by the respondent from the NADMO-Ashanti Region office. This organization has a structure which transcends from the Ministry of Interior at the national level down to each DVG at the community level (*Figure 5.3*). However, in the case of Ayigya, no DVGs were established based on the interviews conducted with the respondents from the NADMO offices and the Unit Committees of Ayigya.

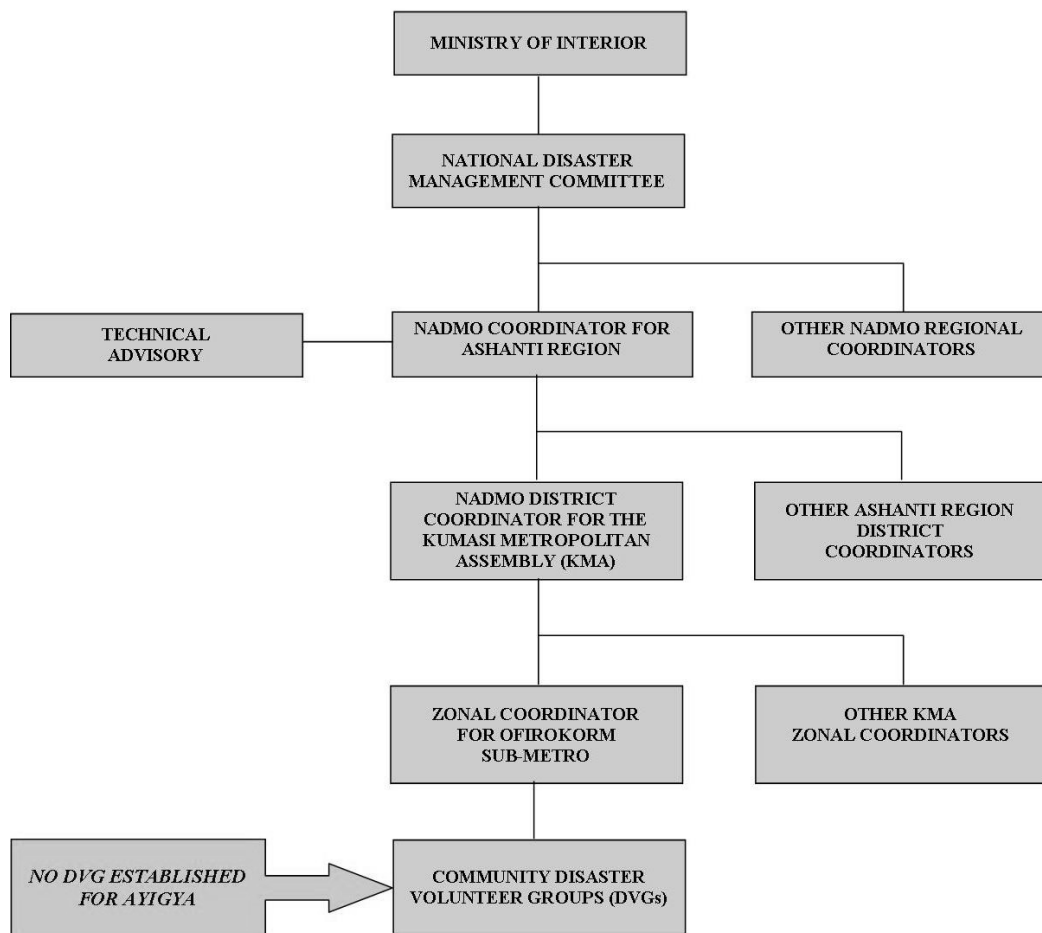


Figure 5.3: NADMO Organizational Structure

NADMO has also established partnerships with international organizations such as the UNDP and Red Cross to support its functions through capacity buildings and resource augmentation. To support its operations, the NADMO primarily gets its funding from the national budget and is distributed to the different regional and district offices. Aside from the national government funding, NADMO also accepts grants and donations which are remitted to the NADMO National Office and again is distributed to the different regional and district offices. No amount in figures was disclosed during the interviews conducted but the amount of funding NADMO receives is just sufficient to cover the personnel services and operation expenses, and relief operations especially this year which NADMO considers as the worst year they experienced in terms of the frequency and magnitude of damage brought about by flooding. Some of NADMO's operations are being implemented by the DVGs at the communities such as information campaigns and first-hand rescue and first-aid procedures. This way, NADMO is able to compensate for the lack of field personnel for their operations.

In the interviews conducted with respondents from the government offices, the main problem they have in performing their functions to the public is the lack of manpower and institutional capacity. In the interviews conducted with the KNUST experts, they mentioned that KNUST is only involved in government activities if invited or summoned to do so and not in an "*ex-officio*" capacity in the government's committees and councils. Until they don't receive any form of notice or invitation they could not be involved at any capacity in the government's affairs. With the KNUST, technically competent people are not exactly scarce especially in the Metro Kumasi area where the campus is situated. The KNUST is the only university (until 2008) in Ghana that is offering courses in Architecture and Planning. However, KMA has not been able to capitalize on the advantage of having experts in different development fields from KNUST which could have helped them in making more sound and appropriate development plans and implement projects with guidance from local technical experts.

- *Planning and Management*

In Ghana, the preparation and monitoring of the implementation of the DRMP is the sole responsibility of NADMO and their stakeholders. According to the interviews conducted with the officials from NADMO and the TCPD, NADMO's coordination with the TCPD happens only in the planning and programming of projects related to disaster mitigation. Aside from this, the TCPD is only sought for advice if there are matters concerning the land use and zoning which NADMO does in identifying and proposing projects on disaster mitigation.

At present the use of ICT tools such as GIS in planning and management functions of the government has not been realized in Ghana both due to constraints on financing the initial investment and the capable manpower to operate such technology. This is another aspect that KNUST could actually have a valuable contribution to the government's operations.

- *Budget*

In terms of budget, NADMO gets its budget from national government allocations and also from grants and donations from international donors and organizations. The budget coming from these two sources are then allocated to each regional and district office of NADMO by its national office. However, most of their budget can only cover the expenses for salaries and wages of their staff and other operating expenses including relief operations. According to the NADMO-Ashanti Region official interviewed, this year has so far been the most difficult for them in terms of addressing the impacts of flooding in a country wide scale, so much that they have to make appeals and campaigns for financial support especially for relief distribution (see *Inset No.1*).

Box No.1: Floods in Ghana, 2009

Since no record on the frequencies of flooding have been gathered from the NADMO and KMA offices the researcher made use of local periodicals (*Daily Graphic* and *The Chronicle*) to verify the statements of the NADMO officials on the severity of flooding in Ghana for this year. In one of the articles gathered from the *Daily Graphic*, Mr. Kofi Portuphy, the NADMO National Coordinator, is appealing to the public for support to help the victims of floods in Ghana. These articles showed the impacts of flooding in Ghana caused by torrential rains and clogged drainages in the country's different regions – Greater Accra (*Metro Accra* and *Mataheko*); Western Region (*Nkroful*, *Kwame Nkrumah's hometown*); and *Metro Kumasi* (*Ashanti Region*, where *Ayigya* is located).

At the KMA level, implementation of projects, particularly drainage and flood control infrastructure to mitigate flooding has been hampered due to the budget constraints. The government has even resorted to borrowings from institutions such as the World Bank to finance some of their small and medium infrastructure projects. One of these projects is the on-going drainage constructions along the main road in Ayigya going up to the affordable housing government project site.

5.3 On the socio-economic and ecological conditions in Ayigya

- *Physical Environmental Conditions*

As discussed in the Section 5.1, only 7% of the respondents from the joint household survey experienced annual flooding. Another significant outcome of the joint survey that could be incorporated in this study is the perception on the problems encountered by the residents. Among the 12 problems that were pre-identified, Drainage and Flooding ranked third (12.36%) behind Water Supply (29.59%) and Solid Waste Collection (22.10%) (see Figure 5.4).

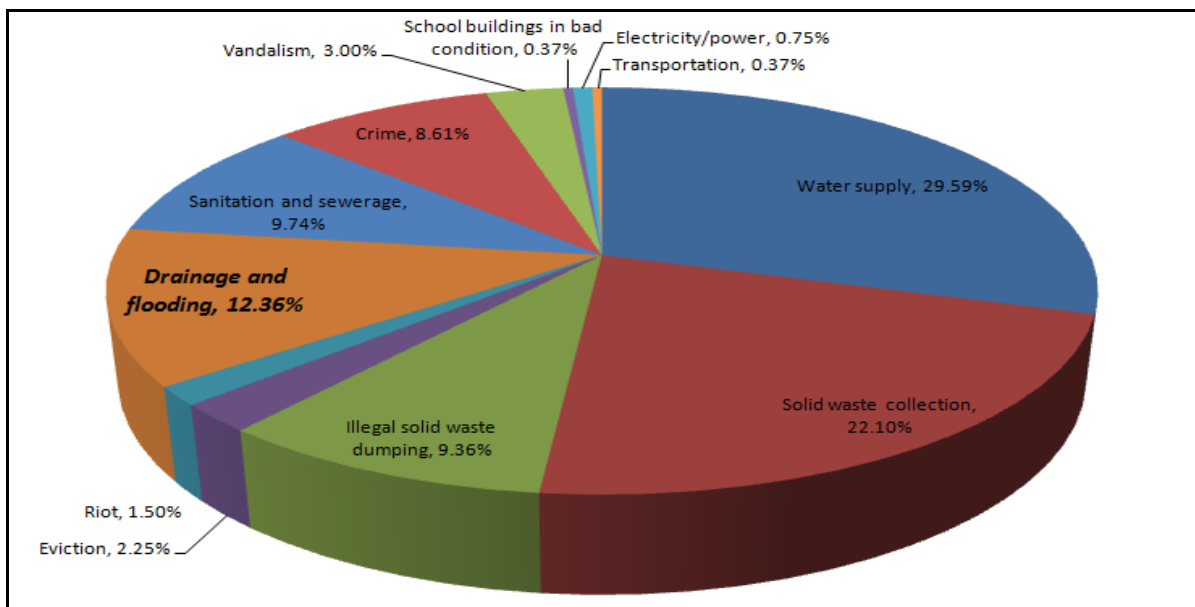


Figure 5.4: HH Survey Responses on the Perception on Top Priority Problems Encountered in Ayigya

From these results, further investigation was done through mapping analysis as to why drainage and flooding still ranked third among the 12 priority problems despite the fact that only 7% (7 out of 100 HH) experienced flooding, with 6 of the 7 HH located in Ayigya Zongo and 3 of them are within the area with annual flooding (refer to Figure 5.1, page 35). Using the 2004 Survey of Ayigya as the basis, the natural slope and topography of Ayigya Zongo was analysed. First analysed was the area where survey respondent HH numbers 17, 31 and 32 were located, and then a section of the whole Ayigya Zongo on the east side. By projecting the map, the slope and topographic characteristics of Ayigya Zongo were plotted out and the resulting land forms are illustrated in Figures 5.5 and 5.6 below.

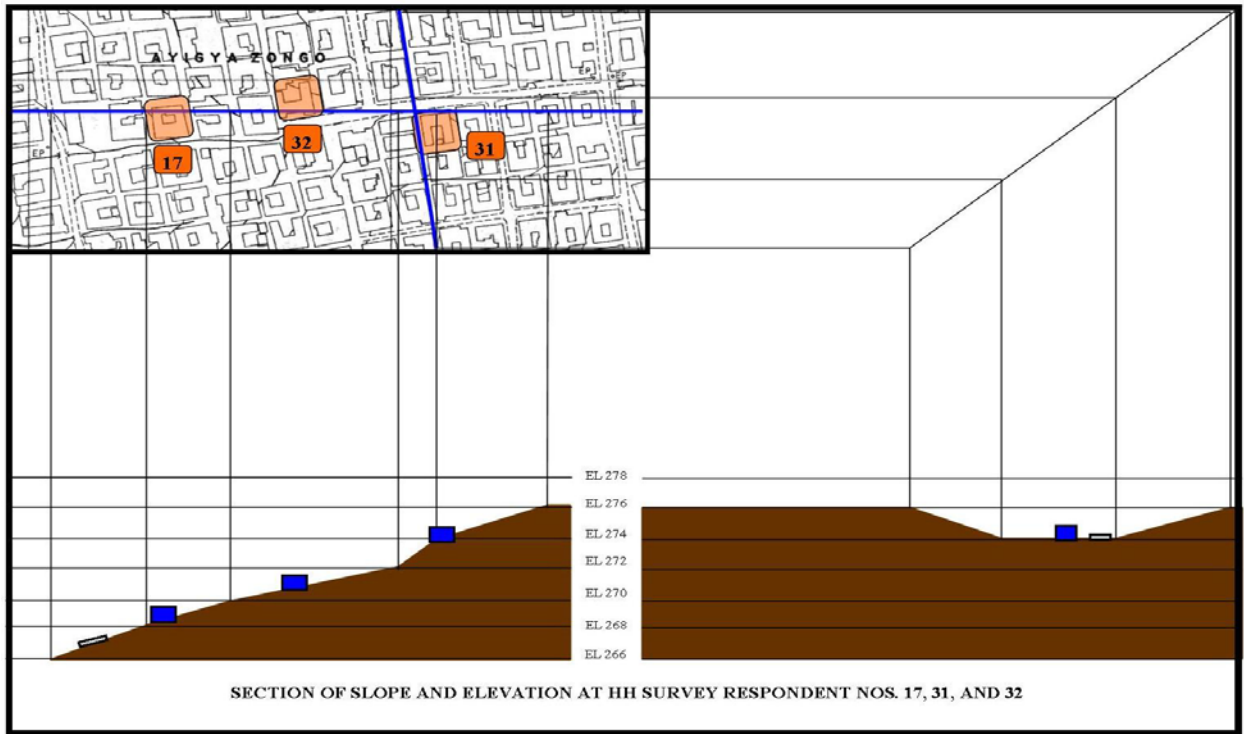


Figure 5.5: Slope and Topographic Projection at HH Survey Respondent 17, 31, and 32 in Ayigya Zongo

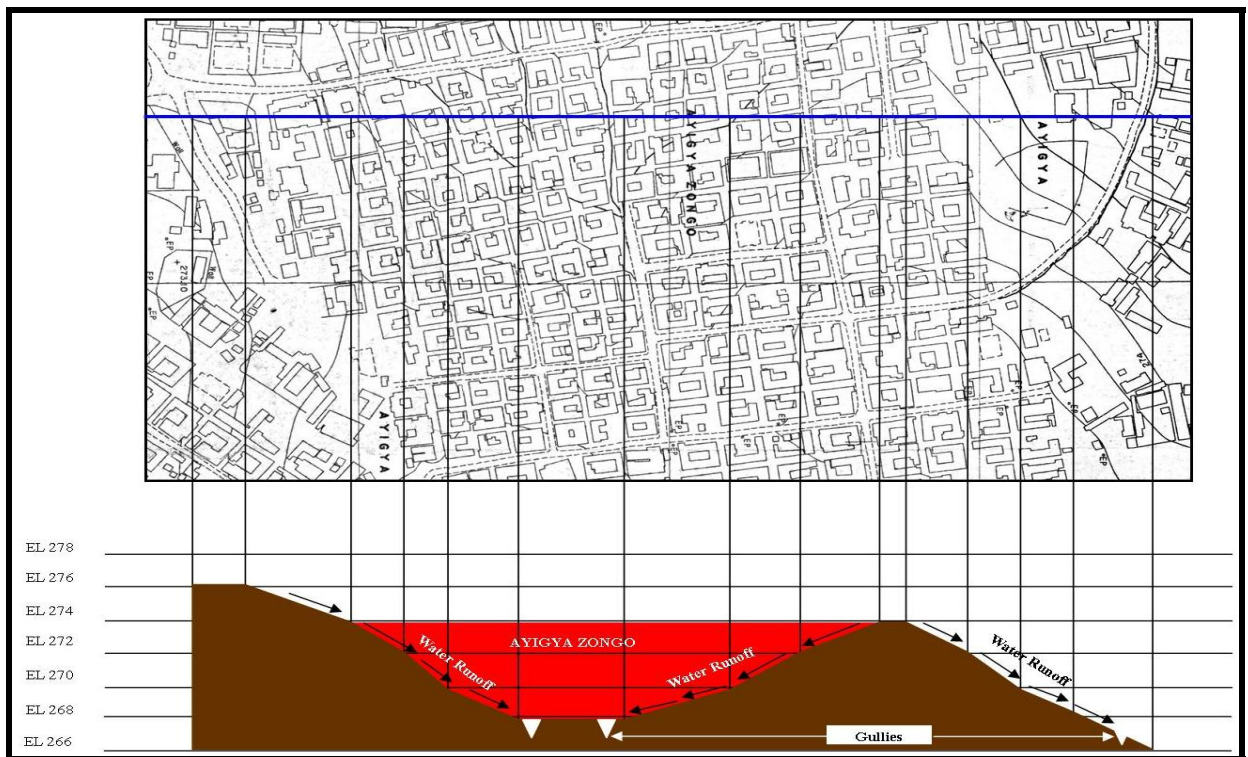


Figure 5.6: Slope and Topographic Projection of the Ayigya Zongo Section on the East Side



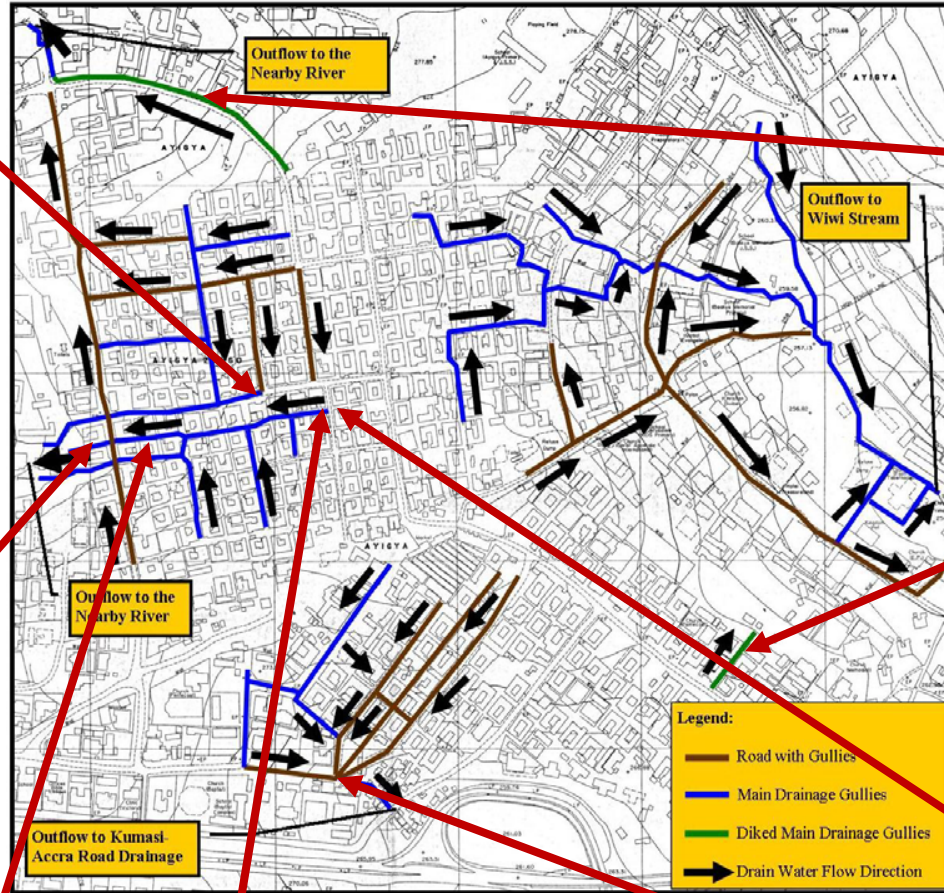
Photo of eroded road near HH 17, 31 and 32, the arrow shows the original height of the road which is about 1.2 meters higher.



Deep gully drainage going to the direction of the river on the west of Ayigya.



One of the drainage gullies that formed in between the houses in Ayigya Zongo.



Drainage gully running at the back of the house of Survey Respondent No. 31



One of the roads with drainage gullies



Portion of the main road in Ayigya where concrete drainage has been constructed on what used to be gullies



One of the drainage gullies where concrete drainage networks have been constructed in Ayigya Ahimbono



House of Survey Respondent No. 31 with Ms. Mutia Razali pointing to the top of the flood water level height.

From the transect walks conducted, it is observed that the drainage gullies in Ayigya Zongo are deeper and has a longer network compared to Ayigya Ahimbono. Also, it is observed that concrete drainages are already being constructed along the drainage gullies that run in between the houses in Ayigya Ahimbono. In Figure 5.5, the land form where HH numbers 17, 31, and 32 are located is actually like situated in one big drainage canal, making it the natural drainage path of rain water for Ayigya Zongo. On the other hand, Figure 5.6 shows that the land form of Ayigya Zongo is actually a small valley formation formed between two hills. This also explains the deeply eroded road deep gully formations near HH numbers 17, 31, and 32.

From the interviews and observations done in this study, the problem of flooding is not as vast as was perceived during the early stages of the research. Considering the meteorological conditions, slope, topography, geomorphology and methods of building construction in Ayigya, the environmental problem which is more of a concern is actually soil erosion. To supplement the previous literature of this study, additional library research was done to further understand the cycle of erosion (*see Inset No.2*) and how this applies to Ayigya. From the Davision Cycle of Erosion, the stage at which the soil conditions in Ayigya now is the so-called “*Stage of Maturity*” where a measure of drainage integration would have been achieved, for streams running into one basin would under favourable circumstances have eroded head-wards to capture the drainage of an adjacent higher basin (Small, 1978).

In the interview conducted with Dr. Charles Akayuli of the Building and Road Research Institute (BRRI) in Kumasi, the topsoil in Ayigya is what commonly called “hardpant” or concrete latirite as it is traditionally used as a material for building houses and has an absorptive characteristic. The layer underneath the topsoil is a hard layer of either Felites or Granite. Both have gritty properties and very low absorptive capacity. That is why when the topsoil is washed away, the exposed layers brittle away when hit by rain into powdery particles causing gradual erosion and thereby exposing the foundations of the houses causing them to collapse. According to the respondents of the in-depth interviews from the two residents who experienced flooding, erosions and collapsing houses started occurring in Ayigya approximately about 30 years ago. Dr. Akayuli added, that based on the photographs and other information that was shown to him during the interview, erosions are still expected to happen in Ayigya in at least within the next 20 years.



Photos of some houses located in Ayigya Zongo with collapsed portions

Box No. 2: The Stages of the Davison Cycle of Erosion with Climatic Interventions

According to Small (1978), the Davison Cycle of Erosion with Climatic Interventions has three stages each discussed as follows:

Stage 1: Stage of Youth

The initial surface would be made of basins, often totally enclosed, fault-scarps, and plateaus, which would be attached by weathering and surface torrents nourished by occasional rainstorms. The scarps would be gradually driven back, and dissected by gorges and canyons, whilst the ephemeral streams would flow towards the low-lying areas, forming in many instances centripetal drainage systems (gullies). Within the basins, great masses of alluvium would be deposited and the basin flows thus progressively raised.

Stage 2: Stage of Maturity

By this stage, a measure of drainage integration would have been achieved, for streams running into one basin would under favourable circumstances have eroded headwards to capture the drainage of an adjacent higher basin. Through maturity, with the continuation of this process, the numerous local base-levels would be of decreasing importance, and in some individual basins alleviation would be replaced by erosion regarding to a lower level. However, erosion of the plateaus would also continue and in this way, the initial surface would be gradually consumed, residual hills would become common, and rock sediments would become even more extensive.

Stage 3: The Stage of Old Age

As a result of the process described, the landscape would by now have been reduced to a series of alluvial plains, marking the main sites of the deepest of the original basins, and rocky plains surmounted by monadnock-type hills would occupy the sites of the former upland blocks. As seen, the integration of drainage would have progressed throughout maturity and perhaps have become virtually complete, so that the general base level of erosion would at last make its influence fully felt. However, during the final stages of the desert cycle, increasing aridity-resulting from a diminution of relief rainfall – would again lead to a fragmentation of the stream pattern. It is possible that the final fashioning of the desert pene-plain could be achieved by wind deflation, which would be work areas of alluvium into extensive sand dunes, or even export the material altogether to reveal and ever-increasing area of bare rock.

The duration of time it would take to complete the three stages is between 5 and 50 million years depending on the type of soil in the particular area.

- *Housing Conditions*

From the field observations done in Ayigya, the residents have so far been only be able to make temporary solutions to the problems brought about by torrential rains, flooding and erosion with regards to keeping their houses safe from the impacts of these natural phenomenon. The problem has its roots from their traditional method of housing construction which makes use of mud for building the foundations and walls of their houses. Mud is

gathered from the topsoil surrounding their plots and also within their compounds. This practice however has also caused the soil to erode faster due to the disturbance of the soil's natural formation and the pressure brought about by the weight of the houses' structure.

From the HH survey conducted, although 46.46% don't know how old the house they are staying in is as they are tenants renting out rooms in the house and have no such information as to the age of the house, 41.41% of the respondents said that the house where they are staying is at least 31 years old. However there is still a probability that a large percentage of the houses whose age was not known in the survey could be at least 31 years old based on the construction materials. This result then

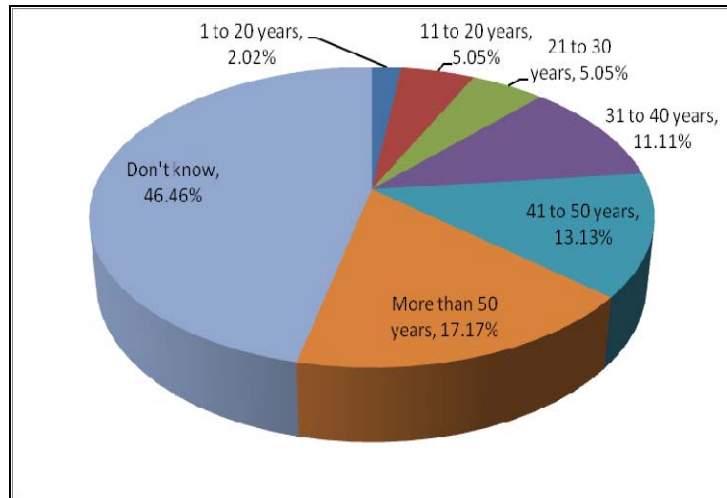


Figure 5.7: HH Survey Responses on Age of Houses

validates the responses of the in-depth interviews with some residents who mentioned about houses starting to collapse some 30 years ago. This makes the traditional building construction method a contributing factor aside from rain, flooding and erosion in the incidences of collapsing structures in Ayigya.



Left Photo: House with original structure made of mud at the left and new structure made of sandcrete at the right half; Right Photo: Foundations of a fence exposed already because of erosion.

From the interviews made with experts from KNUST and the officials from the community and the government, mud is no longer encouraged to be used even by the Chiefs for building materials. Now they made use of either concrete or sandcrete in making houses. There are also physical evidences of this as there are houses which are partly made of mud and partly made of sandcrete or concrete. Based on the in-depth interviews made by Ms. Lisa Hosale on her respondents from the community, the portions of the houses which are made of either sandcrete or concrete are actually extended portions of the houses and those made of mud are the original portions of the house which are likely to be decades old. This means that many of

the houses are still in danger of collapsing as they are still built using the old technology and which the foundations are built not deep enough to support the structure once the foundations are exposed to rainwater infiltration as a result of soil erosion.

Another building construction method that we noticed is that the houses in Ayigya (and in most part of Ghana) have short roof overhangs (usually only about 600 to 800 mm.) compared to the standard set by Section 17.2.5 of the 1989 Ghana Building Code which is at least 1.2 meters (1200 mm). According to the experts interviewed from KNUST and BRRI, the reason for doing this is for minimizing the cost of installing the roof in their respective houses. However, these short overhangs also leave the walls exposed to rain. Considering their traditional method of building using mud, weakening of the walls is also possible due to infiltration of rain water especially in there are un-plastered portions. Aside from this, this also causes the soil surrounding the structure to be withered away by rainwater and in combination with the build-up of surface runoff would cause the soil to erode and expose the building’s foundations.

- *Social and Economic Capital*

Information on the social and economic characteristics of the people in Ayigya were gathered from the joint HH survey. In terms of educational attainment, 49.50% of the respondents graduated from or at least reached secondary school, 19.80% reached primary, and 18.81% have no education at all. Only 3.96% of the respondents were able to finish or at least reach college level.

Disaggregating further the data on educational between the two traditional villages, the results show that 22.86% of the respondents in Ayigya Zongo reached primary school as compared to 13.33% for Ayigya Ahimbono. In secondary education attainment, 44.28% of the respondents from Ayigya Zongo at least reached secondary as compared to 63.33% in Ayigya Ahimbono. For respondents with no education, Ayigya Zongo has 24.28% while Ayigya Ahimbono only has 6.67%. In the rest of the categories both traditional villages are more or less equal. But the abovementioned results can be one reflection that Ayigya Ahimbono’s conditions are more better off compared to Ayigya Zongo which has a high margin of people with no education and lower secondary education attainment.

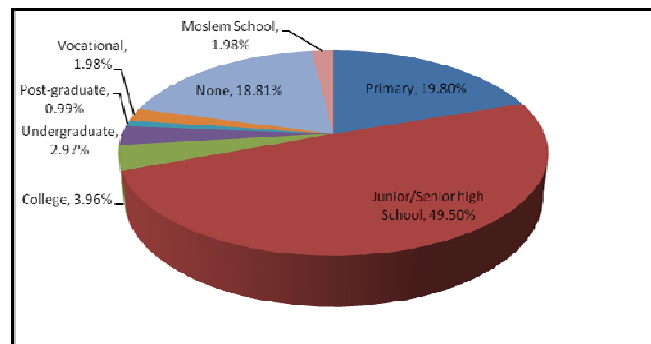


Figure 5.8: HH Survey Responses on Educational Level

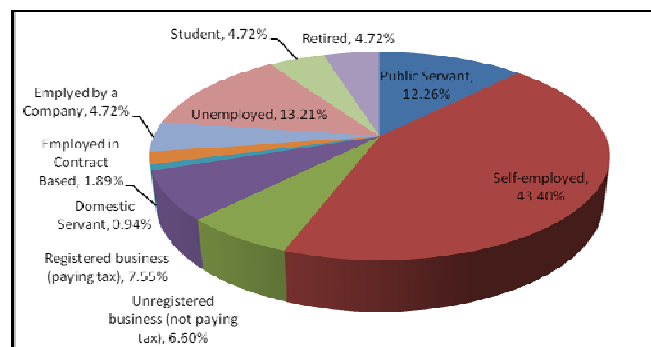


Figure 5.9: HH Survey Responses on the Source of Income

In terms of source of income, 55.66% of the respondents are either in business (registered and unregistered) or self-employed, and 13.21% are unemployed. However 52% of those either self-employed or in business have their business operating only within Ayigya. Of this, 69% are either in retail or food processing business in which 58% are sold also within Ayigya. In terms of monetary income, 29.67% of the respondents earn only about 84 GCD (42 Euros) a month. Disaggregating some of these results further, 14.28% of the respondents from Ayigya Zongo are unemployed while Ayigya Ahimbono has 13.33%. For those respondents earning 84 GCD and below, 31.43% of Ayigya Zongo's respondents are within this bracket as compared to 16.67% for Ayigya Ahimbono.

These findings along with the educational attainment statistics, prove that Ayigya Ahimbono's socio-economic conditions are better compared to Ayigya Zongo which would give the impression that Ayigya Zongo is more socially and economically vulnerable to the impacts of climate change and flooding as compared to Ayigya Ahimbono.

5.4 Vulnerabilities, Potential Impacts and Institutional Gaps

Based on the findings presented in the previous subsections of this chapter, the following vulnerabilities and potential environmental, social and economic impacts of climate change and flooding in Ayigya are identified as well as the governance/institutional gaps on the part of the KMA.

5.4.1 Physical and Environmental Vulnerabilities and Potential Impacts

- *Repeated incidences of soil erosion.*

From the responses of the interviews from experts, field observations on the natural physical features of Ayigya, and library research on the kind of development that had occurred for the past 50 or so years, the possibility of erosions occurring in Ayigya, especially in Ayigya Zongo, is not far from happening.

In a study conducted in 1975 by the KNUST Department of Planning, the 1948 census indicated that Ayigya only has about 35 compound houses occupied by 387 people (Stanley, 1975). With the establishment of the KNUST campus in 1952 and thereafter the arrival of the migrant northerners in 1954 saw the start of Ayigya as a crowding suburb. Since then Ayigya served mainly as the place where KNUST employees and students find cheap accommodation. And with the growth of the university, the demand for rental housing also increased causing the original compound houses to expand and structures were build not in accordance with the scheme developed by the TCPD. This haphazard development disrupted the natural drainage path of rainwater in Ayigya which then caused the formation of gullies along the roads, alleys and in spaces in between the houses due to erosion. This phenomenon has worsened through the years due mainly to the absence of a proper drainage network.

- *Repeated incidences of weakening of house structures causing them to collapse.*

Taking off from what was previously discussed, the haphazard development has caused the disruption of the natural rainwater drainage path in Ayigya and the concentrated water flow volume in certain areas has caused the soil to erode and thereby exposing the foundations of the house structures. According to the residents interviewed, houses started collapsing about 30 years ago but so far residents have only responded with temporary solutions such as patching the exposed foundations to prevent water from penetrating it. However the soils below these patches continue to erode thereby causing the foundations to be exposed again.

- *Expansion of identified area with annual flooding and eroded lands.*

In the 1978 scheme of Ayigya, provisions were given to protect the settlements from the possible impacts of flooding and erosion. In this scheme, easements and public parks along the existing drainage gullies were incorporated to provide settlements protection (see Figure 5.10). However these drainage gullies have expanded inward to the settlements areas which also meant the expansion of low-lying areas as soil is slowly being carved out through the years. It is in these areas where annual flooding of up to approximately 1.5 meters deep is experienced every year.

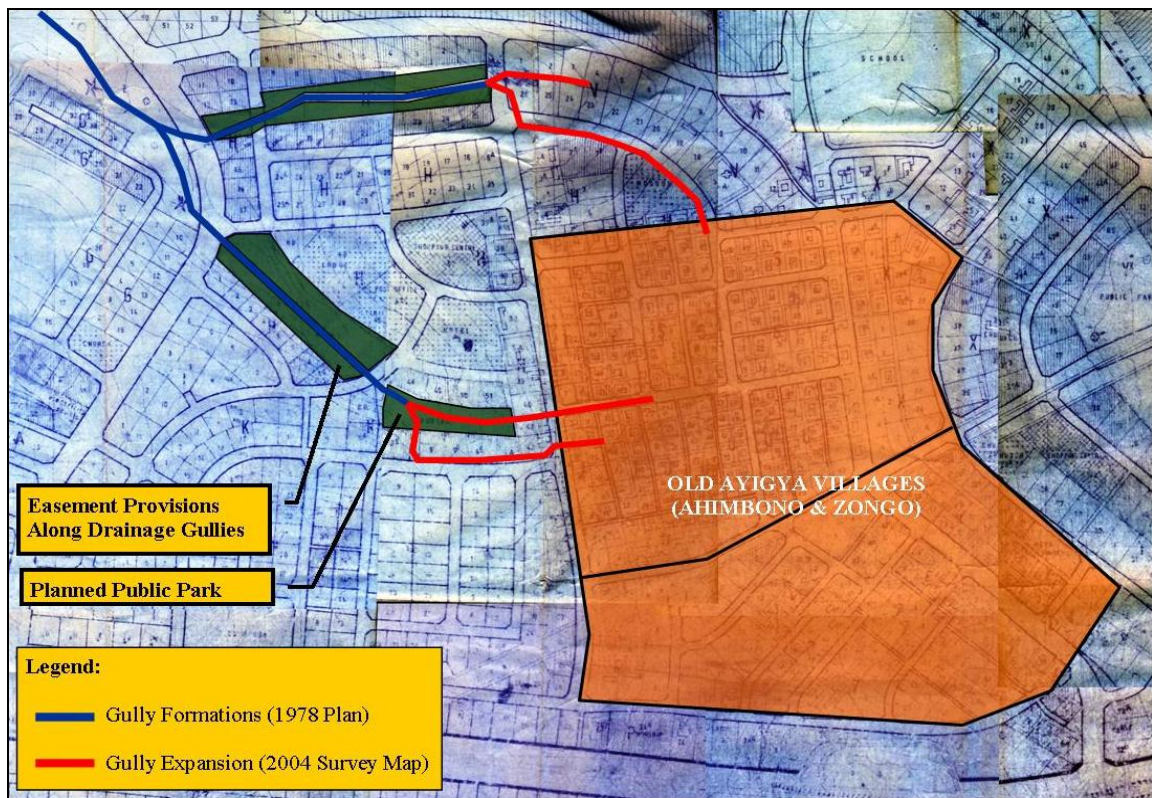


Figure 5.10: The 1978 Scheme of Ayigya showing the line of gully formations and its line of extension based on the 2004 survey map.

Quantitatively, the estimated amount of erosion intensity as well as sediment production and transportation can be done using the Erosion Potential Method (EPM)⁹ of estimation. From the interviews, field observations, secondary information and analysis of maps of Ayigya, qualitatively described, the area is indeed susceptible to erosion. To make the analysis of the potential physical and environmental vulnerabilities and impacts in Ayigya, the EPM method shall be used considering the geological, meteorological, and land use factors present in Ayigya. First the level of severity of potential erosion will be determined by determining the coefficient of erosion (Z) through the following equation:

$$Z = Y \times X \times (\square + \sqrt{I}) \quad (1)$$

Where:

- Z = erosion coefficient
- Y = coefficient of rock and soil resistance to erosion
- X = land use coefficient
- = coefficient value for observed erosion process
- I = slope in %

As described in the first part of Chapter 3, Ayigya has slopes ranging from 5 to 12%, and a soil type with a high moisture holding capacity with susceptibility to erosion that is moderate to severe. For this calculation, the maximum slope of 12% shall be used. The mean of ranges of the coefficient values for Y, X, and □ shall be also used which will be based on the following parameters (see Annex 1 for the complete table of coefficients for Y, X, and □).

Table 5.1: Coefficient Values for Y, X, and □

Coefficient	Description	Range	Mean
Rock and Soil Resistance to Erosion (Y)	Sediments, clay and other rock with little resistance	1.30 – 1.80	1.55
Land Use (X)	Areas without vegetal cover	0.80 – 1.00	0.90
Observed Erosion Process (□)	Erosion in rivers, gullies and alluvial deposits	0.60 – 0.70	0.65

Source: Stefanidis P., and Kalinderis I., (2008), *Soil Erosion Estimation Through GIS Techniques, the Gavrilovic Model, Institute of Mountainous Water Management and Control, Faculty of Forestry and Natural Environment, Aristotle University of Thessaloniki, Greece*

⁹ The Erosion Potential Method (EPM) for estimating erosion potential which is also known as the Gavrilovic Method, is a parametric distributed model for analysing erosion severity and estimating catchment degradation or sediment yield was originally using a combination geological, meteorological, and land use factors. It was developed by Gavrilovic in 1988 to analyze the erosion potential of watersheds in Yugoslavia and afterwards other watersheds in other parts of Europe.

Substituting the aforementioned values to Equation (1) we get:

$$Z = 1.55 \times 0.90 \times (0.65 + \sqrt{0.12})$$

$$Z = 1.39$$

From Equation (1), we get a Erosion Coefficient (Z) value of 1.39, using the mean slope of Ayigya which is about 9%, we still get a calculated erosion coefficient of 1.32. Based on Table 5.2, the magnitude of erosion in Ayigya falls under Category I, which is “*Excessive Erosion – deep erosion process*”.

Table 5.2: Erosion Coefficient, Z

Erosion Category	Qualitative Name of Erosion Category	Range of Coefficient Values (Z)	Mean Values (Z)
I	Excessive Erosion – deep erosion process (gullies, rills rockslides and similar)	$Z > 1.0$	$Z = 1.25$
II	Heavy/Intensive Erosion – milder forms of excessive erosion	$0.71 < Z < 1.0$	$Z = 0.85$
III	Medium Erosion	$0.41 < Z < 0.70$	$Z = 0.55$
IV	Slight Erosion	$0.20 < Z < 0.40$	$Z = 0.30$
V	Very Slight Erosion	$Z < 0.19$	$Z = 0.10$

Source: Haghizadeh A., et.al. (2009), *Forecasting Sediment with Erosion Potential Method with Emphasis on Land Use Changes at Basin, University Putra Malaysia, Selangor, Malaysia*

In estimating the annual catchment degradation (in $\text{m}^3/\text{km}^2/\text{year}$) the following equation is used in the EPM method:

$$W_{sp} = T \times h \times \prod \times (aZ^3 \times F) \quad (2)$$

Where:

W_{sp} = annual catchment degradation, in m^3/km^2 per year
 T = temperature coefficient based on the average annual mean air temperature (T_o) and is determined using the equation,

$$T = \sqrt{\frac{T_o}{10} + 0.1} \quad (3)$$

h = average annual rainfall (mm)
 \prod = mathematical constant equivalent to 3.14159
 a = conservation coefficient
 F = catchment area (km^2)

For the conservation coefficient (a) a value of 1.0 shall be used due to the absence of parameters to determine an accurate value. For the purpose of estimating the annual catchment degradation in Ayigya the following values shall be assigned to Equations (2) and

(3) based on available meteorological data of Kumasi from the 2006-2009 KMA Development Plan, as follows:

Average annual mean temperature, $T_o = 30.7 \text{ }^\circ\text{C}$

Average annual rainfall, $h = 214.3 \text{ mm}$

The catchment area to be considered in this case shall be the whole study area which has an area of about 55 hectares or 0.55 sq. km. Computing first for the temperature coefficient (T) using Equation (3), we get the following:

$$T = \sqrt{\frac{30.7}{10} + 0.1}$$

$$T = 1.78$$

Computing for the annual catchment degradation using Equation (2) and substituting the computed value of Z from Equation (1), we get the following:

$$W_{sp} = 1.78 \times 214.3 \times \text{[]} \times [(1) (1.39)^3 \times 0.55]$$

$$W_{sp} = 1,770.10 \text{ m}^3/\text{km}^2/\text{year}$$

As a simple illustration, the amount of sediments per square km. is equivalent to about 90 units of 20 cubic meter truck load capacity. In the case of Old Ayigya which is about 0.5 sq.km. in land area, the amount of sediments is equivalent to about 45 units of 20 cubic meter truck load capacity. This means for the next 20 years, the amount of soil that could possibly erode in Ayigya is equivalent to about 900 units of 20 cubic meters truck load capacity.

5.4.2 Social Development Vulnerabilities and Potential Impacts

- *Disruption of classes of school children.*

From the interviews conducted, the families affected by deep flooding in Ayigya Zongo usually just stay at home during the time when floods occur and just wait till the waters subside or at least their means of access is passable. But for as long as the flood waters are there, all of them do nothing, and sometimes even eat nothing if food runs out, and even the school-going children are not able to attend classes.

- *Possible displacement of settlers located on “valley” areas.*

As illustrated in Figure 5.10 above, drainage gullies have expanded inward to the existing settlements based on the 2004 survey map. But what is illustrated here are only the main drainage gullies which flow out to the river. Figure 5.2, page 37 shows the network of drainage gullies which form along the sloping topography of Ayigya, which basically is a hilly area. Ayigya Zongo on particular is situated on the valley-like part of these hill formations. If no measures will be done to control erosion and the flow of rainwater run-offs,

the further expansion of drainage gullies will also not be controlled which will lead to more erosions, collapsing houses and changes in land form, and thereafter displacement of settlements.

- *Increased incidence of Malaria cases*

There have been some debates on the relation of diseases such as Malaria to climate change. However in the case of Ayigya, Malaria is already considered a regular disease. Although people here are somewhat used to it already, the fact and the possibility of acquiring the fatal type of Malaria strain is still possible. With the possible expansion of areas that experience annual flooding and poor drainage, stagnant water would mean proliferation of mosquitoes, and the possible increase on incidents of Malaria among the Ayigya settlers. Considering their social and economic situation, this could possibly lead to increase in mortality and morbidity due to malaria in Ayigya.

5.4.3 Economic Development Vulnerabilities and Potential Impacts

- *Disruption of livelihood of individuals and families whose income depend on trading and other micro-small enterprises.*

As the case of school-going children not being able to go to school as they are trapped within their homes, the same also goes for the individuals from whom their family depends upon for livelihood. As previously mentioned, 55.66% of the households in the HH survey conducted are either into trading or small businesses, or self-employed. Their full dependence on their livelihood would mean disruption of their livelihood activities as they not able to go out of their houses and trade or go about their businesses. On the other way around, even if they are able to trade or do business, the potential customers would be much lower and would mean little income for them. This is on contrast with those that are formally employed who can still be compensated by their employers even if they are not able to go to work for a few days.

- *Accumulating long-term expenses on house maintenance due to low-cost temporary solutions.*

As previously mentioned, residents often resort to temporary, low-cost preventive solutions to the possible damages that erosion might cause to their houses. Although no amount in figures can be given to support this, considering that erosions have started occurring more than 30 years ago, the accumulated costs on these temporary solutions could have at been used to make more expensive but long-lasting solutions. However, considering the way houses are spaced, solutions to strengthen their house structures should be a synergized and collective effort of the community. One fact to be considered which could make the situation more complicated is that most of the landlords delegate to their tenants the maintenance of their rental units which again would made affordability to spend for maintenance a constraint.

- *Continued dependence on credit/loan to augment the financial losses for capital of micro-small enterprises.*

Due to the foreseen combined incidences of livelihood disruption and costs on spending for house maintenance, many individuals resort to credit/loan to augment their need to finance their capital for their small business as the flooding has caused them to be living without income for several days. This means that the money that is supposed to be spent for another day's capital would be spent on buying food (if they can get access). In the HH interviews conducted, the respondents who experienced flooding said that they did not receive any form of help from the government. Any assistance given to them was given either from friends and neighbours, or some relatives who live closed to them.

5.4.4 Governance/Institutional Gaps

1. *Ineffective implementation of DRM strategies at the community level due to the absence of a DVG in Ayigya and outdated governance tools.*

In the interview with Dr. Charles Akayuli of BRRI, he affirmed that Ayigya, particularly Ayigya Zongo can be considered a hazardous area for settlements considering the physical factors and the impacts that meteorological patterns have made on the community. Even with a DRM plan, the strategies and measures embedded in the plan would be of no use to Ayigya if no DVGs would be established that will respond immediately to the needs of the community in the event of disasters.

2. *Budget and logistical constraints on implementing DRM measures.*

This is the common response of the respondents interviewed from the government and also from experts – the lack of budget for operations and inadequate logistics. The budget allocated for NADMO is only sufficient to cover their operational expenses and salaries and wages, with some budget allocation for relief operations. Although they also get some additional funding from donors it is only enough to supplement their budget for relief operations. To augment the lack of logistical capacity of NADMO and KMA, rescue operations are so far being done in partnership with the military, local hospital staff, and the police. Still budget constraints are being experienced in rehabilitation projects like damaged roads and bridges and dikes. According to the TCPD, KMA does not have enough budget to implement such projects. Eventhough these projects are identified by NADMO to prevent disasters, the planning of such infrastructure has to be coordinated with the TCPD and the implementation with the other departments of KMA such as the Metropolitan Engineer's Department.

3. *Lack of coordination with technical experts and inavailability of competent manpower in government offices.*

This is another common response of all the respondents on the expert's interviews conducted. The load of work is not directly proportional to the number of personnel needed and also the

proper equipment such as vehicles is also lacking. Also as mentioned in the previous discussions, the presence of KNUST in Kumasi has not been maximized by the government as their expertise are sought only during times when some “patch-work” is to be done. With the fact that more of the country’s educated young professionals are either preferring to work in private companies or on other countries where better pay and benefits are offered compared with working for the government, the involvement of experts from KNUST would be a very valuable contribution in planning and implementing initiatives for the development of Kumasi including disaster management.

4. *Need to improve/synergize governance systems and tools.*

Aside from NADMO, there a number of government offices that have in a way has an involvement in disaster management in Kumasi. In his study about flooding in Atonsu, also in Kumasi, Kakrab (2005) identified these government departments/offices that have a role in disaster management in Kumasi.

These offices and a brief description of their roles and responsibilities of these different agencies are as follows:

- a. *Town and Country Planning Department.* The TCPD’s task is to ensure the coordination of the various types of land uses and development that is to be promoted by the various departments and agencies of government and private developers to facilitate the achievement of the highest possible means of health, efficiencies, aesthetics, and order in the physical environment.
- b. *Metropolitan Engineer’s Department.* This department is responsible for the planning and preparation of projects and programs, and administration of these projects and programs for the development and maintenance of Kumasi’s physical environment. Other offices under this department are the Electrical Unit, Drawing Office and the Building Inspection Unit which ensures that all developments comply with the approved plans.
- c. *Metropolitan Works Department.* The Metropolitan Works Department is responsible for the development and maintenance of structures dealing with sanitation and in the management of the Assembly’s landed properties, design and management of all building projects of KMA.
- d. *Metropolitan Road Department.* This department is in charge of the maintenance of road networks and drains, and the provision of road signs at appropriate locations.
- e. *Department of Urban Roads.* This department is primarily responsible for the construction of all major roads, drains, bridges, culverts, and roadside drains within Kumasi’s urban areas.
- f. *Waste Management Department.* This department’s main responsibility is on liquid and solid waste disposal. They are also in-charge of the cleaning of the streets and drains,

public open spaces, and weeding of grass on roadsides and open public spaces. Aside from this, they also supervise and monitor the activities of private contractors engaged by KMA in solid and liquid waste management, education of the public on waste management and the provision of sanitation facilities in homes. This department is also in-charge of the implementation of the on-going drainage improvement works in Ayigya.

- g. *Hydrological Services Department*. This department is in charge of conducting inspections and evaluation for assessing the capacity of all drains and existing water course to ascertain if they contain runoff. Aside from this, they also undertake activities for planning and design of drainage plans, supervision of construction works, and maintenance of primary and secondary drains.
- h. *National Disaster Management Office (NADMO)* . The main function of NADMO, as perceived by many, is to provide relief items to disaster victims. However the other more vital roles of NADMO is to prevent and mitigate disasters through their district offices, including the preparation of disaster management plans within their respective areas of jurisdiction.

From the roles and responsibilities stated above, it could be noticed that there are some roles that overlap particularly on the construction and maintenance of drainage infrastructures. One example is the on-going drainage construction in Ayigya which is basically a rainwater drainage system. This project is being undertaken by the Waste Management Department whereas on paper, it should be under the jurisdiction of the Hydrological Services Department.

Another important aspect that the Kumasi and Ghana government should work on are the policies and tools that should be revised, re-assessed and updated – i.e. land use plans, building codes, etc. which are already outdated and are not adapt anymore to the existing situation and development needs of Kumasi, especially in Ayigya. The government should also soon realize the benefist on investing in ICT tools like GIS and MIS systems which can aid them in decision-making, development planning, and delivering services to the public.

Another constraint that has hindered primarily the offices that performs planning functions are the traditional rulers. In the interview conducted with Prof. George Insitful and Prof. Samuel Afrane of the KNUST Architecture and Planning Department, the authority of the Chiefs in the Ashanti Region are given much respect that every development concerning their stool lands has to undergo first with their permission. This was personally experienced by the IHS team who are conducting their respective studies in Ayigya. Also according to them, the Ashanti Region is quite unique in the sense that it is the only region with a King figure. Apart from that, all lands within the Ashanti Region basically belongs to the King and is entrusted to the Chiefs. This gives them absolute control of the developments concernng lands within the Ashanti Region that even the government has to have the approval or at least have to inform the traditional rulers of any development that they would like to impose on a certain area under their jurisdiction.

5.5 Application of Lessons from Related Cases

- *Enhancing the Capacity of Communities in DRM, from The Case of HPHP, Philippines*

This lesson learned from the Philippines' case shows that with proper organization and partnership mechanisms established low-income communities can be effective partners in implementing DRM strategies at the community level. In the case of Ayigya, the involvement of the community in DRM is a big loophole that has to be filled and the Philippine case provides a good example of how it can be done.

- *Enhancing DR Management using GIS as a Decision-Making Tool, from The Case of Allahabad, India*

Investing in ICT tools indeed involves a big sum of money from the purchase of hardware and software, and hiring competent people to operate such technology. However, the benefits of ICT technology such as GIS has proved to have saved more money in the long run as it aided the government in making decisions as to the right investments to make in establishing DRM measures to mitigate the impacts of flooding and prevent big losses in life and property. This aspect of governance (use of ICT tools such as GIS) is still absent in the city of Kumasi. Especially with a city that is urbanizing amidst several disaster risks and hazards, the aid of ICT tools such as GIS would be very helpful in ensuring that the right investments and measures are made to ensure that the impacts of natural disaster won't be as severe as the previous incidents.

- *Involving Think-Tanks in DRM Planning, from The Case of Mexico*

The case of Mexico is one good example of involving experts from the academe and research institutions in mapping-out solutions to their countries problems in mitigating disaster impacts. This case would prove to be a learning lesson for KMA which has not been able to capitalize on the presence of KNUST and research institutions like BRRI which are based in Kumasi to assist them in their activities like disaster management planning.

- *DR Management with Emphasis on Livelihood Security, from The Case of Kenya*

The case of Kenya in Africa is an example of adapting to the impacts of climate change and disasters through the enhancement of support facilities and programs to enhance the local economic activities particularly agriculture. This is needed in Ayigya, although agriculture is not the dominant economic activity there, majority of the working population, those who have small enterprises and self-employed, are proved to be vulnerable to the impacts of climate change especially flooding. Therefore measures have to be done to protect the people socially and economically.

5.6 Summary

The findings of the study focused on three main things – the existing strategies and measures related to climate change adaptation and DRM; institutional mechanisms to operationalize disaster preparedness strategies; and the socio-economic and ecological characteristics of Ayigya. From these, the vulnerabilities and potential impacts to climate change and natural disaster were drawn and the analysis yielded among others the following salient results – (i) erosion is the most severe environmental problem in Ayigya which is supported by qualitative data from field and secondary sources and also from the results of the quantitative analysis using the EPM method; (ii) Ayigya Zongo is the more socially and economically vulnerable to climate change and disaster impacts compared to Ayigya Ahimbono; and (iii) there are overlapping of functions existing between several government agencies and the governance tools being used are too outdated and are almost unapplicable to the existing conditions especially in Ayigya. Based on the analysis of the findings, the applicability of the lessons learned from the four related cases in the previous chapter was also discussed to see what benefits could be gained from initiatives involving the community, investing in ITC tools, partnering with academic and research institutions, and in giving much needed emphasis on the economic aspect of disaster risk management.

CHAPTER 6: CONCLUSIONS AND RECOMMENDATIONS

The sixth and final chapter answers the fifth and last research question of this study. Based on the findings from the primary and secondary sources and the analysis of the data gathered, conclusions were drawn regarding Ayigya's collective vulnerability to the impacts of climate change and disasters and the capacity of the community and the government to address these vulnerabilities and potential impacts. Also tackled in this chapter is the linkage of the results of this study to the concept of sustainable development discussed in Chapter 2. The last part of this chapter consists of indicative frameworks for timing of cooperation and collaboration mechanisms to bridge the identified institutional gaps, the assessment of climate change adaptation options based on the identified vulnerabilities and potential impacts, and the areas for further research.

6.1 Conclusions

- ***On Adaptation Strategies and Mitigation Measures in Kumasi***

The findings of the study showed that there are adaptation strategies and measures in place in Kumasi, one of which is a disaster management plan. In the DRM plan, the strategies in place are a combination of some perceptive measures such as the establishment of DVGs and information dissemination in schools and communities about disaster prevention and emergency response procedures. However, due to lack of operational budget and inadequate logistics, the NADMO in particular is limited to only providing relief distribution in times of disasters like flooding. This would make the strategies and measures "*perceptive and proactive on paper*" but in reality are still "*reactive*" as actions are just based on the occurrences of events.

In the case of Ayigya the more that these strategies and measures are hardly even felt. The fact that they don't get any assistance from the government in times when flooding and erosion has affected them and that there is not a single DVG established in both Ayigya Ahimbono and Ayigya Zongo, the impacts of climate change and flooding would continue to bring negative outcomes on these communities in the coming years.

- ***On Implementation Capacity***

On the part of the community, especially in Ayigya Zongo which is the more vulnerable and poses higher risk of negative impacts, the socio-economic characteristics would make it difficult for them to be involved. Mr. John Maoli, Unit Committee Member of Ayigya West, stated that the low educational attainment of the people in Ayigya has made it difficult for development to foster as people have the mentality that all initiatives to improve their community should be the sole responsibility of the government. From this statement, encouraging volunteerism among the community would be a very ambitious undertaking considering their economic situation wherein doing something "*for free*" seems to be not a part of the majority's considerations for rendering services.

On the part of the government, aside from budget and logistics, cooperation and coordination of roles and responsibilities should be done to prevent overlapping of responsibilities. Aside from this, with the rapid urbanization that is happening in Kumasi and with the existing level of technology available, the planning and strategizing of development efforts is hardly catching up. For one, the land use plans and schemes are too outdated making again the functioning of governments just reactive to the occurring events – whether natural or man-made. Even the assistance of technical experts is only regarded as a last resort.

The preparation and implementation of climate change and disaster adaptation strategies is a tool to prevent negative impacts from hampering the proposed development initiatives of a city. This requires a pro-active involvement of the government, the community and the civil society. In the case of Kumasi, the human and institutional elements are actually in place, however the capacity to implement DRM strategies would take some synergizing, and capacity-building activities are still needed on the part of the government. But the most vital element and would be the success factor is getting the involvement and cooperation of the community which can be done with the active involvement of the traditional rulers.

- ***On Ayigya’s Vulnerability to the Impacts of Climate Change and Flooding***

On Ayigya’s vulnerability to the impacts of climate change and flooding, the hazards and risks are there considering first and foremost the physical characteristics and development that has occurred there through the past 50 years. With the expanding network of gullies brought about by years of continuous erosion, the houses are at risk of collapsing and drastic measures (considering their culture) such as relocation would be a difficult future adaptation strategy to undertake. Therefore appropriate risk reduction should be the immediate focus of the strategies and measures that should be done specifically for Ayigya.

On social and economic factors, the low level of education has made most of them not too receptive to new ideas if “*high costs*” are involved. In most instances, money for initial investment and not the long term benefits of investing is where they set their sights on. Considering the lack of good roads and drainage networks in Ayigya, especially in Ayigya Zongo, the level of poverty could possibly worsen if events such as displacement of settlements due to natural causes such as erosion occurred which would trigger lost opportunities for making a living and other impacts like children not being able to go to school. Most of the people in Ayigya are either engaged in trading (usually micro-small enterprises) or self-employed. If they succumb to such events, one day without doing about their business would mean a day without income. Based on the HH surveys, about 30% of the respondents earn only about 84 GCD (roughly 42 Euros) in a month. This amount is just enough to buy food and basic necessities for their families which means one day without doing business is a big loss.

These factors, plus the physical conditions of Ayigya, leave the people settling there socially and economically vulnerable to the impacts of climate change and flooding.

- ***Linking the Study to the Concept of Sustainable Development***

Going back to the conceptual framework of this study, we would recall that sustainable development depends on how humans utilize the available global resources and this affects the lives of people not only in the present but in the future as well. From the results of this study, Ayigya is actually a formal settlement. But the informal process of development of Ayigya through the past 50 years has led to problems such as overcrowding and inadequacy of support facilities like roads and drainage which has made them vulnerable to climate change and disaster impacts. A huge amount of work has to be done by both the community and the government to foster in sustainable development in Ayigya. This has somehow started by discouraging the people to use mud as building material which through the years has been identified in this study as one of the causes of erosion. However, acceptable cheaper alternative materials have to be developed for the people to use. This is just one aspect, but getting back to the physical, social, economic, and governance issues in Ayigya and Kumasi, sustainable development still has a long way to go.

6.2 Recommendations

6.2.1 Potential Areas/Mechanisms for Enhancing Institutional Capacity

Based on the identified governance and institutional gaps, the following mechanisms have the potential for enhancing institutional capacity of the various stakeholders.

1. *Establishment of Ayigya DVG.* Although this is already part of the institutional set-up of NADMO, it has yet to be established in Ayigya. Along with capacity building and training the community, this will contribute significantly in enabling the people to adapt to the potential impacts of climate change and flooding and how to respond to these impacts.
2. *Capacity Building and Trainings.* This covers not only the community but also the different government offices involved in DRM. Potential partners for this are the academe and research institutions of Ghana which are holding office in Kumasi.
3. *Establishment of Partnerships for Resource Generation.* This mechanism shall be designed to produce not only financial resources but also expansion of human resource capacity through partnerships with the academe and research institutes established in Kumasi which shall assist KMA in scouting for potential organizations and donors within and outside Ghana to assist them in their endeavours.
4. *Development Planning.* Though a regular function of the government, development planning can be a mechanism for enhancing institutional capacity by involving all the government departments mentioned above in the formulation of DRM plans. This would make them not only just involved but will also enable them to be aware of their respective roles and responsibilities in performing their functions thus enhancing their coordination and cooperation skills. Selected experts from the academe and research institutions in Kumasi should also form part of the revamped planning committee.

There are various co-management mechanisms for strengthening cooperation and collaboration in a multi-stakeholder management set-up such as formation of volunteer groups, capacity building, etc. In this section, recommendations on the timing of inputs or appropriateness for planning and management will be given to each identified mechanism for institutional strengthening. As defined by Mitchell¹⁰, there are three levels of timing for inputs for co-management mechanisms, these are:

1. Normative – determining what ought to be done (setting targets and goals formulation).
2. Strategic – determining what can be done (selecting options or courses of actions).
3. Operational – determining what will be done (activities involved/implementation tools).

Table 6.1: Timing of Inputs of Mechanisms for Enhancing Institutional Capacity

Mechanisms	Level of timing			Target Groups	Main Responsible Organizations/ Offices
	Normative	Strategic	Operational		
Establishment of Disaster Volunteer Group	●	●	●	Community	NADMO
Planning and Research	●	●		Government & Community	KMA
Capacity Building			●	Government	KNUST
Information, Education and Communication (IEC)	●	●	●	Community	KMA Sub Metro

6.2.2 Options for Adaptation and Institutional Interventions

Based on the vulnerabilities and potential impacts identified in the previous chapter, options for adaptation were outlined for each including the possible institutional interventions which would enhance the institutional capability of Kumasi as a city to plan and implement strategies and measures to adapt and mitigate the impacts of climate change and flooding, and also other natural disaster that may affect them. A summary of these options are outlined in Table 6.2 below.

¹⁰ Mitchell, B. (2002), Resource and Environmental Management, Second Edition. Pearson Education Limited.

Table 6.2: Options for Adaptation and Institutional Interventions to Vulnerabilities and Potential Impacts of Climate Change and Flooding

Vulnerabilities and Potential Impacts	Who/What is vulnerable?	Triggers/Agents	Recommended Options for Adaptation	Institutional Intervention
<i>Environmental</i>				
<i>Repeated incidences of soil erosion</i>	Ayigya residents	Excessive torrential rains and surface runoff	House improvements through approved methods Road and drainage improvements Emergency preparedness	Planning and Research Establishment of DVG
<i>Repeated incidences of weakening of house structures causing them to collapse</i>	Ayigya residents	Erosion and excessive water surface runoff due to torrential rains	House improvements through approved methods	Planning and Research
<i>Expansion of identified area with annual flooding</i>	Ayigya Zongo residents	Gully erosions and excessive water surface runoff due to torrential rains	House improvements through approved methods Road and drainage improvements Emergency preparedness	Planning and Research Establishment of DVG
<i>Social Development</i>				
<i>Disruption of classes of school children</i>	School-going children	Excessive torrential rains causing floods	Road and drainage improvements Provision of social safety nets at the sub-metro level	Planning and Research
<i>Possible displacement of settlers located on “valley” areas</i>	Ayigya Zongo residents	Gully erosions and excessive water surface runoff due to torrential rains	Relocation	Planning and Research
<i>Increased incidence of Malaria cases</i>	Ayigya residents	Excessive torrential rains causing prolonged watered potholes	Drainage improvements Awareness creation	IEC networking with media

Vulnerabilities and Potential Impacts	Who/What is vulnerable?	Triggers/Agents	Recommended Options for Adaptation	Institutional Intervention
<i>Economic Development</i>				
<i>Disruption of livelihood of individuals and families whose income depend on trading and other micro-small enterprises</i>	Ayigya residents engaged in small businesses and trading and who are self-employed Consumers	Excessive rains Prolonged flooding	Provision of social safety nets at the sub-metro level Diversification of livelihoods Expansion of trading market access outside Ayigya	Capacity Building and Training
<i>Accumulating long-term expenses on house maintenance due to low-cost temporary solutions</i>	Ayigya residents	Erosion and excessive water surface runoff due to torrential rains	House improvements through approved methods and alternative materials (e.g. bamboo + concrete)	Planning and Research Capacity Building and Training
<i>Continued dependence on credit/loan to augment the financial losses for capital of micro-small enterprises</i>	Ayigya residents engaged in small businesses and trading	Excessive rains Prolonged flooding	Provision of social safety nets at the sub-metro level House improvements through approved methods	Capacity Building and Training IEC

6.2.3 Potential Areas for Further Research

- Health impacts of haphazard development and climate change

This study has so far been able only to look into the impacts of climate change and flooding on common diseases such as malaria. However the possible health impacts of overcrowding, sufficiency of ventilation and how these correlate to the changes in ambient and indoor temperature due to climate change is an interesting study to be conducted. Conducting this kind of study could not only contribute to improving the health programs of KMA but also can provide a valuable input in re-visiting local and national policies such as the National Building Code of Ghana where provisions for the design and construction of access to light and ventilation are stipulated.

- Economic potentials in a crowding suburb to reduce socio-economic vulnerability

This can be seen as both a challenged and also an interesting area for research. With the repeated incidences of erosion, flooding and other possible impacts of climate change, the

need for diversifying the livelihood and income options of the people should be explored in order for them to be less vulnerable to the disruption of their primary economic activities. The low educational attainment is seen as a big hindrance to them as access to formal employment is not a big possibility for them. Inhabitants in the Zongo area used to be farmers in their place of origin based on the responses from the HH survey. The potentials of introducing urban agriculture could be one possible specific area of research in Ayigya since the local soil type is suitable for such activities.

6.3 Summary

In this concluding chapter of the thesis, the research concluded first of all that the most severe problem in Ayigya related to climate change and disaster impacts is erosion which is an after-effect of torrential rains and flooding. However in relation to these phenomena, the strategies and measures on disaster management in Kumasi are more reactive in nature. On the institutional mechanisms, there are some overlaps in the functions of several agencies involved in disaster management and the common problem faced by all of them is the lack of financial resources especially in implementing projects and also shortages in logistics especially in conducting field operations. The NADMO also has a good organizational structure from the national down to the local level but this has fallen short in Ayigya where no disaster volunteer group has been established to assist NADMO in the on-site operations particularly in implementing emergency response measures. To address these concerns, several actions have to be done both at the level of KMA and also at the community level to enhance their institutional capacity in disaster management. Among the things that need to be done are the establishment of the community-based DVG, capacity-building, and establishment of partnerships with local and international institutions and organizations. Recommendations were also given on the possible strategies and measures that could be done to address the identified vulnerabilities and potential impacts of climate change and flooding in Ayigya as well as areas for further research that could be taken off from this study. In the concept of sustainable development, this study concluded that given the physical, social, economic, and governance issues existing in Ayigya and Kumasi, achieving sustainable development in this case still has a long way to go.

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Annexes:

Annex 1: Range of Coefficient Values for Y, X, and \square

Land Use/Soil Cover Coefficient	X
Mixed and dense forest	0.05 – 0.20
Thin forest with grove	0.05 – 0.20
Coniferous forest with little grove, scarce bushes, bushy prairie	0.20 – 0.40
Damaged forest and bushes, pasture	0.40 – 0.60
Damaged pasture and cultivated land	0.60 – 0.80
Areas without vegetal cover	0.80 – 1.00
Coefficient of Soil Resistance	Y
Hard rock, erosion resistant	0.20 – 0.60
Rock with moderate erosion resistance	0.60 – 1.00
Weak rock, schistose, stabilized	1.00 – 1.30
Sediments, moraines, clay and other rock with little resistance	1.30 – 1.80
Fine sediments and soils without erosion resistance	1.80 – 2.00
Coefficient of Type and Extent of Erosion	
Little erosion on watershed	0.10 – 0.20
Erosion in waterways on 20-50% of the catchment area	0.30 – 0.50
Erosion in rivers, gullies, and alluvial deposits, karstic erosion	0.60 – 0.70
50 – 80% of catchment area affected by surface erosion and landslides	0.80 – 0.90
Whole watershed affected by erosion	1.00

Annex 2: Joint HH Survey Questionnaire

INSTITUTE FOR HOUSING AND URBAN DEVELOPMENT STUDIES (IHS) ERASMUS UNIVERSITY-ROTTERDAM, THE NETHERLANDS GHANA ATELIER HOUSEHOLD SURVEY QUESTIONNAIRE	
<p>Purpose of the HH Survey: The purpose of this HH survey is to gather socio-economic data thru responses from the inhabitants of Ayigya which will aid the students of IHS in the analyses of their respective research works for their master's theses. The results of this survey shall be used solely for academic purposes.</p>	
Enumerator:	Control No.:
A. Respondent's Profile	
1. Age:	4. Main Source of Employment: (1) Public Servant <input type="checkbox"/> (2) Self-employed <input type="checkbox"/> (3) Unregistered Business, not paying taxes <input type="checkbox"/> (4) Registered Business, paying taxes <input type="checkbox"/> (5) Domestic Servant <input type="checkbox"/> (6) Employed in Contract Based <input type="checkbox"/> (7) Employed by a Company <input type="checkbox"/> (8) Unemployed <input type="checkbox"/> Others (specify): _____
2. Gender: (1) Male <input type="checkbox"/> (2) Female <input type="checkbox"/>	
3. Civil Status: (1) Single <input type="checkbox"/> (2) Married <input type="checkbox"/> (3) Separated <input type="checkbox"/> (4) Widow/Widower <input type="checkbox"/> (5) Living-in <input type="checkbox"/> Others: _____	
6. Place of Birth:	5. Education: (1) Primary <input type="checkbox"/> (5) Post-graduate <input type="checkbox"/> (2) Junior/Senior High School <input type="checkbox"/> (6) Vocational <input type="checkbox"/> (3) College <input type="checkbox"/> (7) None <input type="checkbox"/> (4) Undergraduate <input type="checkbox"/>
7. Number of years living in Ayigya:	
8. What type of house do you live in? (1) Compound House- Single Storey <input type="checkbox"/> (4) Single family house-Multi-storey <input type="checkbox"/> (2) Single family house- Single Storey <input type="checkbox"/> (5) Others, please specify _____ (3) Compound house multi-storey <input type="checkbox"/> (6) I don't know <input type="checkbox"/> 8a. If it's a compound house, How many households/ families living in the house?	
9. What is your tenure status? (1) Owner of the House/ Not renting out <input type="checkbox"/> (5) Family member to owner <input type="checkbox"/> (2) Owner of the House/ Landlord <input type="checkbox"/> (6) Others, please specify <input type="checkbox"/> (3) Tenant, pays rent <input type="checkbox"/> (7) I don't know <input type="checkbox"/> (4) Tenants, pays no rent/ Sharer <input type="checkbox"/>	
10. Total number of people living in the house (including house-helpers, extended family):	

B. Income and Livelihood	
<p>11. Sources of Income: (can choose more than 1 answer)</p> <p>(1) Business <input type="checkbox"/> (4) Pension <input type="checkbox"/> (2) Employee <input type="checkbox"/> (5) Income from Rent (3) Remittance <input type="checkbox"/> (6) Others: _____</p> <p><i>Note: If answer is not "Business" skip Nos. 12 to 16 and proceed to No. 17</i></p>	
<p>12. Where do you sell your products? (Mark more than 1 option if applicable)</p> <p>(1) Within Ayigya <input type="checkbox"/> (4) Others, please specify _____ (2) Outside Ayigya but within Kumasi <input type="checkbox"/> (3) Outside Kumasi <input type="checkbox"/></p>	
<p>13. How many paid full time employees does your business have?</p> <p>(1) None <input type="checkbox"/> (4) Three employees <input type="checkbox"/> (2) One employee <input type="checkbox"/> (5) More than three employees <input type="checkbox"/> (3) Two employees <input type="checkbox"/></p> <p>13a. Where do your employees live/originate from? (Mark more than 1 option if applicable)</p> <p>(1) Within Ayigya <input type="checkbox"/> (4) Outside Ghana <input type="checkbox"/> (2) Outside Ayigya but within Kumasi <input type="checkbox"/> (5) Both Ayigya and Kumasi <input type="checkbox"/> (3) Outside Kumasi but within Ghana <input type="checkbox"/> (6) I don't know <input type="checkbox"/></p>	
<p>14. How long has your business been operating?</p> <p>(1) Less than 1 year <input type="checkbox"/> (3) Two years <input type="checkbox"/> (5) More than three years <input type="checkbox"/> (2) One year <input type="checkbox"/> (4) Three years <input type="checkbox"/></p>	
<p>15. How much did it cost to start your business?</p> <p>(1) 0- 500 GH¢ <input type="checkbox"/> (4) GH¢ 1501 to GH¢ 2000 <input type="checkbox"/> (7) No Answer (2) GH¢ 501 to GH¢ 1000 <input type="checkbox"/> (5) More than GH¢ 2000 <input type="checkbox"/> (3) GH¢ 1001 to GH¢ 1500 <input type="checkbox"/> (6) I don't know/ No Idea</p>	
<p>16. What is the type or nature of your business?</p> <p>(1) Retail <input type="checkbox"/> (5) Textile <input type="checkbox"/> (2) Food processing <input type="checkbox"/> (6) Services <input type="checkbox"/> (3) Construction <input type="checkbox"/> (7) Metal work <input type="checkbox"/> (4) Woodwork/furniture <input type="checkbox"/> Others (specify): _____</p> <p>16a. Do you need a permit if you want to open a store/business in your own house? (1) Yes <input type="checkbox"/> (2) No <input type="checkbox"/> (3) I Don't Know <input type="checkbox"/></p> <p>16b. If Yes, from whom? (1) Landlord <input type="checkbox"/> (2) Chief <input type="checkbox"/> (3) Government <input type="checkbox"/></p>	
<p>17. How much is your family's estimated monthly income?</p> <p>(1) Below 84 GH¢ <input type="checkbox"/> (2) GH¢ 85.00 to GH¢ 168.00 <input type="checkbox"/> (3) GH¢ 169.00 to GH¢ 252.00 <input type="checkbox"/> (4) Above GH¢ 336 <input type="checkbox"/> (5) No Idea/ I don't know (6) No Answer</p>	<p>18. How much is your family's estimated monthly expenditure?</p>

19. Where is the location of your present work? (Mark more than 1 option if applicable)

- (1) Within Ayigya (4) Outside Ghana
(2) Outside Ayigya but within Kumasi (5) Both Ayigya and Kumasi
(3) Outside Kumasi but within Ghana Others (specify) : _____

C. Housing and Tenure

20. How long have you been staying in your house?

- (1) Less than 1 year (5) Three to five years
(2) One year (6) More than 5 years
(3) Two years (7) Don't Know/Can't Remember
(4) Three years

21. Do you know how old is the building/house that you're staying in?

- (1) 1 to 20 years (5) 41-50 years
(2) 11-20 years (6) More than 50 years
(3) 21-30 years (7) I Don't Know
(4) 31-40 years

22. Have you built any part of the house where you live?

- (1) Yes (2) No (3) Don't Know

22a. If Yes, what part?

- (1) All of the main house (4) Others, please specify _____
(2) A portion of the main house (5) I don't know
(3) An extension on the outside
(for business or service)

22b. What materials did you use?

- (1) Wood (4) Concrete Blocks
(2) Metal (5) Others, please specify
(3) Earth

22c. Do you have building permit when you built those part/s of your house?

- (1) Yes (2) No (3) I Don't Know

23. If you want to build a house/ or parts of your house, do you need a building permit?

- (1) Yes (2) No (3) I Don't Know

23a. If Yes, from whom?

- (1) Landlord (2) Chief (3) Government

24. Have you repaired or fixed any part of the house where you live?

- (1) Yes (2) No (3) I Don't Know

D. Urban-Rural Linkages

25. Do you sell/trade goods in the rural markets?

- (1) Yes (2) No

25a. If yes, how often?
 (1) Daily (3) Once a month
 (2) Once a week (4) Every 3 months

25b. If no, what problems prevent you from accessing rural markets?
 (1) Poor infrastructure/roads (4) High transport cost
 (2) Lack of Information (5) Other (Specify): _____
 (3) Low demand (6) I don't know

26. Were you born outside Ayigya?
 (1) Yes (2) No

26a. If yes, why did you come/move to Ayigya? (You can mark more than 1 option if applicable)
 (1) To look for a job (4) To be with my husband/family
 (2) Start business (5) Other (Specify): _____
 (3) To study (6) I don't know

26b. Would you still consider returning to your place of origin in the future?
 (1) Yes (2) No (3) Don't Know

27. Where did you live before coming to Ayigya?
 (1) Another area of Kumasi
 (2) Another City in Ghana, please specify _____
 (3) Outside Ghana, please specify _____
 (4) No answer

28. Do you have family members/relatives living in rural areas?
 (1) Yes (2) No (3) Don't Know

28a. If yes, what kind of relationship do you have with them?
 (You can mark more than 1 option if applicable)

(1) I visit them regularly (4) Paying for the education of family members
 (2) I call them regularly (5) I never visit or have contact with them
 (3) Sending money (6) Other (Specify): _____

28b. Do your family members/relatives visit you?
 (1) Yes (2) No (3) Never

28ba. If yes, how often do they visit you?
 (1) Once a week (4) Once on 6 months
 (2) Once a month (5) Once a year
 (3) Twice a month

29. Do you help your family of origin?
 (1) Yes (2) No

29a. If yes, how do you help them? (You can mark more than 1 option if applicable)
 (1) Sending money (4) Health care
 (2) Paying for education of students (5) All of the above
 (3) Buying clothes and household utensils Other (Specify): _____

- 29b. If you send some money to them how often do you do it?
- (1) Once a month (4) Once a year
 (2) Once every 3 months (5) Occasionally/ when the need arises
 (3) Once every 6 months (6) I can't remember/ I don't know

30. Do you receive some help from families and friends from rural areas?

- (1) Yes (2) No

30a. If yes, what kind of help?

- (1) Money (4) Raw materials
 (2) Food Other (specify): _____
 (3) Medicine

30b. If money, how often do you receive money from your family?

- (1) Once a month (4) Once a year
 (2) Once every 3 months (5) Occasionally/when the need arises
 (3) Once every 6 months (6) I can't remember/ I don't know

31. Do you have a business in the rural areas?

- (1) Land rent (5) Shop/s
 (2) Houses (6) Transport services (i.e. matatu)
 (3) Local clinic (7) Other (specify): _____
 (4) Farm/dairy industry

E. Environmental Issues

32. Have you ever experienced being affected by floods?

- (1) Yes (2) No/Never (3) Don't know (4) No Answer

32a. If yes, how often in a year?

- (1) Once a year (4) More than 3 times a year
 (2) 2 times a year (5) Don't know/can't remember
 (3) 3 times a year

32b. What is the highest flood level rise that you've experienced?

- (1) Feet level (3) Chest level and higher
 (2) Knee level (4) Don't know/not sure
 (3) Waist level

32c. What item/property damages or losses did you encounter from these floods?

- (1) Furniture, appliance and other personal effects (i.e. clothing, jewelry)
 (2) Frontyard access/street damages
 (3) House structure damages
 Other (specify): _____

33. How have you been able to cope with the effects of flooding in your place?
 (1) Made house improvements
 (2) Relocated
 (3) Sold/mortgage property/valuables to spend for re-building
 (4) Planted trees on frontyard
 (5) Made flood barriers like fences and diversion channels
 (6) Did nothing *If this is the response, why?* _____
 (7) Other responses (specify): _____
 (8) No Answer

34. What kind of help have you received in times of flooding?
 (1) Food (4) None
 (2) Food and Clothing Other (specify): _____
 (3) Food + clothing + help on housing

35. Do you know where the help you received came from?
 (1) Yes (2) No (3) Don't Know
 35a. If Yes, from where?
 (1) Government (4) Family/relatives from other areas
 (2) Red Cross (5) I don't know
 (3) United Nations Agency (6) Others (specify): _____

36. How do you rate the emergency response measures in your community?
 (1) Poor (2) Fair enough (3) Good (4) Don't know

F. Infrastructure and Services Provision

37. Check all of the problems that you experience.
 () Problem with Water supply () Poor Drainage and flooding
 () Problem with Solid waste management collection () Sanitation and sewerage
 () Illegal solid waste dumping () Crime
 () Eviction () Vandalism
 () Riot () others , specify _____

38. How do you store your domestic waste in your house?
 (1) garbage bin (4) cardboard box
 (2) plastic bag (5) others, specify _____
 (3) plastic bag with garbage bin

39. Are you satisfied with the solid waste collection in Ayigya?
 (1) Yes (2) No (3) I Don't Know
 39a. If No, check all of the reasons that is applicable.
 () the service is not reliable () lack of clean appearance of neighborhood
 () the frequency of service (long interval) () other reasons, please specify _____
 () long distance to communal container

40. Do you have the following services in Ayigya?

Types of Services	Availability In Ayigya (1) Yes (2) No (3) I don't know	Accessibility (1) Far (2) Average (3) Near	Quality of Service (1) Good (2) Moderate (3) Poor	Frequency of Usage (1) Often (2) Occasionally (3) Never
Public Transportation				
Access Road to and from the House				
Primary School				
Secondary School				
Health Centres/ Clinics				

41. Where do you get the following? (Please specify for each)

a. Water: _____

b. Electricity: _____

c. Gas/oil: _____

G. Community Participation in City Planning

42. Does the government inform you about their projects and/or works in Ayigya?

(1) Yes (2) No (3) I Don't Know (4) No Answer

42a. If yes, what kind of projects/ works?

43. Were you being informed by the government about the current road construction in your neighbourhood?

(1) Yes (2) No (3) I Don't Know (4) No Answer

44. If government invites you to attend the meeting, will you come and/or attend?

(1) Yes (2) No (3) Don't Know

44a. If NO, what are your reasons for not wanting to attend/join?

45. Who built the public toilets in Ayigya?

(1) Government (2) Landowners (3) Community
 (4) Unit Committee (5) I don't know/ No idea
 (6) Others, please specify _____

<p>46. Who maintains the public toilets in Ayigya?</p> <p>(1) Government <input type="checkbox"/> (4) Unit Committee (2) Landowners <input type="checkbox"/> (5) I don't know/ No idea (3) Community <input type="checkbox"/> (6) Others, please specify _____</p>
<p>47. Are you member in a community organization in Ayigya?</p> <p>(1) Yes <input type="checkbox"/> (2) No <input type="checkbox"/> (3) Don't Know <input type="checkbox"/></p> <p>47a. If Yes, which organization? _____</p>
<p>48. Can we contact you again for a follow-up survey?</p> <p>(1) Yes <input type="checkbox"/> (2) No <input type="checkbox"/></p> <p>48a. If yes, kindly provide us your contact information:</p> <p>_____</p> <p>_____</p> <p>_____</p>

Annex 3: In-Depth Interview Questionnaire for Institutions

NAME OF INSTITUTION:	
NATURE OF INSTITUTION:	
PURPOSE OF THE INTERVIEW: <i>To aid the researcher in assessing the capacity of the institution in relation to implementing disaster preparedness programs and projects.</i>	
QUESTIONS/QUERIES	REMARKS
INSTITUTIONAL MANDATE	
1. What is the thrust/mandate of the institution?	
2. Does the institution have specific disaster-preparedness related programs and projects? If yes, what are these?	
3. Who are the target groups of your organization?	
INSTITUTION PROFILE	
4. What services related to disaster preparedness does the institution provide?	
5. Does the institution have policies and practices relating to disaster preparedness programmes?	
6. How many staff does the institution have and what are their main competencies?	
7. Do you also have a pool of volunteers? If yes how many and what are their competencies?	

FINANCING AND RESOURCES	
8. Does the institution have in its budget specific allocation for disaster preparedness programs? If yes, how much in terms of percentage?	
9. Does the institution accept or receive funds specifically for disaster preparedness programs?	
10. Does the institution have a standard procedure or tool for disaster preparedness? If yes, how did the institution develop these?	
11. Are there any information and program monitoring systems that the institution uses specifically for disaster preparedness programs?	
NETWORKING AND AFFILIATIONS	
12. Does the institution have any institutional partners in implementing its disaster preparedness programs?	
13. What type of service does the network provide to the institution and to its other members?	
CAPACITY BUILDING	
14. Does the institution have any organizational development plans related to disaster preparedness? If yes, where does the institution get financial support for its capacity-building activities?	
15. At present, do you see any skills and knowledge gaps of the institution in implementing disaster preparedness programs?	
16. What other institutions do you think could help your institution address these gaps?	
<i>The outline of this questionnaire was adapted from the instrument used by UN-Habitat Philippines in the Sorsogon City Climate Change Vulnerability and Adaptation Assessment study.</i>	