ENVIRONMENTAL HAZARDS IN GHANAIAN CITIES: THE INCIDENCE OF ANNUAL FLOODS ALONG THE ABOABO RIVER IN THE KUMASI METROPOLITAN AREA (KMA) OF THE ASHANTI REGION OF GHANA

by

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DECLARATION

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

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ABSTRACT

Floods do occur annually in the Aboabo river basin. Floods occur when a body of water rises to overflow land which is normally not submerged. The Aboabo river basin is home to various communities namely Anloga, Dichemso, Aboabo and Amakom which were selected for this study. Flooding in the river basin affects life and property in many ways. The causes and socioeconomic effects of flooding in the Aboabo river basin have been investigated in this research. The cross-sectional research design was used in this study. Primary and secondary data were used. The purposive sampling method was used to choose a good sample to investigate the problem better. Related institutions were also contacted to give their own perspectives of the problem. It was found out that the causes of flooding in the Aboabo river basin are both natural and artificial. Climate change has contributed to the natural cause of flooding through rise in average temperatures and increase in annual and seasonal rainfall at least, over the last thirty years. Rise in temperature and increase in rainfall have led to increases in the discharge of the Aboabo river with the excess overflowing to inundate the flood plain. The man-made causes of flooding in the Aboabo include poor land use, unplanned development of settlements, indiscriminate disposal of refuse into and on the banks of the Aboabo river. The socioeconomic effects of floods in the basin include loss of life and property as well as financial and health problems faced by inhabitants of the basin. From the research, it was established that average temperatures and rainfall have generally been increasing over the last thirty years and the indiscriminate disposal of refuse into and on the banks of the Aboabo river have led to the annual floods in the Aboabo. Also, the actions and

inactions of concerned institutions have encouraged the haphazard development of settlements in the basin. The resettlement of communities in the Aboabo basin and the enforcement of laws which protect the environment and its inhabitants as well as the proper disposal of refuse are recommended solutions to the problem.

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CHAPTER ONE

GENERAL INTRODUCTION

1. 1 BACKGROUND TO THE STUDY

The world has experienced several hazards from past decades up till now. These hazards have taken various forms including earthquakes, volcanic eruptions, tsunamis, tornadoes, hurricanes, landslides, floods among others. In all these environmental hazards, huge financial losses are incurred and in some cases, precious human lives are lost.

"Flooding is the most common environmental hazard worldwide, after disease and transport accidents. This is because of the widespread geographical distribution of river floodplains and low-lying coasts and their long-standing attractions for human settlement. Every year, floods claim around 20,000 lives and adversely affect at least 20 million people worldwide, mostly through homelessness" (Smith, 2004).

The issue of flooding has been of profound interest to humanity especially in recent years, where the effects of climate change is believed to have compounded the changing weather conditions in many places. This is believed to have led to varying resultant effects of extended periods of either torrential rain or severe drought or extreme heat conditions in different parts of the world. Flooding is now a global issue which has attracted a considerable measure of attention from academia, the media and other international discourse.

Flooding has been defined in various ways. It is believed to be a natural and inevitable process which occurs when a river's channel cannot hold all the water supplied to it by its watershed (Geology Labs On-Line, 2007). An all embracing definition is that given by Ayoade (1988:230) as: "A flood is said to occur when a

body of water rises to overflow land which is normally not submerged". When a river floods in the lower part of its basin, water spills out over its channel onto the floodplain.

On the global scale, the effect of floods is phenomenal. A recent example is the floods in the United Kingdom which left thousands of people displaced and without clean water and electricity for several weeks. According to a United Nations Regional Coordinator in Dakar (October 2007), the worst flooding in 30 years that battered West Africa from July, 2007 caused more than 210 deaths and affected more than 785,000 people. According to the UN Office for the Coordination of Humanitarian Affairs OCHA (2007) in a press conference, "We are now in the after-crisis, with the end of the rains. Today, the issue is to evaluate the impact at the medium and long-term, notably to evaluate the expanse of the area affected by the rains, the livestock losses... and mobilise funds to distribute them to the sectors needed.' It was also noted that the catastrophic rains hit almost half of all African countries, causing a total of more than 350 deaths with hundreds of thousands of people affected. According to a statement distributed by OCHA, the most affected countries are Nigeria, with 68 deaths and 50,000 affected, Ghana, counting 56 deaths and 332,000 affected, 46 dead in Burkina Faso and 92,979 affected by the floods, and Togo, with 23 deaths and 120,000 affected, of which 11,483 have been displaced (www.google.com, Google news).

The issue of flooding in Ghana has become more and more prominent over the years. Many of the world's cities were built around rivers. This situation is not different in Ghana where historically and for economic purposes, towns and major cities were built along river banks. During periods of flooding, human lives have been lost in

Ghana with thousands of people displaced. A good example is the floods in Northern Ghana which destroyed properties worth millions of Ghana cedis with the attendant problems of loss of life, displaced people and the emerging adverse health implications, especially the threat of the outbreak of epidemics. Classrooms, which were supposed to be used to educate children, were turned into makeshift shelters for the displaced people while the National Disaster Management Organisation (NADMO) was struggling to provide adequate food and other aid for the flood victims. Mr. Kwamena Bartels, the then Minister of the Interior indicated that the Ghana government had so far approved 610, 000 Ghana Cedis for the acquisition of additional relief items to supplement the NADMO's strategic reserve (Briefing Session for Diplomatic Corps on the Flood situation, 3/09/2007).

In parts of Accra including Gbawe, Odawna, Avenor and Alajo, severe flooding is an almost annual affair damaging property and taking priceless lives. So many reasons have been assigned to the causes of these floods but it seems year in year out, nothing is bdone about it and history repeats itself. These reasons include haphazard urban development and poor sanitation leading to choked waterways and gutters.

Kumasi is the capital city of the Ashanti Region of Ghana and happens to be among the three most populous and economically vibrant urban centers in the country. Kumasi is drained by several rivers and streams including the Aboabo and Sisa rivers which run through the city center. Due to population growth and urbanisation, the banks of these rivers have been settled, with buildings and businesses (such as shops) as well as other physical infrastructure springing up along the river banks in place of the usual vegetative cover. Many families have settled in homes built in such places. Whenever there is torrential rainfall, the rivers overflow

their banks and in the process, properties are flooded and houses submerged in water. In some cases, occupants of such structures are forced to abandon them and become displaced. The socioeconomic effects of flooding in the Aboabo basin include periodic homelessness, the break up of the family unit as well as financial and health problems.

The problem of flooding in the world, in Africa and specifically in Ghana and Kumasi to be precise needs to be recognised and tackled before the situation gets completely out of hand. The thrust of this study is to investigate this very pressing problem of flooding and its socio-economic effects.

1.2 STATEMENT OF THE PROBLEM

The Aboabo river in Kumasi overflows its banks every year taking over vast areas of land around it and in some cases, casualties result with people losing their lives. According to Smith (2004), flood-related deaths and homelessness are concentrated in Less Developed Countries and Ghana is no exception. The socioeconomic effect of flooding of selected communities along the Aboabo River in Kumasi is the focus of this study.

The socio-economic effects of flooding can never be overemphasised. At Dichemso, a settlement in Kumasi along the Aboabo River, homes are flooded annually. Basements are submerged by water to as high as window level. The associated health problems coupled with the exposure to dangerous reptiles such as snakes is life threatening. Moreover, the danger of staying in such buildings which could easily collapse on its occupants is a critical life endangering escapade.

On a reconnaissance visit to communities along river Aboabo, the researcher realised the resolve of residents to keep on staying in these flood prone areas. Adams (2008) in his research into flooding in the Accra metropolitan area indicated that people still resided in flood prone areas such as Odawna bearing the hazards of flooding every year. In his research, he found out that land use was a major cause of flooding in Accra. Institutional weaknesses hindered the solution to the problem since they were unable to perform their mandates efficiently for various reasons. The Hydrological Services Department have not been able to document the several incidences of flooding of the Aboabo river. This has made it difficult to monitor the situation and to take appropriate steps to help these communities.

Buildings are located very close to the bank of the Aboabo river. These buildings include residential facilities, carpentry shops and even churches. Buildings are flooded during the flood period so residents living at Dichemso close to the Airport Roundabout have constructed wooden bridges from the main street to their homes. This is to enable them reach their homes or walk to their homes during floods since it takes quite a long time for the flood waters to recede and the land to dry. These bridges which have been constructed without any technical advice are weak and on the verge of collapsing. At certain places, big stones have been placed on the ground to provide access to buildings. The area is generally swampy in nature and is inhabited by dangerous reptiles such as snakes especially during the rainy season. The area is sometimes completely cut off from the city for 3 to 4 days when the Aboabo river overflows its banks.

The lack of appropriate drainage systems in these places are largely responsible for the frequent flooding in the metropolis. In areas where there are no drains, residents have put in place temporary drains especially to redirect flood waters from their properties. It could be realised that gutters and culverts provided by city authorities are unable to contain flood waters during and after torrential rains. Some of these gutters have also been partially blocked with refuse. The issue of general sanitation thus arises and probably contributes to flooding in the study areas.

When communities around the Aboabo river are flooded by water from the river, normal life is invariably disrupted. Time and resources must be devoted to managing the situation in order not to lose valuable property and human life. One wonders how residents perceived the problem of flooding and its effects in their environment and what they had done and continue to do to mitigate it. One would again wonder if they had put any pressure on the appropriate authorities to ensure that something is done to save the situation. This precarious situation of distress and insecurity prevails until the flood waters recede. The problems associated with flooding along the Aboabo river are real and there is the need to conduct research into the cause and effects of these problems in order to contribute to the solutions required to address this problem.

1.2.1 RESEARCH QUESTIONS

The serious and sometimes life threatening nature of problems associated with flooding sometimes makes it difficult to understand why the floodplains of the Aboabo river continue to be inhabited by people despite the annual risks they face.

The question is, why are communities along the Aboabo river flooded every year? What are the real causes of flooding of the river with its attendant effects on these communities?

Why does such a situation persist and occur annually?

Are the causes of the floods in the basin of the Aboabo river artificial or natural?

Natural processes exist to enable river beds manage excess water and one of the processes is for the water to spill over its banks. However, is the Aboabo river in its original or natural state without the influence of human activities?

What are the effects of flooding on these communities?

One question that has always baffled many people is why people living in flood prone areas in the communities along the Aboabo river continue to stay on and put their lives in danger of floods every year. Why have they set up their homes or businesses in such areas in the first place and why have they not been relocated?

What are authorities in charge doing to solve the problem?

These questions need to be answered if any solution at all can be found to the annual floods along the Aboabo river.

1.3 OBJECTIVES OF THE STUDY

The general objective of this study is to investigate the causes and effects of flooding in communities along the Aboabo river, as an environmental hazard on life, property and the socio-economic activities of residents.

The specific objectives are to:

i. Identify the causes of flooding in communities along the Aboabo river.
ii. Find out the environmental and socioeconomic effects of flooding in these communities.
iii. Ascertain the reasons why people affected by such floods keep on staying in flood prone areas.
iv. Find out how the flood victims cope with the flood situation in the area.
v. Recommend ways of preventing flooding and its effects on the communities as well as ways of managing floods before, during and after they occur.

1.4 PROPOSITIONS / HYPOTHESIS

The following propositions and hypothesis guide the research:

1.4.1 Socioeconomic constraints are the motivation of inhabitants' continual stay in flood prone areas.

1.4.2 The main cause of flooding in the Aboabo river basin is natural.

1.4.3 Annual flooding in communities along the Aboabo river is caused by unplanned human settlements.

HYPOTHESIS

1.4.4 Local climatic change is responsible for intense rainfall that causes flooding along the Aboabo river.

1.5 DEFINITION OF TERMS

Flood - A flood is said to occur when a body of water rises to overflow land which is normally not submerged. 'Floods occur when peak discharges exceeds channel

capacity; and this may be brought about naturally by intense precipitation, snow and ice melt, storm surges in coastal regions, and the rifting of barriers such as ice dams, or by man-made structures, by deforestation, urbanisation, which reduce infiltration and interception, and by engineering works such as land drainage and straightening and embarkment of rivers' (Mayhew, 1997).

Floodplain – A flat area immediately adjacent to the river channel that has been built by river (fluvial) depositional processes. Mayhew (1997) defines it as 'The relatively flat land stretching from either side of a river to the bottom of the valley walls. Flood plains are periodically inundated by river water; hence the name'. This definition is reinforced by McKnight's (1992) description of floodplain indicating that a stream is likely to occupy only a small proportion of the relatively flat valley floor but during periods of flood flow, the entire floor may be flooded. The valley floor or bottom is thus properly termed a floodplain.

Terrace – A flat raised strip of beach or ground that has been formed naturally along the coast, beside a river or lake, or along the side of a valley by erosion or the changing sea level.

River Basin – A river basin is defined simply as land draining into a river that is 'an area of land drained by a river and its tributaries' (Microsoft Encarta, 2007). The Aboabo river basin is therefore the entire area covered by the river and its tributaries.

Flood Prone areas – A flood prone area is generally the low lying lands or areas on either side of a river channel. Floods are thus more likely to occur in valleys leading to the floodplain being inundated and in situations where there are structures or settlements in these areas, they are also taken over by flood waters.

Urbanisation – 'This is the migration of rural populations into towns and cities; an increasing proportion of the world's population resides in towns' (Mayhew, 1997).

Infiltration Capacity – Infiltration in this context is simply the process of water entering rocks or soil. However, infiltration capacity is 'the maximum rate at which water can pass through the soil and is expressed in millimetres per hour mm/hr' (Waugh, 1995). A more comprehensive definition is however given by Mayhew (1997) as 'the rate at which water can infiltrate the soil. The basic mechanism is that the upper soil surface receives precipitation so that existing soil moisture is displaced downwards by newly infiltrated water. Infiltration may be controlled by factors including cracks, cultivation, freezing, the intensity and type of precipitation, and the porosity of the soil.'

1.6 JUSTIFICATION FOR THE STUDY

A lot of researches on flooding have been conducted in other parts of the country providing vast information for town and country planning. However, more research needs to be conducted particularly in Kumasi to bring to bear the causes and the effects of flooding on the socioeconomic lives of the people. This research is an applied urban geographic research that provides reliable information on the causes and effects of flooding in urban areas. This would facilitate urban planning in the city of Kumasi.

In recent years, talk of climate change has taken center stage in a lot of global conferences. Scientists have warned against the extreme weather conditions that will accompany climate change with the resultant effect of the rise in global

temperatures. A research of this nature will provide important insight into the real challenges of flooding especially in cities and the need to find lasting solutions instead of ad hoc measures to solve the problem especially with the challenges of climate change looming. The Growth and Poverty Reduction Strategy II (GPRS II) indicates the vital role that the natural and built environments play in achieving long-term growth and development. It draws attention to the need therefore for amenable, efficient, safe and healthy built environments for growth and development. Finding lasting solutions to the recurrent hazard of flooding is very necessary in achieving such an appropriate environment to ensure national growth and development.

Information provided in this research could also serve as a basis for further research into the problem of flooding in Kumasi and other parts of the country.

1.7 SCOPE OF THE STUDY

The research considered the case of flooding as it occurs in communities along the Aboabo river. The communities chosen were Anloga, Aboabo, Dichemso and Amakom in the Kumasi Metropolis. These communities were chosen because after visits to them and enquiries from related authorities and departments, it was discovered that they are the most affected whenever the Aboabo river exceeds its carrying capacity, overflows its banks and floods its basin.

The research was designed to carefully identify the causes, effects, prevention and management techniques of flooding in the selected communities. It is important to note that the causes as well as effects of flooding in these areas may not be only natural but also man-made. The study identified both the natural and man-made

causes and effects of flooding in the selected communities. The proper management of flooding by both authorities and the affected members of the communities was also investigated and recommendations made where necessary.

Through observation and analysis of responses from affected members of the communities, the effects of floods were identified. Reasons were sought as to why the households continued to endure the losses which sometimes could be as priceless as the loss of life by still living in this 'danger' zone.

Prevention they say is better than cure. The study demanded answers from concerned authorities including the metropolitan assembly and the respective assemblies and leaders in the communities in a bid to understand what methods had so far been adopted to at least reduce the impact of flooding on family members and the successes and failures of these methods. Coping strategies adopted by affected communities were thus identified and discussed in this study.

1.8 LIMITATIONS

The researcher was faced with quite a number of limitations including constraints which were mainly financial and logistical in nature. The researcher was also constrained by time since specified time periods have been set by the university for the completion and submission of theses.

1.9 METHODOLOGY

Research methodology is crucial for the success of any research and more especially, academic research. The methodology helps to put the study in proper perspective by

presenting the underlying rules and principles for a particular research. A successful research is thus based on an appropriate choice of design and control in order to efficiently achieve the objectives of the study.

1.9.1 RESEARCH DESIGN

The research design was basically a systematic plan or strategy of investigation using the most efficient methods. Qualitative and quantitative design methods featured prominently in this research. A cross-sectional design was adopted in this research because only a cross-section of the problem could be studied given the constraint of time. It followed a logical sequence from the collection of data to its analysis after which appropriate recommendations were made.

1.9.2 TYPES AND SOURCES OF DATA COLLECTED

Primary data used included information from selected residents and other business owners about the causes of flooding and its effect on their socio-economic lives.

Secondary data was collected from selected institutions in Kumasi. Information sought included the government institutions' primary functions and specific roles in flood prevention and management as well as their views as to the causes and possible preventive measures needed to deal with floods in Kumasi. These institutions included:

Ghana Meteorological Agency, Kumasi

Town and Country Planning, Kumasi

Ghana Hydrological Service (GHS)

Waste Management Department of the Kumasi Metropolitan Assembly

National Disaster Management Organisation (NADMO), Kumasi

Ghana Statistical Service (GSS), Kumasi

Other forms of data including maps, population figures, rainfall figures and city plans were also sourced from the relevant institutions mentioned above. Secondary data was carefully studied and reviewed to come out with information relevant to the better understanding and execution of the research study. Tertiary sources of data in the form of text books about flooding were also consulted.

1.9.3 METHODS OF DATA COLLECTION

Primary data was used in this study. Questionnaires were administered to 394 respondents and five relevant institutions in the field to gather primary data relevant to the study.

The interview technique was used to gather qualitative primary data in the study area. Furthermore, the structured type of interviews was conducted using an interview schedule with the households and relevant institutions as key informants to the research problem.

Observation was one of the methods used in data collection. Through this, the effects of flooding on various physical structures were observed and noted and some pictures were taken. The levels of flood water in and around such structures in times of floods were also identified and measured.

Relevant information from secondary data was also used to help in the better understanding and execution of the research study.

1.10 SAMPLING DESIGN AND TECHNIQUE

The researcher was faced with a very large sample size. The total population of the Anloga, Aboabo, Dichemso and Amakom communities lying within the Aboabo river basin is 26, 621 people (2000 population census, GSS).

Table 1.1: Flood – prone areas and population at risk

Area	Number of Households	Sample Size (% of population)
Anloga	7,694	113.8712
Aboabo	6,794	98.0648
Dichemso	4,156	61.5088
Amakom	8,145	120.5460
TOTAL	26,621	394.0786

Source: Ghana Statistical Service, 2000

The population from which the sample was drawn consisted of all the households within 100 meters of the Aboabo river in the respective communities. The purposive sampling method was used in choosing households because there was the need to interview those situated close to the river who had experienced flooding. The stratified sampling method was used to calculate the number of households per

community, the total of which made up the sample frame. The household head or the next adult in charge was interviewed.

Table 1.1 shows the respective sample sizes of the communities within the catchment area indicated in the study. The calculation of these can be found in appendix 1. Officials of the Town and Country Planning Department, the Waste Management Department and the Ghana Meteorological Service in the Kumasi Metropolis were interviewed. Attempts were also made to interview the Hydro Engineer of the Hydrological Services Department and personnel from the National Disaster Management Organisation in Kumasi. All these institutions are related in one way or the other to the problem under investigation as key informants.

1.11 DATA ANALYSIS

The data collected was summarised and analysed using both qualitative and quantitative methods. Responses from households and other institutions were coded and entered into a database to generate tables and cross tabulation where necessary to facilitate the analyses of the quantitative data. This was necessary to help establish relationships between variables. All these were done with the aid of the Microsoft Office Excel (2007) and Statistical Package for Social Sciences (SPSS). The specific tools of the package utilised include cross tabulations, regression, correlation, percentages, pie charts and bar graphs. Maps of the drainage basin of the Aboabo river and the selected communities especially in low lying areas were also analysed to show the areas around the Aboabo river which are most liable to flooding. Various types of tables, charts and graphs have been used in descriptive analysis of both qualitative and quantitative data gathered.

1.12 PRESENTATION OF RESULTS

Efforts were made to present results in a clear and comprehensive manner. Responses obtained from questionnaires were coded and entered into a database with the help of the SPSS for analyses. Results were represented mainly using tables, maps, graphs and charts.

1.13 ORGANISATION OF THE STUDY

The study has been organised into six chapters. The first chapter gives a general orientation of the study. This contains the introduction, problem statement, objectives, method of study as well as the rationale for the whole exercise.

Chapter two is an in depth review of literature and the conceptual framework on the problem of flooding. It considered and examined other works done on the problem identifying gaps that needed to be filled where necessary.

Chapter three is a discussion of the profile of the study area while chapter four deals with the analysis, presentation and discussion of data collected on the field. It involves the organisation of field data for analysis and discussion using specific tools of data analysis.

Chapter five presents a discussion based on the institutional perspective of the problem. Finally, chapter six which is the last chapter presents a summary of the findings of the study. Conclusions are then drawn with recommended solutions for solving the problem.

CHAPTER TWO

LITERATURE REVIEW AND CONCEPTUAL FRAMEWORK

2.1 Introduction

"Only about 15% to 20% of rainfall normally ends up as surface runoff in rivers; the rest soaks into the ground or returns to the atmosphere by evaporation and transpiration from plants. The amount of runoff ranges from 2% to more than 25% with variations in climate, steepness of slope, soil and rock type and vegetation. Steady, continuous rains can saturate the ground and the atmosphere, however, and lead to floods as runoff approaches 100% of rainfall" (Plummer and McGeary, 1993).

Many researchers worldwide have studied the nature and effects of environmental hazards on humans, animals and the earth's structure in general. In spite of these numerous studies, the problems associated with environmental hazards especially flooding, a major challenge yet to be overcome is still with us. This section of the study is devoted to review the existing literature on flooding in the world and particularly in Ghana. A critical look at the nature, causes and effects of flooding as well as techniques of mitigating flood hazards have been considered.

2.2 Definitions of Flooding

Flooding like many other environmental hazards is a natural and inevitable process which occurs when a river's channel cannot hold all the water supplied to it by its watershed – i.e. the area the river drains (Geology Labs On-Line, http://www.mountain.org). When this occurs in the lower part of a watershed, water spills out onto the floodplain which is a flat plain immediately adjacent to the river channel that has been built by river (fluvial) processes. As previously indicated flat areas that lie above floodplains are called terraces and often reflect some past climate conditions. The Microsoft Encarta Dictionary (2007) simply defines flooding as the 'state of being under water, which is the situation that results when land that is usually dry is covered with water as a result of a river overflowing or heavy rain.' Flooding is thus essentially the situation whereby water inundates an area usually for a period of time for various reasons. The consequences of flooding on the socioeconomic activities of society are usually preventable although in this case, most victims prefer to taking the option of 'cure instead of prevention' leaving a huge burden on the state.

2.3 Types of flooding in urban areas

Urban areas are generally cities with relatively large population sizes and more vibrant local economies. In Ghana, an urban area would have a population of more than 5000. Kumasi is the second largest city in Ghana second only to the capital Accra and has as of 2007 an estimated population size of over 1.604.909 (www.wikepedia.org). In the city of Kumasi, the incidence of flooding is prevalent annually mainly because major rivers such as the Subin and Aboabo run through the city. Reconnaissance visits to areas along the river such as Dichemso and Aboabo

revealed that communities have sprung up so close to the Aboabo river that people living in such areas are in constant danger of being inundated whenever there is a heavy downpour of rain.

The October 2006 report by ActionAid on climate change, urban flooding and the rights of the urban poor in Africa designates flooding in urban areas into four main types. These are localised flooding, flooding caused by small streams in urban areas, major rivers and wet season flooding in low land and coastal cities.

- Localised flooding occurs several times a year in slum areas. This is because of the few drains and the highly compacted ground with pathways between dwellings becoming streams after a heavy downpour of rain. Unfortunately, the situation is worsened by the filth (waste and debris) which blocks the few drains.

- In most urban areas, there can be found small streams which can quickly increase in volume after heavy rain. Unfortunately, relatively small culverts are provided by city authorities as passageways for these streams. Although these culverts may seem appropriate in size relative to the normal water volume of such streams, changes in the urban area and storm intensity over time usually lead to higher flows that exceed the capacity of the culverts. These channels in most cases are also filled with debris making them smaller over time.

- The third type of urban flooding consists of major rivers like the Aboabo river of Kumasi which flow through urban areas. Flooding in such areas is also influenced by land use changes and engineering works up stream. Urban

growth leads to expansion of land use over the flood plains of these major rivers leading to major socioeconomic losses as well as loss of human life anytime these rivers overflow their banks and inundate the flood plains. Although in some developed countries, levees have been raised artificially, there is always the risk that these may be breached causing massive urban flooding. A very bad flood covering 160,000 acres on Canvey Island which killed 300 people in Essex in 1953 led to the formation of a committee by the government of the United Kingdom to look into the phenomenon of flooding. It was through this that the Thames Barrier was built at Woolwich Reach. This consists of nine concrete barriers with a large metal gate between each. This large metal gate can be raised when need be to guard against flooding. The Barrier has since 1982 been raised 25 times apart from monthly tests. In Sierra Leone for example, the ActionAid 2006 report indicates that the situation of flooding has worsened over the years. "Earlier days, water used to come with low power, now it comes with heavy force that sometimes brings fishes from the sea to our rooms....Isatu Fofanah, Kroo Bay, Freetown, Sierra Leone" (ActionAid, 2006 pg 3).

- The fourth type of urban flooding occurs in lowland and coastal cities where wet season flooding could prevail in some areas for eight or more weeks due to the combination of rain and river water leading to a rise in the levels of water in swamps which under normal circumstances, would have been naturally submerged during certain times of the year. Storm waves also contribute in some cases to lowland and coastal flooding.

The general terrain in Kumasi is undulating in nature as can be observed from topographical maps of the area. There are thus some really low lying areas where communities have developed in valleys. This is one major cause of flooding in such areas where rivers and streams flow through and inadequate drains are common.

2.3.1 Other Types of Flooding

"Flooding is the most lethal and destructive of all natural hazards, affecting both industrialized and developing countries alike" (McGuire et al, 2004). This rather strong assertion draws attention to the serious problem of floods and the urgency with which this phenomenon must be handled and/or managed. Floods affect people from all walks of life and countries, from the developed Northern countries to developing Southern countries. The most powerful nations of the world experience floods too. Thus, the issue of flooding is a major global issue needing urgent attention and solutions. Flooding can also be grouped broadly into those resulting from overflowing rivers and those arising from coastal inundation by the sea. Another type of floods (which will not be elaborated in this research) is ice-jam floods (McGuire et al, 2004).

2.3.1.1 River floods

River floods are very common and in the context of this research, of major concern. The Aboabo river floods every year causing a lot of problems to communities situated on its banks. According to McGuire et al (2004), river flooding depends on factors such as the form of the catchment and climatic conditions. Human activities such as deforestation and urbanization also contribute to river flooding by increasing surface runoff leading to the modification of a river's hydrograph – which is the

curve of discharge over time. Technically, river flooding depends on the relationship between a river's stage (i.e. height of the water level) and its discharge which is the volume of water passing per unit of time. These in turn also depend on factors such as cross-sectional area of the river as well as the gradient of the river's channel. River floods thus occur when the river's discharge increases leading to an increase in the height of the water level such that it overflows its banks (McGuire et al, 2004). This increase in discharge with specific reference to the Aboabo river arises mainly from prolonged rainfall as well as the impediments (caused by sedimentation and dumping of waste and debris) in the river.

2.3.1.2 Flash Floods

This type of floods is very dangerous especially because of its sudden occurrence. Flash floods as defined by Plummer and McGeary (1996) are 'local, sudden floods of large volume and short duration, often triggered by heavy thunderstorms'. A flash flood can also be defined as 'a sudden and often destructive surge of water down a narrow channel or sloping ground, usually caused by heavy rainfall'(Microsoft Encarta, 2007). Abott (1996) simply defines flash floods by briefly describing how it occurs. According to him ' large convective thunderstorms can build up in a matter of hours and quickly set loose the terrifying walls of water known as flash floods. Steep topography helps thunderstorms build and then provides the rugged valleys to channelize the killer floods'. It is thus clear that this type of flood easily takes residents by surprise; especially in areas where little or no technology exists to predict the possibility of a flash flood occurring in order to alert communities likely to be affected. An unfortunate example is the flash flood which occurred in Instabul,

Turkey killing 23 people (T.V. 3 news, 09/09/2009). In all three definitions of flash floods, the issue of heavy thunderstorms or heavy rainfall is raised alongside that of timing. Topography also contributes to the occurrence of flash floods since the steep slope of the river channel enhances this sudden rush of water down the river channel leading to flooding as it approaches areas of gentle slope along the river channel. An example of flash floods occurred in 1976 in north-central Colorado along the Big Thompson River when 'strong winds from the east pushed moist air up the front of the Colorado Rockies, causing thunderstorms in the steep mountains' (Plummer and McGeary, 1996). The heavy down pour led to the river volume swelling up to four times the previously recorded volume increasing the river's velocity to 15miles per hour during the night of July 31, 1976. By the next morning, the flood was over leaving behind 139 dead and 5 missing people with damages exceeding 35 million US$ (Plummer and McGeary, 1996).

Flash floods may be occurring along the Aboabo river although there are no records to verify this assertion. However, during a reconnaissance survey in (March, 2008), a resident at Dichemso whose house is located just a couple of yards from the Aboabo river claimed that some floods took them by surprise causing them to be cut off from the city for days without adequate supply of food and water.

2.4. Causes of Floods

The causes of flooding can be divided into two broad lines. These are natural causes and human causes of flooding (www.geocities.com). Natural causes of flooding simply refer to those causes of flooding which do not have any direct human

influence. On the other hand, human causes of flooding include all flooding caused by the actions or inactions of humans; there is therefore a direct human influence.

2.4.1 Natural Causes of Floods

Even though flooding is perceived generally as an environmental hazard, it is quite a natural process and is simply the response of a natural system (a river system) to the presence of too much water during an interval of time. Nelson (2008) uses the equation below to explain how flooding occurs technically. This is expressed mathematically in a relation:

$$Q = A \times V$$

Where Q = Discharge (m^3/sec)

A = Cross-sectional area: width x average depth (m^2)

V = Average velocity (m/sec)

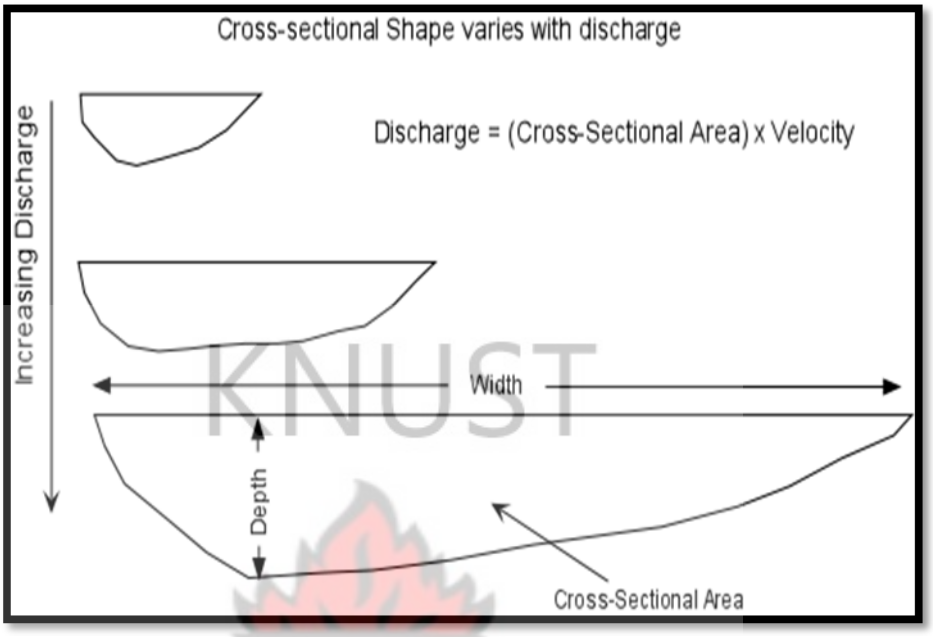
He goes on to define the terms as follows:

Discharge – The discharge of a stream is the amount of water passing at any point in a given time.

Average Velocity – The average velocity is the time it takes a given particle of water to traverse a given distance.

Cross-sectional Area – The cross-sectional area is indicated in the following diagram

Figure. 2.1: Cross – sectional shape and discharge variations



Source: Nelson (2008), River Systems and Causes of Flooding, EENS 204.

From figure 2, as discharge increases downstream, so does the width and depth of the stream. Thus, the cross sectional shape will change with the stream becoming deeper and wider, thereby influencing the cross-sectional area. It is also worthy to note from the diagram that the deepest part of channel occurs where the stream velocity is highest.

The stream must adjust its velocity and cross sectional area in order to form a balance as the amount of water in a stream increases. Discharge increases are caused by factors which include rainfall and tributary streams. More water is added to increase discharge through groundwater seeping into the stream. The velocity and cross-sectional area increase gradually over time as water in the stream increases. However, after a heavy downpour of rainfall, if these factors are unable to adjust adequately to accommodate more water, the stream cannot accommodate all its discharge leading to it overflowing

its banks and thereby flooding its floodplains. Although the floodplain is the area that is first inundated, flooding may move beyond this area.

i. The first natural cause of flooding is the incidence of heavy rainfall. This is a generally common cause of flooding. Heavy rainfall raises the water level of streams and rivers as well as other water bodies beyond the carrying capacity of the channels subsequently leading to the overflowing of excess water first onto the immediate floodplains and later, beyond. This is a common cause of flooding in Ghana, and Kumasi to be specific. The Aboabo which is a major river draining the city center usually cannot contain all the water in its channel after a heavy downpour of rain thereby causing flooding. It is worth noting that this is reinforced by the influence of human activities. This is based on information retrieved through interactions with communities along the Aboabo river during a reconnaissance survey in March, 2008.

ii. The nature of relief is also a natural cause of floods. Flooding is prevalent in low lying areas or lowlands. Since rivers flow more slowly in such areas, if the water volume increases abruptly or suddenly, floods occur. In the Kumasi metropolis for example, the terrain is generally undulating characterised by hills and valleys. Most communities along the Aboabo river which get flooded lie in the river valley (Aboabo Drainage Basin sub-catchment areas map, Hydrological Services Department, March, 2008).

iii. Coastal Flooding occurs by virtue of the fact that the sea level at a point in time is higher than the adjoining coastal area. Thus, flooding occurs because land lying close to the sea can be submerged by sea water during high tides, tsunamis or storms. Under such circumstances, low lying coastal areas are flooded. A typical example is that which occurred on the 5th of September, 2008 in parts of the Keta municipality in the Volta region of Ghana through high tidal waves (which is reinforced by rising sea levels). About 500 residents were displaced at Dzita and Atorko when sea water took over their homes leading to the eventual collapse of some houses (www.kwavic.blogspot.com, Tidal waves cause havoc in Keta).

2.4.2 Human Causes of Floods

It has always been said that some floods have 'human finger prints'! The activities of man have led to major changes in the nature of the earth's natural systems. Some of these changes reinforce the incidence of flooding resulting in serious consequences on man and the environment in general. The following are some of the human causes of floods.

2.4.2.1 Deforestation

Population growth and development has led to man's chronic need for land to provide needs such as settlements, roads, farmlands and other resources such as minerals of all kinds. This has led to large areas of forests near water, bodies such as rivers and streams being cleared to make room for such developments (Causes of Flooding, http://hk.geocities.com).

In Ghana for example, apart from these uses of land, trees are also cut down to be used as fire wood and furniture. With less vegetation left to protect the soil, no trees to soak up water (thus more water flows into the rivers) and to bind the soil particles together, soil erosion quickly sets in with runoff washing the top soil into the water bodies. Such sediments when deposited in the river makes the river channel shallower; raising the river bed such that the river overflows its banks easily with the slightest increase in the volume of water it carries (Causes of Flooding, http://hk.geocities.com). Trees around the Aboabo river have been cut down to make way for human settlements and this has increased erosion leading to siltation of the river which contributes to flooding in the study area.

2.4.2.2 Poor farming practices

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

2.4.2.3 Poor Water Management

The use of water bodies especially rivers by man over the years has led to various problems especially with the proper management of water. Dams have been constructed on rivers in order to generate hydroelectric power for man's use. These lead to the formation of artificial lakes like the Lake Volta of Ghana. 'The construction of the Akosombo dam required the flooding of the Volta River Basin and its upstream fields, resulting in the creation of Lake Volta which covers 3.6% of Ghana's total land area. Lake Volta was formed between the years of 1962 and 1966, and necessitated the relocation of 80,000 people into 52 resettlement villages two years prior to the lake's completion. The 80,000 people, that represented 1% of the population, made up 700 villages prior to resettlement. Two percent of the resettlement population were riparian fishers and most were subsistence farmers' (Akosombo Dam, http://en.wikipedia.org).

Dams which are poorly constructed or maintained can easily collapse resulting in flooding downstream. In China for example, several lakes along major rivers have been silted and reclaimed. The Dongting Hu along the Chang Jiang river is an example. With the need for more farm land increasing, reclamation of land from lakes is bound to continue and if not properly managed, reducing the size of such lakes through silting may cause flooding easily (www.geocities.com).

2.4.2.4 Population Pressure

Population pressure is perhaps the overriding human cause of floods in the world. With world population increasing so rapidly, the need for resources and other basic necessities such as food, water and shelter is putting pressure on nature. It is very difficult at this rate for resources to regenerate quickly enough to meet the ever increasing needs of the world's teeming population. Forests are quickly vanishing due to the need for wood for furniture and to provide shelter as well as the need for land to be used to cultivate food as well as cash crops. The need to grow more food especially in developing countries has led to over cultivation and over grazing as previously discussed. Flood plains have been reduced so much that farms can be found close to rivers and streams. Erosion is intensive and this has led to silting of river beds, raising of river beds and consequent flooding at the least opportunity given that there is a heavy down pour or steady rainfall over some hours! Population pressure has also led to the development of settlements so close to rivers and streams with the resultant dumping of refuse in such water bodies as can be found along the Aboabo river in Kumasi. Stories recounted by residents close to the river during a reconnaissance survey in March 2008 indicated that people dump refuse and even defecate into the river impeding the smooth flow of discharge during heavy rainfall. These water bodies overflow their banks very often flooding homes and destroying property while causing the displacement of many people.

2.5 Effects of flooding

The effects of flooding are many and in most cases very fatal. Most of the time, loss of life and property as well as livelihoods top the list of the negative effects of flooding. However, are there any positive effects of flooding? This section will discuss both the positive and negative effects of floods.

2.5.1 Positive Effects of Floods

Although not many, the positive effects of floods need to be considered in a discussion of this nature. Floods are nature's way of managing excess water from precipitation as well as the hydrologic cycle. This helps to maintain a balance in the cycle. Also, when floods occur, much needed nutrients are deposited on adjacent lands or the flood plains to be precise. The alluvium from such floods provides essential nutrients needed by plants to grow well. This indirectly helps in protecting water bodies since plants which grow on the flood plains help to check erosion and protect against silting. Also, crops cultivated in alluvial soils usually produce bumper harvests and thus provide communities in such areas with sufficient food. Bolt et al (1975) explain that stream channels also play the important role of carrying flood waters to a non-damaging location, '...but along its banks live a great proportion of the world's population, because the streams, over geological time, have built the alluvium deposits that make the best agricultural lands'. Thus, the fertile nature of such alluvial soils helps in increasing agricultural yields to feed more people.

Some alluvial deposits also contain precious minerals such as gold. In Ghana, alluvial deposits which contain gold can be found in streams or rivers that run over

areas with Birimian rocks. The gold which is finely divided can be found in riverbeds, riverbanks, dry valleys, gravel beds, beach gravels and sand. Concessions given to small scale miners (galamsey operators) in many parts of the country such as the Eastern and Ashanti regions involve this type of deposit (Gold: The Link between Ancient and Modern Ghana, http://www.crvp.org). Although the mining of gold and other precious materials give rise to environmental concerns worldwide, flood waters which leave these alluvium deposits on river banks provide many nations with foreign exchange when these minerals are exported.

2.5.2 Negative Effects of Floods

The consequences of flooding have generally been negative in nature. This is especially so in situations where human settlements have developed on the flood plains of rivers. When floods occur in urban areas, a lot of people are rendered homeless with water taking over their homes and destroying a lot of their properties. Such people now become a burden on the state which must ensure that adequate food, water and make shift shelters as well as blankets are provided for such victims. In September 2007, President John Agyekum Kufuor announced a five million Ghana cedi support for the three Northern regions and parts of the Western region hit by flooding. Two hundred thousand Ghana cedis out of this money was to be used to procure relief items for the victims (Ghana News Agency, 2007). Unfortunately, the National Disaster Management Organisation (NADMO) which is in charge of such victims in Ghana is unable to provide for all the victims because of inadequate resources making it incumbent on government and other corporate organisations to help. Ghana as a developing country cannot afford to use scarce resources annually

to manage environmental hazards such as floods. There is therefore the need for more research to provide more information to direct policy toward reducing the consequences of this annual ritual to its barest minimum.

Another disastrous effect of flooding is the considerable loss of life in dire situations. Children and women are often the victims of such floods. A case in point is the discovery of a dead body at Dichemso, a suburb of Kumasi close to the bank of the Aboabo river in 2006 as reported by a resident in the area. Floods can also lead to massive destruction of infrastructure such as bridges, roads and drains. It can also cut off access to other parts of the community or city. In urban areas such as Kumasi, this phenomenon can occur when major roads are taken over by water or bridges are submerged in flood water. It makes such routes impassable for a while. In the Northern parts of the country where socio economic infrastructure is either limited or absent in villages, communities can be isolated for days without access to other communities. Last but not the least; flooding can lead to the outbreak of epidemics such as malaria and cholera in communities along the Aboabo river. This is made even worse by the generally poor sanitation situation in majority of these communities. Also, flood waters carry debris and sewage into homes. As Nelson (2007) puts it, 'with higher velocities, streams are able to transport larger particles as suspended load. Such large particles include not only rocks and sediment, but, during a flood, it could include such large objects as automobiles, houses and bridges'. A reconnaissance survey to Dichemso in March 2008, a community found along the Aboabo river revealed that reptiles and other insects are also carried into homes exposing people to all sorts of infections. One resident claimed she found a big snake in her house days after recession of the floods. Socioeconomic activities

usually slow down or grind to a halt depending on the intensity of floods leading to loss of productive man hours.

2.5.3 Primary, Secondary and Tertiary Effects of Floods

The effects of flooding as a hazard can be divided into three main effects according to Nelson (2007). These are the primary, secondary and tertiary effects. He explains primary effects of floods as those which occur due to direct contact with flood water while secondary effects occur because of the primary effects. On the other hand, tertiary effects are the long term changes that take place as are result of flood hazards.

Primary effects of floods

The primary effects of floods are perhaps the most common since it is evident during and immediately after the flood waters recede. The damage caused usually calls for instant harnessing of resources to come to the aid of victims. Nelson (2007) enumerates some of the primary effects of flood hazards as follows:

- As previously noted, higher velocities enable streams to transport larger particles as suspended load. These include rocks and sediments as well large objects like trees, automobiles, houses and bridges.
- Flood water can cause massive erosion leading to collapse of buildings, bridge structures and levees. In Northern Ghana, many homes collapsed during the 2007 floods. Most of these buildings were mud houses and easily got washed away during the floods.

- Another primary effect of floods is the destruction and loss of personal effects and other properties when flood waters enter human built structures. Furniture, floors and walls can be damaged even with minor flooding. Personal effects such as pictures, documents and other machines like mowing machines and air conditioners can be damaged and in some case washed away by the fast moving flood waters.

- Flood waters also destroy farmlands often washing away crops and stored produce. Livestock and pets usually drown and are carried away.

- People who get caught up in the rushing flood waters often drown. This could be because of the many impediments in the way of the flood waters or the larger suspended load such as cars and trees also being carried along by the flood waters. Floods which occurred in the Upper East region of Ghana led to eight deaths (www.ghanaweb.com).

- Debris, garbage and other toxic pollutants are sometimes carried in flood waters. These can cause secondary effects of health hazards. In Ghana, the possibility of many victims getting malaria or cholera as a result of poor sanitation brought on by flooding is a reality.

- The high velocity of flood water which allows more sediment to be carried as suspended load generally reduces when flood waters retreat leading to the deposition of such sediments. Everything is usually covered with a thick layer of stream deposited mud. The interior as well as exterior of buildings are also covered with this mud.

Secondary Effects of Floods

Secondary effects of flood hazards occur because of the primary effects. These are generally the disruption in service delivery such as contamination of water supply (especially if sewerage treatment plants are flooded), disruption of gas and electricity supply and disruption of transportation systems. Disruption of transportation systems occur when bridges are broken and parts of roads washed away. Some communities may be extremely difficult to reach leading to shortages in food and medical supplies which may result in disease and other health effects especially in developing countries such as Ghana (Nelson, 2007).

Tertiary Effects of Floods

These refer to the long term effects of flood hazards. These effects usually occur over time but could be more permanent in nature and more difficult to remedy. For example, location of river channels could change due to flooding. New channels may develop leaving old channels dry. Nelson (2007) also mentions that disruption of business activities could lead to loss of jobs. However, the aftermath of such hazards usually witness a boom in the construction industry with some jobs also being created. Again, wild habitats and farmlands may be destroyed. Corruption is usually rife during such times if proper supervision of aid activities is not done. Relief funds may be misused. Insurance rates may also be increased due to flood hazards due perhaps to the need to pay affected victims their compensation and/or replace damaged properties (Nelson, 2007). These are some of the tertiary or long term effects of flood hazards.

All these effects are applicable to the Aboabo basin although some may be more prominent than others. The tertiary effects of flooding in the Aboabo are not very visible yet. However, the primary effects of flooding are very obvious in the Aboabo basin to the extent that some buildings have been abandoned due to their structural defects brought on by flood water. Flood water deposits so many materials (usually dangerous) into the various communities making life uncomfortable to residents. The secondary effects are also evident in the Aboabo basin since members of the communities are sometimes cut off from the rest of the city for days while electricity and water supply are also disrupted.

2.6. Mitigating floods

Many countries have adapted several means of flood control. These include desilting of drains and dredging of water bodies, destruction of buildings blocking water ways, reforestation exercises, proper town and country planning and the putting up of levees and other barriers. In Ghana, many of these activities have been taken to prevent and control the causes and effects of flooding especially in urban areas.

Nelson (2007) groups response into flood hazards into two main categories. These are the engineering approach to flood control and then a regulatory approach designed to reduce vulnerability to flooding.

2.6.1 Engineering approach

The engineering approach incorporates the use of channel modifications, dams, retention ponds, levees, dikes and floodwalls and flood ways. Channelization helps enlarge the cross-sectional area enabling the channel to carry the higher discharge during floods. In Ghana, efforts are made to dredge rivers which are liable to flooding or those blocked with debris. A reconnaissance visit in March, 2008 to communities located near the Aboabo river such as the Airport roundabout area and Aboabo showed clear signs of dredging in parts of the Aboabo river channel. Residents confirmed that the Kumasi Metropolitan Assembly had facilitated the dredging of parts of the river about three years ago. Sediments and debris from the river bed has been deposited on the banks of the river, creating some form of levees to help hold back flood waters. Unfortunately, these embankments may be gradually washed back into the river during heavy downpour of rain. The use of levees, dikes and floodwalls which are structures built along the sides of the channel is thus another way of mitigating floods.

Dams and retention ponds are also forms of mitigating floods. Dams can be built to hold back water so that discharge downstream can be regulated at a desired rate while spill ways on such dams can be opened when necessary to reduce the level of water in the reservoir which develops behind the dam (Nelson, 2007). This therefore allows for some form of control and monitoring of flood waters to reduce its impacts. Retention ponds virtually serve the same purpose as dams since water can be trapped in the retention pond and then released at a preferred rate to prevent flooding downstream. Flood ways can also be used to prevent flooding. These

provide an outlet to a stream allowing it to flood into an area that has been designated as a flood way. No construction is allowed in flood ways; such areas are used for other purposes such as recreational purposes when there is no threat of floods. The Bonnet Carrie Spillway found west of New Orleans in the USA is an example of such a flood way (Nelson, 2007). Unfortunately, in developing countries such as Ghana, dams, retention ponds and flood ways are not used due perhaps to scarce resources and lack of proper urban planning.

2.6.2 Reduction of vulnerability approach

This approach incorporates floodplain building codes, zoning, buyout programmes and mortgage limitations. Floodplain building codes ensure the restriction of structures that are allowed in such areas such that only structures which can withstand the high velocity of flood waters and are high enough off the ground reducing risk of contact with flood water are permitted. Floodplain zoning on the other hand involves the passing of laws that restrict construction and habitation of floodplains with such areas rather zoned for other purposes such as recreational use wherein lives and properties are not endangered when floodwaters re-occupy the floodplain. This type of approach requires proper urban planning which is a big problem in Ghana where haphazard development is the order of the day especially in major urban centers such as Accra and Kumasi. The Kumasi Metropolitan Assembly (KMA) under the stewardship of the then mayor, Mr. Maxwell Kofi Jumah in 2003 presented a proposal through Cities Alliance in an effort to prepare a City Development Strategy (CDS) for the metropolitan region of Kumasi. The expected impact and result of this project was to produce 'a CDS programme

designed with broad local participation and with strong links to the national government and the National Association of Local Authorities of Ghana (NALAG), that will enhance prospects for mobilising internal and external funding for the CDS process and for a sustainable process resulting in coherent and implementable development plans' (www.citiesalliance.org). These efforts of the city authority is a clear admission of the fact that the city of Kumasi is poorly planned and there is the need to enforce proper development plans to ensure such that natural resources like the Aboabo river are properly maintained.

Floodplain buyout programs generally involves government buying the rights to the land (floodplain) rather than pay the cost of reconstruction and then have to pay again the next time the river floods while mortgage limitations could help prevent flooding with lending institutions refusing to give loans for buying or constructing dwellings or businesses in flood prone areas (Nelson, 2007). These two strategies however are yet to be used in Ghana.

Bolt et al (1975) also break flood mitigation into two main measures which are corrective measures and preventive measures. These measures and their components are summarised in the table below:

Table 2.1 Flood Damage Preventive Programme

Corrective Measures		**Preventive Measures**	
FLOOD CONTROL	OTHER	FLOOD PLAIN REGULATION	OTHER

Dams and reservoirs	Evacuation	Zoning ordinances	Development policies
Levees	Flood forecasting	Subdivision regulations	Open space
Channel improvement	Flood proofing	Building codes	Tax incentives
Watershed treatment	Urban development	Health regulations	Warning signs
			Flood insurance

Source: Bolt et al, (1975), Geological Hazards: Eathquakes, Tsuanamis, Volcanoes, Avalanches, Landslides, Floods.

Table 2.1 groups techniques of preventing floods into two main categories, corrective measures and preventive measures. Most of the components of these categories have been previously discussed and so attention will be focused those which were not touched such as watershed treatment and evacuation under corrective measures.

Watershed treatment includes undertaking contour ploughing and terracing in order to retard surface runoff and increase infiltration (Bolt et al, 1975). The effectiveness of these methods are however usually dependent on the steepness of the terrain, ground cover, storage possibilities and geological factors such as the permeability and porosity of the soil. It is worthy to note that this method may not be very effective if applied to major streams.

Evacuation is another corrective measure which could be used to manage flood hazards. This can only be used when there is a well developed and rehearsed evacuation plan in place. Flood forecasting and warning must be well developed if such a method is to be effective. "A flood forecasting service that is accepted by the public and operating agencies is obviously one that provides both reliable and timely forecasts. To accomplish this most difficult task, a 'Flood Forecasting Center' must have access to meteorologic and hydrologic data, must develop forecast procedures with a well-trained staff, and possess a communication system that permits rapid dissemination of the prediction. In addition, there must be "effective local organisation and plan of evacuation to make use of the forecasts" (Bolt et al, 1975).

In Ghana, the Meteorological Agency and the Hydrological Services Department are responsible for providing valuable information to National Disaster Management Organisation (NADMO) and other agencies which have the logistics to develop evacuation plans and set it in motion as soon as it becomes necessary. Unfortunately, these agencies are under-resourced and are unable to perform to meet international standards. The NADMO, in the June 7, 2006 edition of the Daily Graphic advocated for the establishment of an independent national disaster fund devoid of governmental control. This appeal was made in order to remove undue bureaucracy which usually delays the release of funds by government during disasters so as to enable the organisation act promptly during disasters. The benefits of proper forecasting and warning of floods can never be overemphasised. It can go a long way in saving lives and property during such disasters.

Preventive measures in flood mitigation as can be seen from the table include floodplain regulation and health regulations as well as other forms of prevention

such as warning signs and tax incentives. Floodplain regulations such as zoning ordinances and building codes can help in planning settlements such that adequate provisions are made in terms of for example flood drains and distance from the water body to ensure that people as well as the environment are safe. Also, health regulations can ensure adequate education on how to live a healthy life in such an area. Warning signs can help in reducing fatalities during floods by alerting people early enough so that they can protect themselves and properties during floods. Flood insurance can help in discouraging many people from settling in flood prone areas.

Flood plain regulations such as zoning ordinances and building codes have previously been discussed. Health regulations could also help in preventing floods by ensuring that people living in such areas know exactly what to do and where to go immediately when flood warnings are issued. Health regulations could also help ensure that residents in such areas only live at an appropriate buffer distance from the stream channel and are also informed adequately of the health risks of living in the flood plain.

Tax incentives could also be given to people who stay off flood prone areas to discourage the putting up of structures in flood plains which could endanger life and property. Better still; an affordable housing policy could be put in place to provide appropriate accommodation for the urban poor most of whom happen to be floodplain dwellers. Warning signs must also be given promptly to allow adequate time for people to be evacuated from flood prone areas. All these measures will go a long way in mitigating floods to save precious lives and property and to reduce the burden on the state during floods.

2.7 CONCEPTUAL FRAMEWORK

The concept of flooding has been thoroughly dealt with by Hugget et al (2004). The processes of flooding have been examined. The causes of flooding can be man-made and natural as well even though more emphasis is placed on the natural causes of flooding which are heavy rainfall and snowmelt (Hugget et al, 2004 p252). The concept of flooding as developed by Hugget et al (2004) deals with the causes, incidence as well as mitigation of floods. This has helped in formulating a good conceptual frame work for this study.

The concept of urban flooding has been divided into four main stages. These are the pre-flood development, flood development, the incidence of flood and post-flood incidence stages. The pre-flood development stage generally outlines the major causes of flooding in cities such as Kumasi. Floods are caused through both natural and artificial means. Naturally, weather conditions could lead to rapid condensation and thus heavy rainfall which causes the soil to be saturated with the excess water flooding as surface run-off. On the other hand, man-made causes or artificial causes of flooding involve the activities or inactivity of humans and their impact on the environment. Choked drains, haphazard siting of buildings in drainage basins, constructed roads and concrete pavements and the resultant impervious urban surface also leads to heavy run-off and consequent flooding.

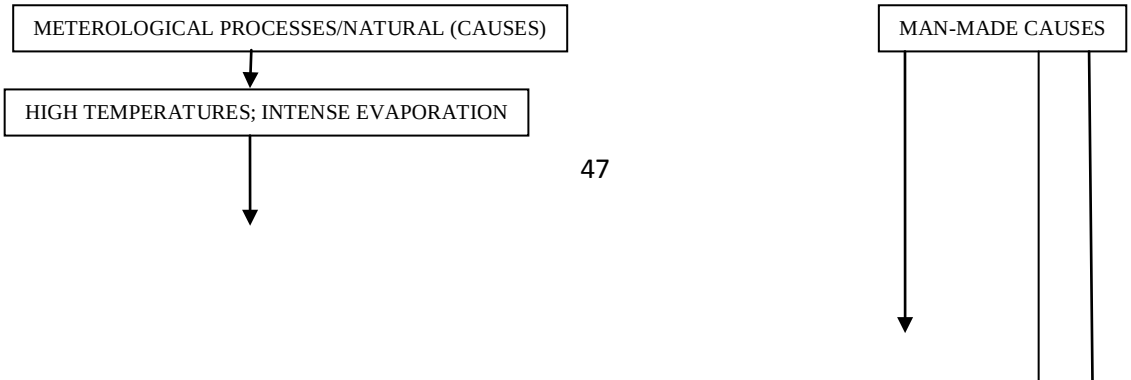
The second stage is the development of floods. This occurs because of heavy run-off on urban surfaces into drains and water bodies which then overflow and inundates land nearby and beyond. Due to inadequate or narrow drains or choked drains,

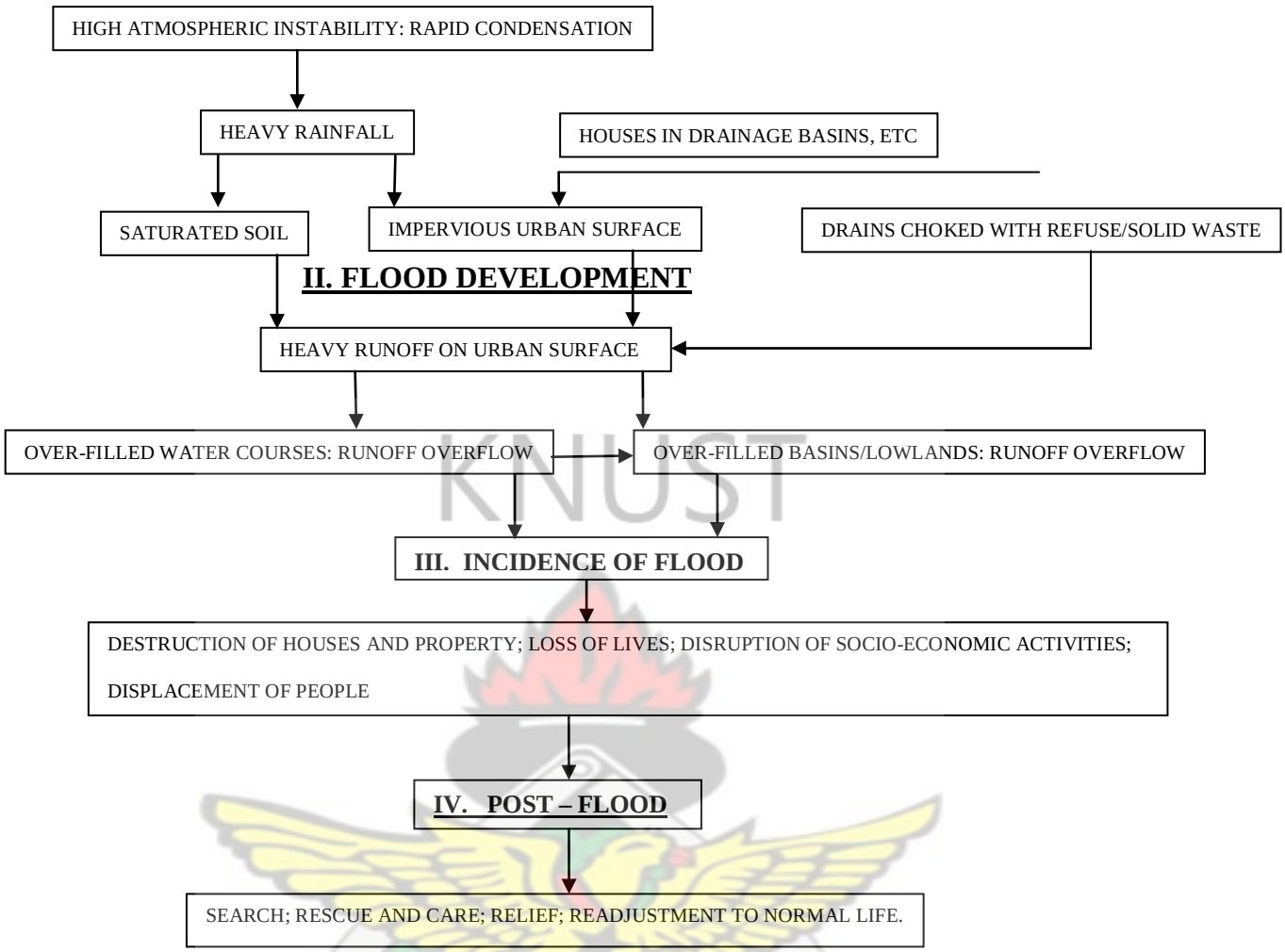
drains cannot carry all the water from a heavy down pour and so it flows over. Low lying areas are flooded because of the very gentle gradient and slow rate of flow leading to the overflow of run-off while rivers burst their banks due to pressure of flood water from upstream.

The third stage is the incidence of flood. At this point, the flooding is either on-going or has already occurred. At this point, the effects of the floods are strongly felt. Houses and other forms of property in the Aboabo basin are destroyed, lives are lost, people are displaced and socio-economic activities are disrupted. The fourth stage is the post-flood incidence involving search and rescue efforts by neighbours and authorities responsible, provision of relief and the attempt to readjust to normal life.

CONCEPTUAL FRAMEWORK

I. PRE-FLOOD DEVELOPMENTS





SOURCE: Author's own construct (2009) based on concept of Hugget et al (2004)

CHAPTER THREE

GEOGRAPHICAL CHARACTERISTICS OF THE STUDY AREA

3.1. Physical Background

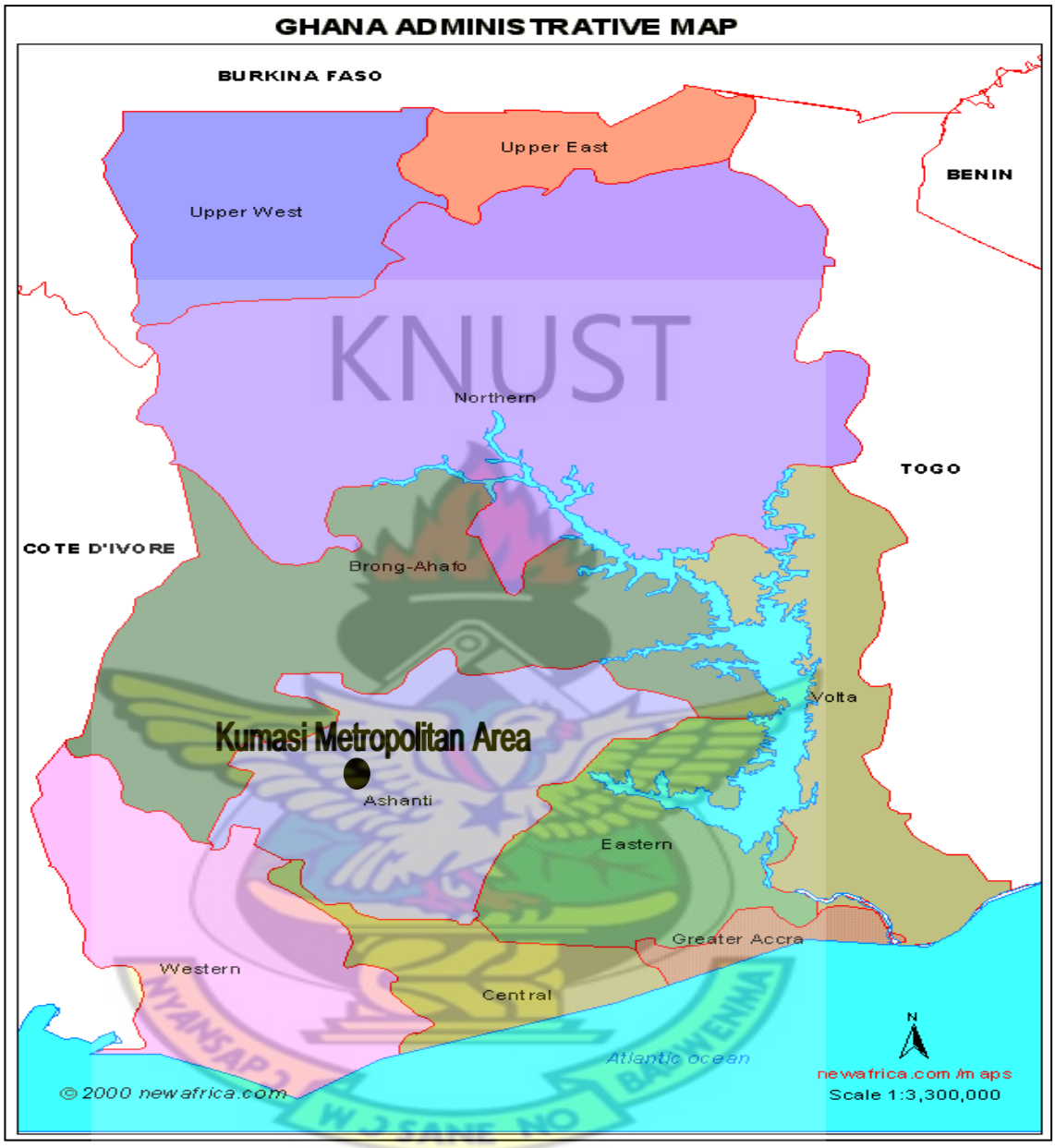
3.1.1. Location and Size

The Aboabo river basin and its immediate environs generally form the study area of this research. It is located in the Kumasi Metropolitan Area of the Ashanti region. Kumasi was founded in the 1680s by King Osei Tutu I to serve as the capital of the

Asante state. From the communities of Adum, Krobo and Bompata, it has grown in a concentric form to cover a total of about 90 suburbs.

The Kumasi Metropolitan Area (KMA) is located in the transitional forest zone of the country and lies about 270km north of Accra, the national capital of Ghana. It covers an area of about 254sq/km, approximately 10km in radius (Profile of Kumasi, 2007). It lies between latitude 6.35^{o} and 6.40^{o} and longitude 1.30^{o} and 1.35^{o} and on an elevation which ranges between 250 and 300 meters above sea level. The unique centrality of the KMA as a traversing point from all parts of the country makes it a special place for many to migrate to. The administrative map of Ghana is shown in Figure 1 with the spatial location of KMA shown boldly.

Figure 3.1: Administrative map of Ghana showing the Kumasi Metropolitan Area.

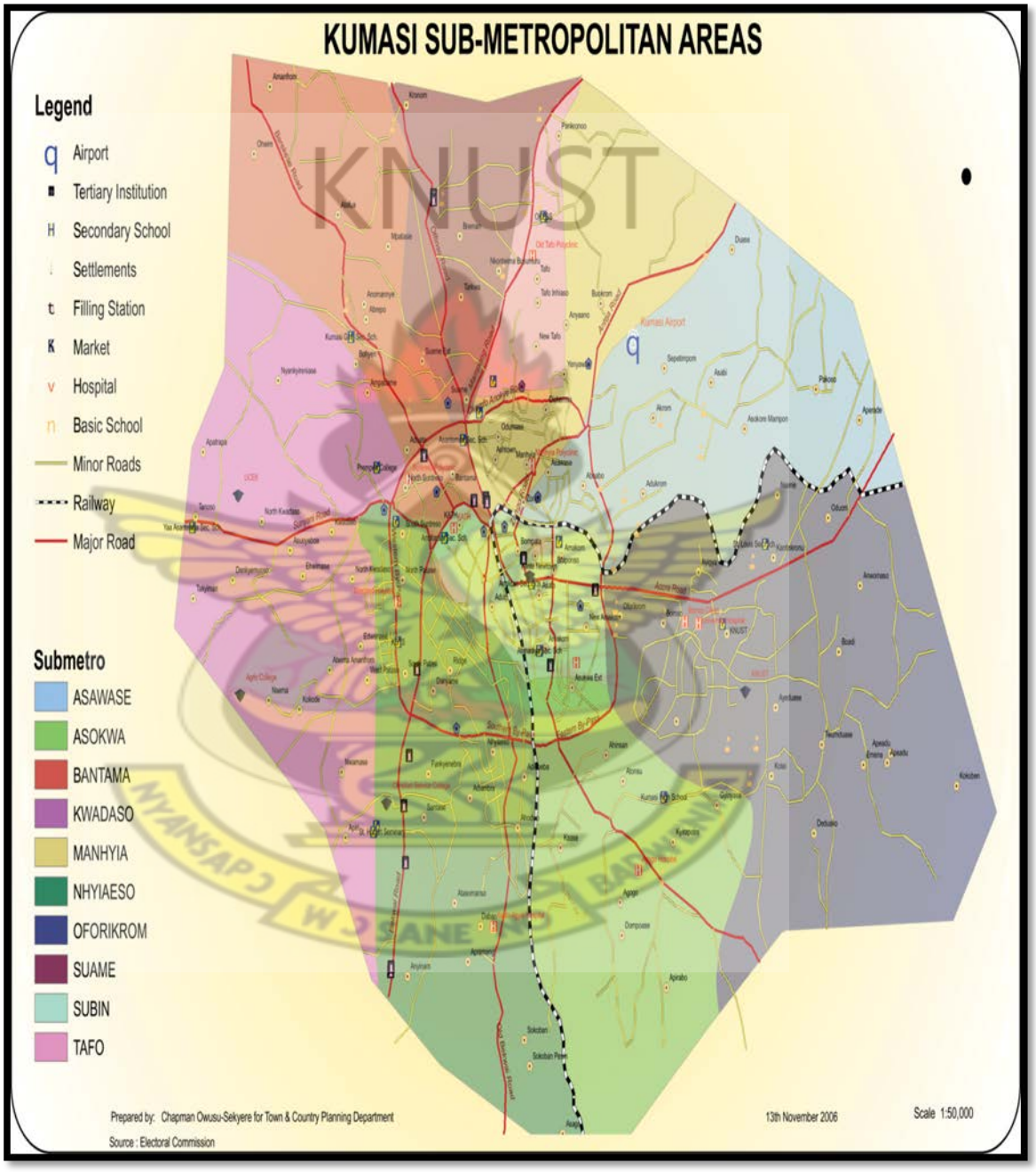


Source: Kumasi Metropolitan Assembly Development Plan (2006-2009).

KMA has been divided into 10 sub metropolitan areas. This is basically to make the development and management of the district more effective. The 10 sub-metropolitan areas are the Manhyia, Suame, Old Tafo, Asawase, Kwadaso,

Nhyiaeso, Asokwa, Subin, Oforikrom and Bantama sub-metros. The map below shows these sub metros from a spatial perspective.

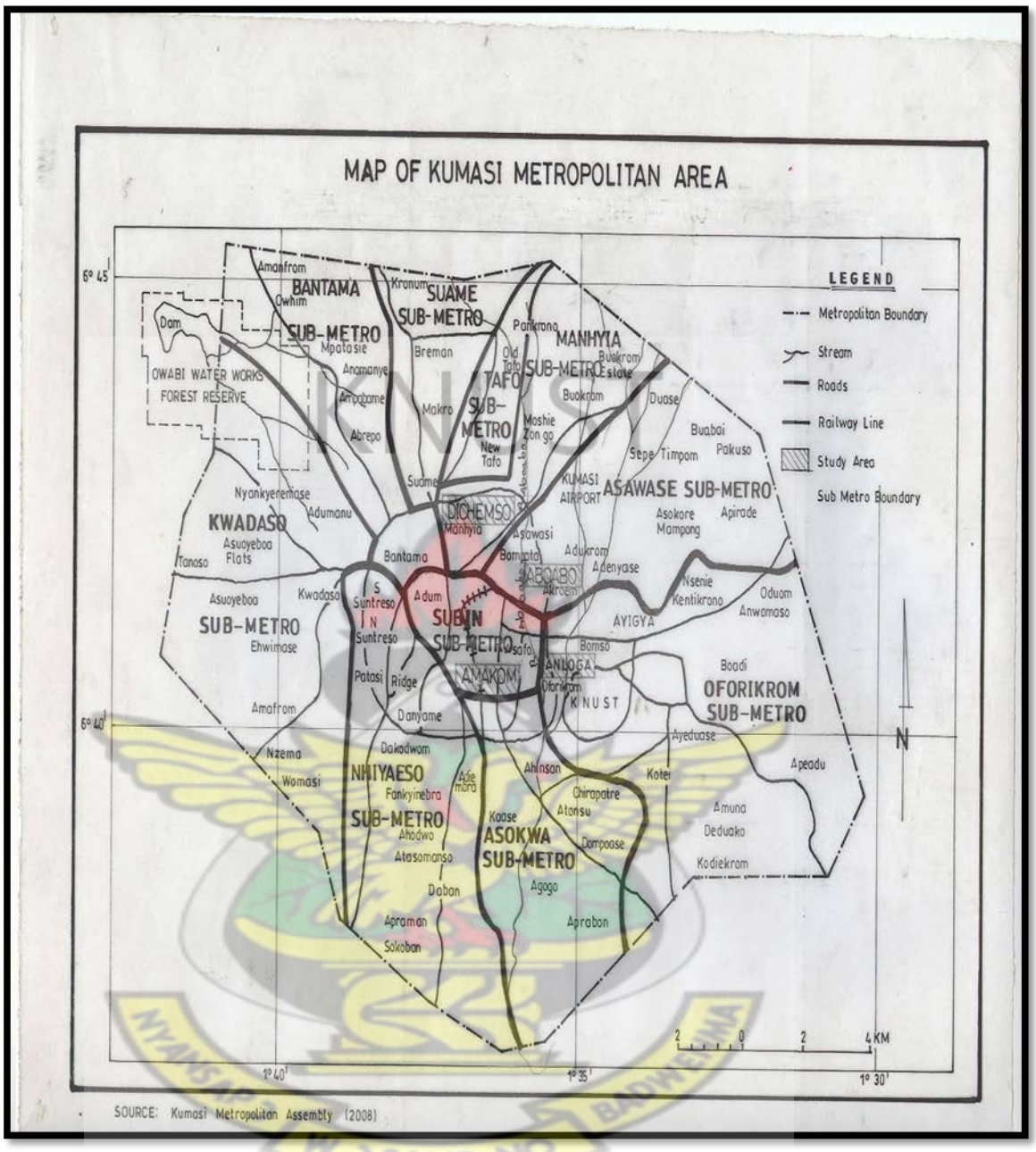
Figure 3. 2: map showing the 10 sub metros of Kumasi Metropolitan Area (KMA)



Source: Profile of Kumasi, June, 2007.

The four communities along the Aboabo river chosen for the purpose of this study are located in four different sub metros. Dichemso is located in the Manhyia sub metro, Anloga in the Oforikrom sub metro, Amakom in the Subin sub metro and Aboabo in the Asawasi sub metro. These can be located in figure 3 which shows the selected communities all located along the Aboabo river but in different sub metros.

Figure 3.3: Map showing selected communities in KMA



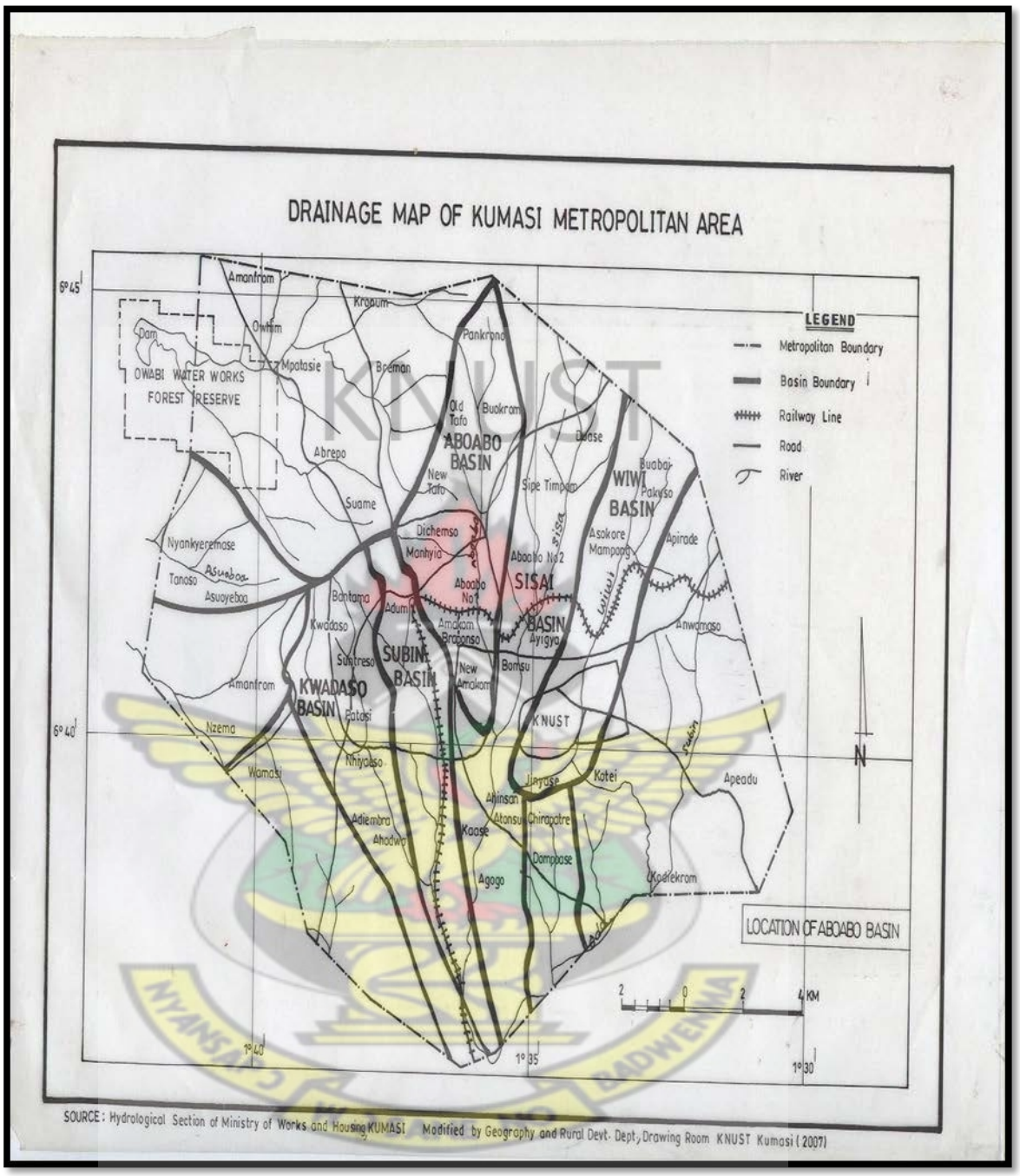
Source: Geography Drawing Room, KNUST (2009).

3.1.2 Relief and Drainage

The Kumasi Metropolis can be found within the plateau of the South – West physical region which ranges from 250 to 300 meters above sea level (KMA D-Plan, 2006-09). It has an undulating topography which is evident in the many hills and

valleys in the city. The city is drained by major rivers and streams including the Subin, Wiwi, Sisai, Owabi, Nsuben and the Aboabo whose drainage basin forms part of the study area of this research. Unfortunately, these water bodies are quickly becoming dead and extinct due mainly to the influence of human activities such as estate development, encroachment and indiscriminate waste disposal activities. This is a very serious problem and contributed to the choice of the research problem being investigated.

Figure 3.4: Map showing the Aboabo and other drainage basins in KMA



Source: Geography Drawing Room, KNUST (2009).

The Aboabo basin extends from Pankrono, its farthest point in the North to New Amakom extension down south and is located at the central parts of the Kumasi

Metropolis. It is characterised in greater portions of the region by ridges covering the entire eastern and northern sections with high altitudes which reach as high as 950ft above sea level. This can be observed mostly in Pankrono and Southern Anhwiaa at the peripheries of the Kumasi metropolis. The central part of the basin on the other hand is covered extensively by lowland running from Moshie Zongo to the Asokwa Extension in the south. This area is mostly undulating in nature with much flat land area in the north-western and southern part of the central lowlands.

The main river in the Aboabo basin is the Aboabo River flowing from the north to south. Its major tributaries are the Owusu Ansa and Dichemso streams. The Aboabo River takes its source from the northern ridges and flows southwards to the confluence with River Sisa at Asokwa. Drainage density is very high especially in the central part of the basin and generally exhibits a dendritic pattern of drainage. The valleys in which the river flows are very wide with floodplains found in the valley floor. Extensive areas here are liable to floods and marshes especially in the north-western part in Dichemso and Aboabo Number 1 along the Kumasi – Accra railway line.

The length of the Aboabo river is 6,050 meters (6.05 km). It is about 2.5 meters wide upstream and 30.5 meters wide downstream (Hydrological Services Department, Kumasi). Among the settlements scattered along the river's banks are Anloga, Moshi Zongo, Dichemso, Ahensan, Amakom, Aboabo and Manhyia; all suburbs in the Kumasi Metropolis. For the purpose of this study however, four of these communities namely Anloga, Amakom, Dichemso and Aboabo were selected.

3.1.3. Climate

KMA falls within the wet sub-equatorial type of climate with an average minimum temperature of about 21.5^{o}c and a maximum average temperature of 30.7^{0}c. Average humidity is about 84.16% at 0900 Greenwich Meridian Time (GMT) and 60% at 1500 GMT. Temperature and humidity conditions of the metropolis can thus be considered as generally moderate with a double maxima rainfall regime of 214.3mm in June and 165.2mm in September (KMA D-Plan, 2006 – 2009). The same conditions apply to the study areas specifically Aboabo, Dichemso, Amakom and Anloga.

3.1.4. Vegetation

The study area falls within the moist semi-decidious South-East Ecological Zone of Ghana. Predominant species of trees found here include Ceiba, Triplochlon and Celtis with Exotic species. Unfortunately, rapid urbanisation has contributed immensely to the rapid depletion of these nature reserves. Vegetation in the Aboabo basin has diminished over the years due mainly to urbanisation. Areas in the basin zoned as open space, supposed to be used as nature reserve to protect the Aboabo river have been encroached upon with buildings springing up everywhere. This has contributed to flooding in the Aboabo basin.

3.1.5. Geology and Minerals

In terms of geology, KMA is dominated by the Middle Precambrian Rock whose unique geological structure in the metropolis has both positive and negative impacts on the local economy (KMA D-Plan, 2006-09). The existence of this type of rock has led to the development of the construction industry in the metropolis in addition to a few small-scale mining activities and a proliferation of stone quarrying and sand

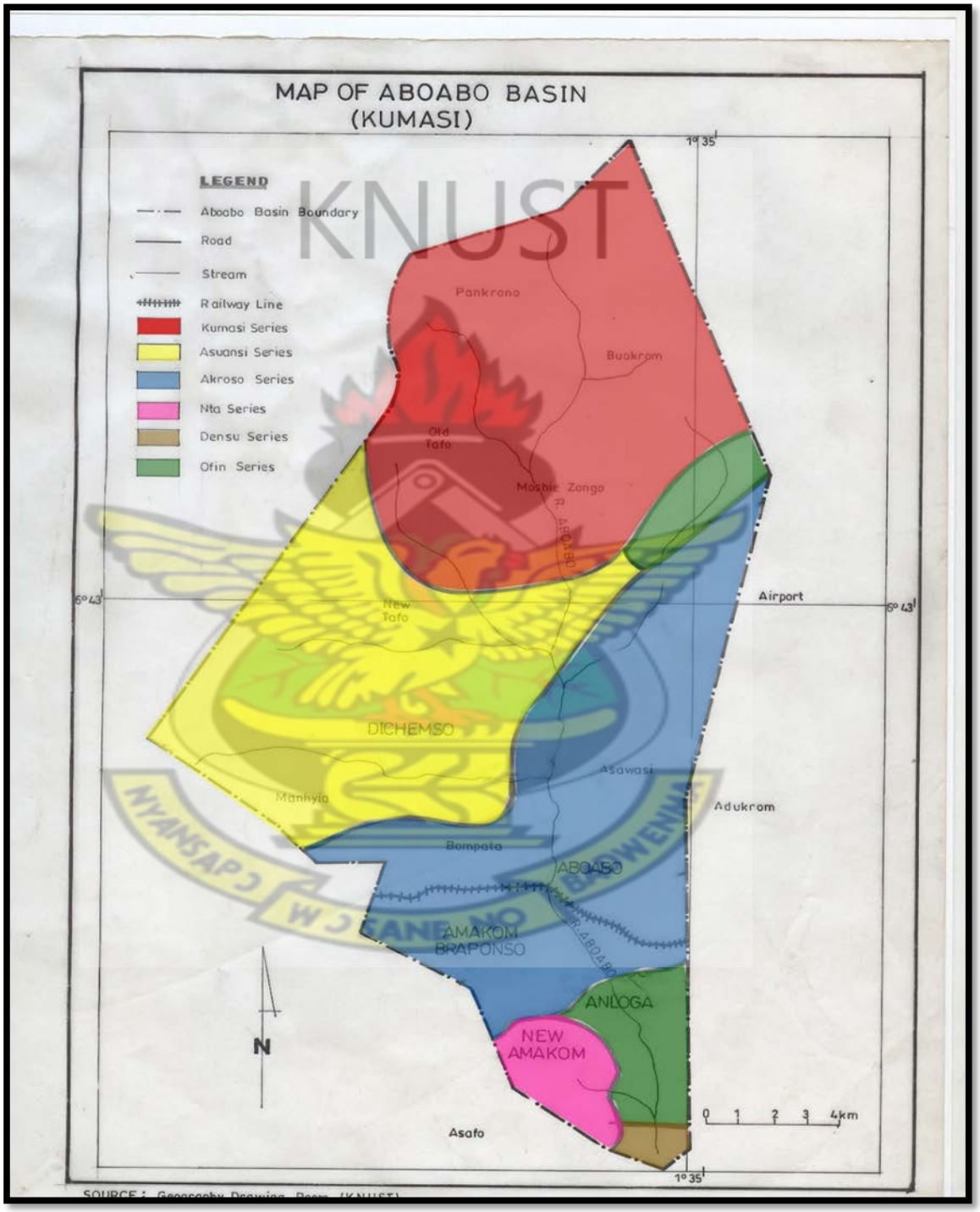
winning industries. Although these to some extent have contributed to job creation in the metropolis, the extraction of these resources is to a large extent uncontrolled exposing the area and its inhabitants to environmental hazards.

3.1.6. Soils In The Aboabo Basin

The Kumasi – Asuansi and Nta – Ofin compound association are the predominant soil types which occur fairly extensively in the entire Aboabo basin and thus the Amakom, Anloga, Dichemso and Aboabo communities which form the study area of this research. This compound association consists of the Kumasi, Asuansi, Akroso, Nta, Ofin and Densu Series.

In a catena arrangement, the reddish brown to red, well drained Kumasi series and the yellowish red, well drained Asuansi series occur on summits and on upper to middle slopes of the undulations in the Aboabo basin. The Kumasi series are noticeably found in the up hills of the Aboabo basin in the townships of Pankrono, Moshie Zongo and Buokurom. The soils of New Tafo (Kurofrom) and at the eastern boundaries of the Aboabo basin particularly Kwadaso come under the Asuansi series classification.

Figure 3.5: Soil map of the Aboabo basin



Source: Geography Drawing Room (KNUST)

The Nta series is located in the southern part of the Aboabo basin. It is found mainly in the New Amakom area. These series consist of deep brownish yellow to yellowish brown, loamy coarse sands developed mostly in hill wash material. Within valley bottoms, for example at Anloga are found deep, grey, poorly drained alluvial coarse sands classified as Ofin series. In the southern most part of the Aboabo basin is found the clayey soils of the Densu series typology. The Densu series, which are soils that are characterised by slow internal drainage very low permeability and very high water holding capacity as well as prolonged water logging, are found in lowland at Kaase below the Aboabo basin.

Soils in the central lowland of the Aboabo basin are classified as part of the Akroso series as shown in figure 5. The Akroso series soils are yellowish brown, moderately well to imperfectly drained soils developed within colluvial parent materials. The soils are deep gritty clays relatively free of gravels and concretions, occurring on gentle, middle to lower slopes below Asuansi series. The soils mainly found within the communities of interest are the Asuansi, Akroso, Densu and the Nta running from the central lowlands to the sounthern low lands of the Aboabo basin.

It is thus not surprising that floods do occur in the Aboabo basin. The soils there are generally clay and are able to hold much water for a long time. It is also known that relative to sandy and loamy soil types, it takes a longer time for water to pass through clayey soils due to poor porosity. Thus, it has a low infiltration rate and this encourages flooding because the excess discharge which overflows from the Aboabo river during floods does not seep through the soil quickly and so it runs over the land spreading further to flood areas around it.

3.2 Socio-economic characteristics

3.2.1. Population Characteristics

As the administrative capital of the Ashanti region, it is no surprise that the Kumasi metropolis is the most populous district in the Ashanti region with a population figure of 1,170,270 recorded during the 2000 population census. The Ashanti region is highly urbanised with a growth rate rising from 2.5% in the 1970s and early 80s to 5.4% in 2006. It is currently the second most urbanised region in the country, after Greater Accra (87.7%).

The flooding situation in the Aboabo, Amakom, Dichemso and Anloga communities found in the Aboabo river basin is of major interest in this research. Table 3.1 shows these communities with their demographic characteristics in the year 2000.

Table 3.1: Demographic characteristics of selected communities

AREA	DEMOGRAPHIC CHARACTERISTICS					
	Total population size	Number of females	Number of males	Total number of houses	Total number of households	Average household size
Aboabo	34206	17262	16944	830	6626	5.2
Anloga	38155	19085	19070	1057	7694	5.0
Dichemso	21281	10444	10837	934	4156	5.1
Amakom	39060	19833	19227	1245	8145	4.8

Source: 2000 population census, Ghana Statistical Service, Kumasi.

The figures in the table 5 give a clear indication that the four communities found in the Aboabo basin are highly populated with an overall total population of 132702. There are generally more females in the communities than males. The Amakom community has the highest number of households and houses but the smallest average household size.

3.2.2. Health care facilities

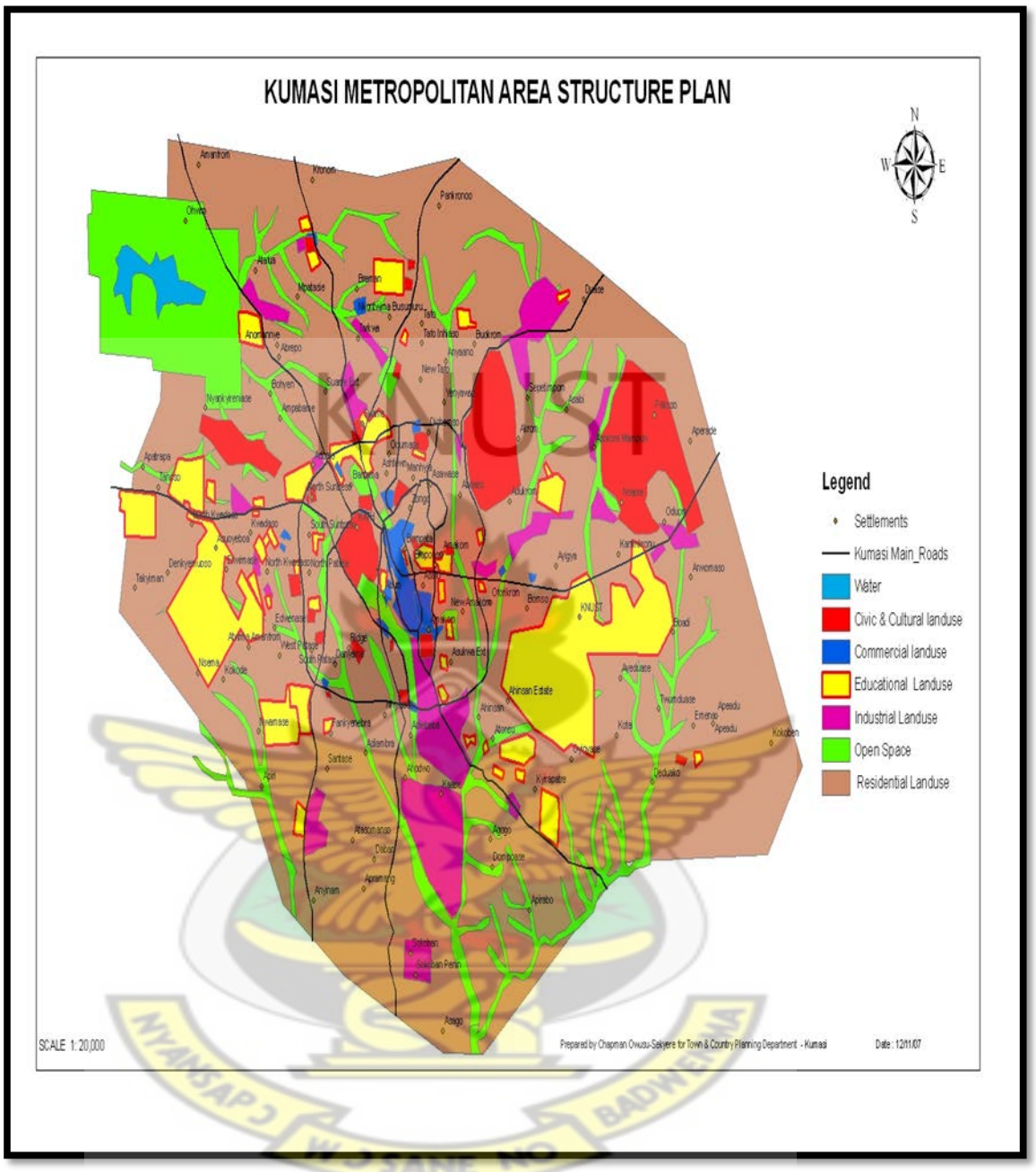
KMA has quite a number of health facilities which provide health care for people in the metropolis. It has 1 Teaching Hospital (i.e. Okomfo Anokye Teaching Hospital) which serves also as a Regional Hospital, 2 quasi-government hospitals (one for the University and the other for the Military), 5 Polyclinics, over 200 known Private Clinics, 13 Industrial Clinics, 9 maternal Health Posts and 169 Outreach Stations. There are also 15 Private Laboratories in addition to the Laboratories in the various hospitals. The adequacy or otherwise of these facilities to provide quality health care for people in the metropolis however is debatable and there seems to be a need for an improvement in health care service provision in general in the metropolis.

3.2.3. Settlements

In the 2000 Population and Housing census, 830 houses with 6626 households can be found in the Aboabo community, 1057 houses with 7694 households can be found in the Anloga community, 934 houses with 4156 households can be found in the Dichemso community and 1245 houses with 8145 households can be found in the Amakom community all located in the Aboabo basin. This is a clear indication that the Aboabo basin is well populated.

The various land use in the Kumasi Metropolis include residential which has always taken up most of the land and is projected to take up 9088.6 hectares of land which is a whopping 44% of the total land of the metropolis. Land is also put to commercial, industrial, educational, civic and cultural uses in the metropolis. Part of the land is used for circulation purposes while others have been zoned as open space with some 18.7% of land still undeveloped in the metropolis. Lands zoned as open space are usually found around water bodies such as the Aboabo river. These are supposed to serve as nature reserves and thus protect such water bodies. Figure 3.6 shows the various types of land use in the KMA.

Figure 3.6: Map showing land use in KMA



Source: KMA D-Plan 2006 – 2009.

There are many settlements found on the map and those of Amakom, Dichemso, Aboabo and Anloga can easily be located. The areas marked green are supposed to be open space and as explained ealier, these areas are supposed to protect the environment and nature such as water bodies like the Aboabo. It must be noted that parts of the communities mentioned can be found right in the area zoned as open

space. The flood plains of the Aboabo have been taken over by settlements and these contribute to flooding in the basin.

3.2.4. Educational facilities

The metropolis has educational facilities which provide education for all. Accessibility and affordability of education especially in private educational facilities in the metropolis however leave much to be desired. This is because of the expensive fees charged by some of these private educational institutions. KMA how ever is endowed with 2 Public Universities, 3 Private Universities, 1 Polytechnic, 2 Teacher Training Colleges, 83 Senior High Schools and over 1,018 Basic Schools (The private sector provides the bulk of these institutions at the pre-school). Basic and Senior High Schools can be found in communities of Aboabo, Anloga, Dichemso and Amakom providing education to children living in these areas in the Aboabo basin under study.

3.2.5. Water and sanitation

Water supply in the Kumasi Metropolis is not good with unreliable pipe borne water situations experienced in many parts of the metropolis. Supply of water to the metropolis is from two surface water treatment plants namely Owabi which is 10km away from the city and Barekese which is 16km away. In the Aboabo basin, underground water is also used as a source of water though on a very small scale. Some homes have wells which provide water especially in times of water shortages in the metropolis. The Aboabo is not put to household use. This may have been the situation in the past but owing to the very poor sanitation in the basin and the filth in the river, people know better than to use it for household activities.

500,000kg tons of solid waste is generated daily in the Kumasi metropolis out of which only 60% are collected and sent to a landfill site. 40% of this waste is dumped in open refuse collection points or burnt by residents. In the Aboabo basin, sanitation is a big problem since most residents as well as other occupants of the land dump both solid and liquid waste directly into the Aboabo river and in some cases on the banks of the river. The river is thus filled with all kinds of waste materials, from polythene bags to human excreta. This is because some people also defecate directly into the river or on the river banks. The choked drains in the basin encourage the breeding of mosquitoes which cause malaria especially during the rainy season. Figures 3.7 and 3.8 show pictures of the Aboabo basin showing the filth deposited into the river as well as the siltation of the river.

Figure 3.7: Picture showing debris and sand in the Aboabo river

Source: Field survey, 2009.

Figure 3.8: Picture showing choked culverts in the Aboabo river

Source: Field survey, 2009.

These pictures were taken in the Dichemso community in the Aboabo basin. The filth and sand found in the river make it difficult for large volumes of water to flow through the culverts during heavy downpours or storms. Thus, in many cases, the road is also flooded making it impassable and dangerous for those who attempt to use it.

3.2.6. Economic activities

Economic activities in the Kumasi metropolis are very intense in nature. Commercial activity is centered on wholesaling and retailing. 71% of economic activity is centered on Trade/Service/Commerce with 24% centered on industry and 5% on Agriculture. This indicates that Kumasi is a highly commercialised metropolis. In the specific communities of Aboabo, Anloga, Dichemso and Amakom under study, the major economic activities include the Anloga wood

industry (wood processing and manufacturing of all kinds of furniture), trading, carpentry and patches of small scale vegetable farming.

Major economic infrastructure can be found in the Kumasi metropolis. In terms of transportation, Kumasi has an Airport, 846km of road network with only 271km asphalted or bitumen surfaced and a railway line which connects it to Accra and Takoradi. The common source of energy used in the metropolis is electricity. Liquified Petroleum Gas as well as charcoal are also widely used in the metropolis as energy. The metropolis has the single largest traditional market in West Africa called the Kumasi Central market with over 10,000 stores and stalls with about 28 satellite markets.

Many financial institutions which offer services, such as giving out loans to fuel economic activities and providing financial solutions to people, can be found in the metropolis.

The Aboabo basin lies within the socio-economic hub of the Ashanti region which is the Kumasi Metropolis. It is important to appreciate the attributes of the study area as presented in this chapter in order to fully comprehend the problem under study.

CHAPTER FOUR

SOCIO - ECONOMIC RAMIFICATIONS OF FLOODING IN THE ABOABO BASIN

4.1 Introduction

Anloga, Dichemso, Amakom and Aboabo which are the communities forming the study area are all drained by the Aboabo river which floods annually. People living in these communities face various problems due to this annual phenomenon. The data obtained from the field has been critically considered and analysed and the discoveries or results from this have been elaborately discussed in this chapter.

4.2 Bio- data of respondents

To get a proper understanding of the issues arising from the problem and also get the appropriate primary data, it was important to obtain the bio data of the respondents so as to put their concerns into proper perspective.

Due to the serious nature of the problem under investigation, it was important to identify respondents in the study area who were old enough to understand the issues and give meaningful responses which will help in giving an appropriate policy direction to correct the problem. Only 15.2% of respondents were below 25 of age and 84.8% of them aged from 26 years to above 55 years old. Thus, information given by respondents were clear and relevant since they clearly understood the problem under investigation. The Majority of respondents interviewed were male (57%) with females being in the minority of (43%). Sixteen point eight percent (16.8%) of the respondents interviewed were dependants of the heads of households who were aged from 15 years to 26 years.

An interesting variety of ethnic groups were found in the study area. The study area is made up of four communities that is Anloga, Dichemso, Amakom and Aboabo. Anloga is predominantly made up of Ewes from the Volta region of Ghana while Aboabo is made up mostly of people from the Northern parts of Ghana such as The Northern, Upper East and Upper West regions. Dichemso and Amakom are mainly Akan communities. There are no strict demarcations since members of these ethnic groups including others like the members of the Ga ethnic group can be found in any of the communities in the study area. This indicates that the communities under study are made up of a mixture of ethnic groups co-existing together peacefully. However, more than half of the respondents interviewed are from Northern tribes with about a quarter of them from the Akan and the rest being Ga and Ewe ethnic groups respectively.

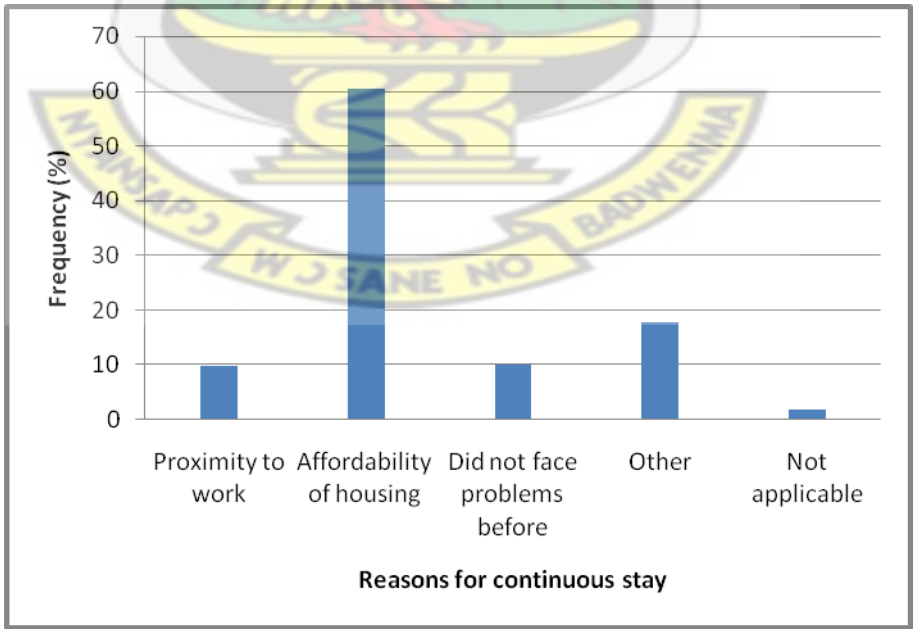
Respondents were mainly traders, students, artisans, wood workers and public servants. Respondents are mostly self-employed with only 2.5% working in the public service. 16.7% of respondents are unemployed. Respondents are mostly of the middle and lower class income levels as is general in the study area. Accommodation in the area is mostly for the middle and lower class income earners. This assertion also reflected in the educational levels of respondents. 45% of respondents had attained primary school education but only 2.8% of them having obtained tertiary education, 14.7% are completely illiterate and 37.2% of respondents are senior secondary school graduates. Only 12.7% of respondents are owners of the houses they lived in. Sixty-three point two (63.2) percent were tenants with 23.5% being free occupants. Free occupants are those people who were living in homes without paying anything and as well not owning the homes.

4.3 REASONS FOR CONTINUOUS STAY IN FLOOD PRONE AREA

One of the objectives of this study was to ascertain the reasons why people who are affected by flooding keep on living in the flood prone areas. This is a very important objective since one nagging question the researcher could not quite answer was if one has to go through such a dangerous hazard every year, why not move away to stay in a safer and more conducive place.

Respondents were asked if they had experienced flooding before and almost all of them had. As many as 98.2% of respondents had experienced flooding with only 1.8% answering no to the question. This led to the attempt to understand why people continued to live in the area although they endure the phenomenon of flooding each year.

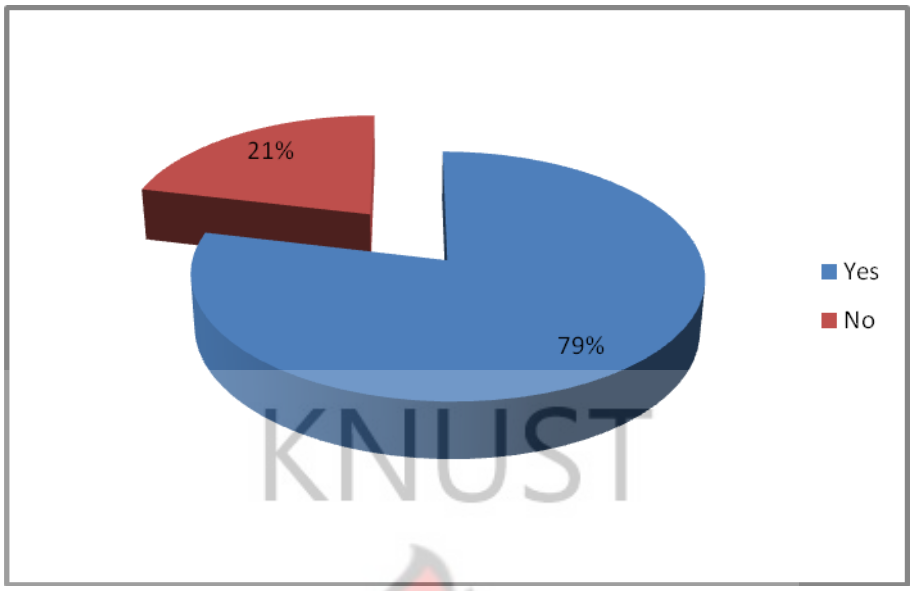
Figure 4.1: Reasons for Continuous Stay



Source: Field survey, 2009.

Figure (4.1) indicates a summary of the varied reasons respondents gave to explain why they continued to stay in the flood prone area under study. It is clear that most people lived in these areas because of affordability of housing or accommodation. Sixty point five (60.5) percent of all respondents were still living in the study area because they just could not afford the cost of moving to another place. Nine point nine (9.9) percent continued to stay on because of proximity to their places of work. This made life a little easier for them especially with regard to earning a livelihood. Some residents had their businesses right there in the study area where they also lived. Most of them were traders and artisans such as carpenters and they operated these businesses in the study area. Seventeen point seven (17.7) percent still lived in the area because of other reasons such as having lived there all their lives or staying on because it is their family houses, just to mention a few. About 10.1% of respondents claimed that their reason for staying on was because they did not face that problem before. This does not debunk the fact that they are not facing the problem since most of them admitted that currently, the issue of flooding was becoming a problem for them. All these go to validate the proposition 1.4.1 which indicates that 'Socioeconomic constraints are the motivation of inhabitants' continual stay in flood prone areas'. While some residents could not afford to move out of their communities, others continued to stay because of social ties such as the need to stay in a family house to take care of it and not pay any rent.

Figure 4.2: Desire to move out



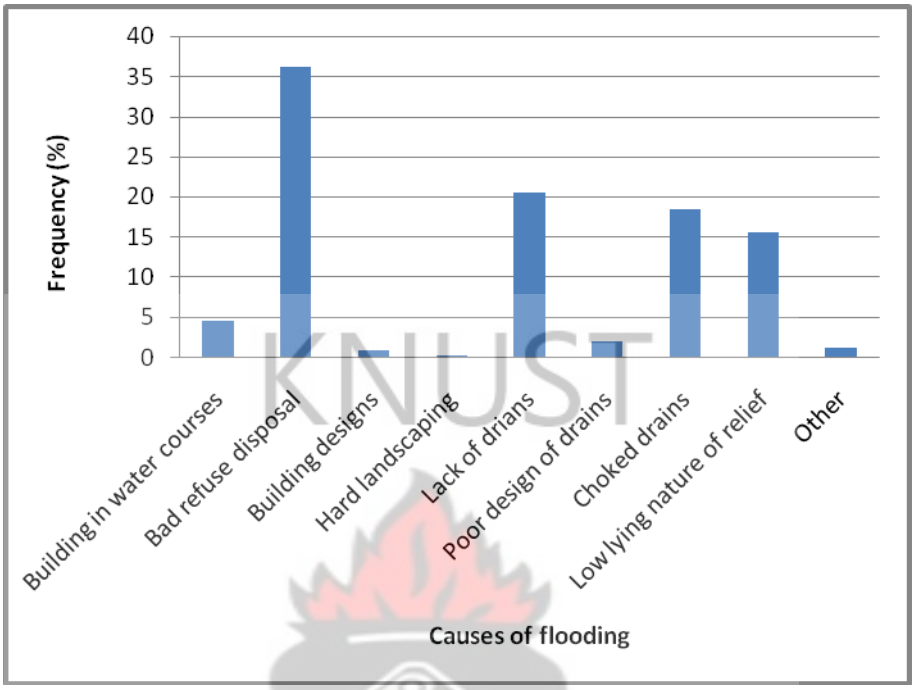
Source: Field survey, 2009.

Many respondents, almost 80% of them, were willing to move that is if they could. 21.3% were however unwilling to move probably because of some the socioeconomic reasons previously discussed.

4.4 CAUSES OF FLOODING IN THE ABOABO RIVER BASIN

One major objective of this study was to find out the causes of floods in the Aboabo river basin. This was essential because the causes revealed would be of immense help to policy makers and other stake holders in the attempt to plan and mitigate current situations and to prevent future occurrences.

Figure 4.3: Causes of floods



Source: Field survey, 2009.

Figure 4.3 gives an interesting insight into the causes of flooding according to the respondents who live in the area. The most important cause of flooding according to the respondents is improper refuse disposal in the area. Thirty-six point two (36.2) percent of the respondents indicated that the method for refuse disposal was an issue and they believed that it was a major cause of the problem since drains and the riverbed were choked with refuse. The next important cause of flooding incidence is the lack of drains in the area. This was really true because observations made in the field indicated that in most areas, proper drainage systems were absent. One could only find a big gutter with temporary drains from buildings in the area connected to it. In some places however, these small temporary drains were connected to the Aboabo stream and this left much to be desired. Eighteen point five (18.5) percent of the respondents said that choked drains are also a cause to flooding. Fifteen point

seven (15.7) percent assign the cause of flooding to the low lying nature of relief. This assertion was made mostly by those staying in the valley floor proper. They bear the most brunt of the floods. Only 1 person out of the sample size of 395 believed that hard landscaping was a cause to flooding. Hard landscaping according to respondents was not an issue for flooding. They however assigned other causes such as poor design of drains and building designs to flooding in the study area.

4.4.1 Land use

With the causes of floods given as they were by respondents in the field, one would wonder if there were any rules, regulations and plans governing land use in the Aboabo basin. Previous interviews with stakeholders such as the Town and Country Planning Department of the KMA proved that the immediate areas around water bodies in the metropolis have been zoned as green belts meant for the planting of trees to create environmentally friendly recreational areas such as parks for relaxation and also to protect the Aboabo river. However, a visit to the field showed that this was just on paper and was woefully not adhered to. Observations made in the field showed buildings were built right next to the Aboabo river and trees are almost totally absent.

Respondents were thus asked to share their views so far as land use in the area was concerned. Majority of respondents believed that land use processes were not followed at all. Buildings were erected anywhere and anyhow without permits around the Aboabo river. Sixty-eight point one percent (68.1%) of respondents believed that rules were not followed and so land use was an issue to be dealt in solving the flooding problem.

Table 4.1: Land use plan implementation according to respondents

Land use	Frequency	Percentage
Yes	126	31.9
No	269	68.1
Total	395	100.0

Source: Field survey, 2009.

4.4.2 Waste disposal

Observations made in the field showed that waste disposal practices in the area were not environmentally friendly at all. Respondents also indicated that this was one important cause of flooding in the area. Seventy-seven point nine (77.9) percent of respondents indicated that they disposed of their domestic and commercial waste either in the Aboabo river itself or on the banks only for it to be washed into the river and away when it rains. Table 4.2 is a summary of respondents views on the issue of waste disposal. It gives a clear indication of the fact that human activities is one of the important causes of flooding in the Aboabo river since the river is choked leading to the overflow of excess discharge into the flood plains causing havoc.

Table 4.2: Methods of waste disposal by respondents

Waste disposal method	Frequency	Percentage
Public dump	81	20.5
Dumping of refuse in the aboabo river	91	23.0
Dumping of refuse at the banks of the Aboabo river	217	54.9
Burning of refuse	4	1.0
Others	2	.5
Total	395	100.0

Source: Field survey, 2009

Ninety-seven point five (97.5%) of respondents indicated that they paid nothing for waste disposal. This was not surprising since they freely throw all their waste into and around the Aboabo river. The remaining 2.5% of respondents paid less than Ghana¢1.00 for their waste to be collected and disposed of properly. Unfortunately, they formed a minority with the majority choking the river daily with refuse and thus contributing to flooding.

4.5 FREQUENCIES OF FLOODING IN THE STUDY AREA

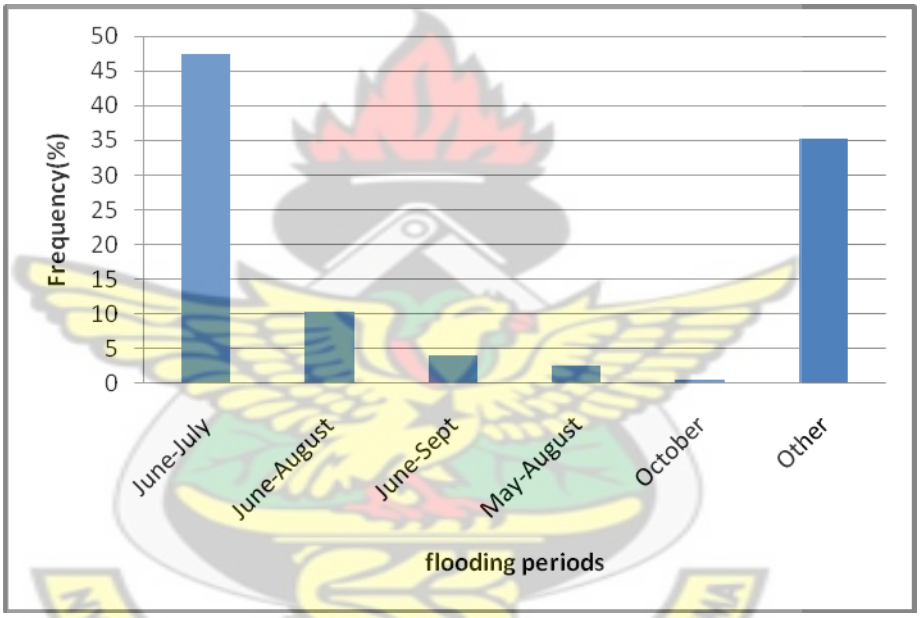
In an attempt to examine the nature of flooding in the study area, the researcher sought for information from the Ghana Meteorological Agency in Kumasi as well as respondents regarding how often floods occurred. In this case, particular months and the rainfall pattern over ten years were compared.

Close to 98% of respondents indicated that flooding was a frequent phenomenon in the study area since according to them, the floods occurred several times annually. Only 2 out of the 395 respondents claimed the floods came once a year with 7 others claiming that it occurred only twice a year. Majority of the respondents (47.34%) also claimed the floods usually occurred during the months of June and July.

35.19% of the respondents found it difficult to indicate the particular months in which the floods usually occurred. They elaborated that the floods came whenever there was heavy rainfall or a long period of heavy rainfall or storms.

According to Figure 4.4 showing the flood frequency in the study area, floods occurred mostly in June and July and least in the month of October. This follows the national rainfall distribution patterns.

Figure 4.4 Periods of Annual Floods



Source: Field survey, 2009.

For an in-depth understanding of the problem and its solution, it was important to find out the duration of floods. Enquiries were made from respondents of which majority (60.3%) indicated that floods and its after-effects usually lasted for as long as 6 days. That is to say that the flood waters took that long to recede. Some 29.6% of the respondents indicated that floods lasted from 2 to 6 hours. However, it was observed that those who made this assertion were not living very close to the

Aboabo river in the valley floor. Those who claimed floods could last for days, however, were those who reside in the bottom of the river basin. Figure 4.5 shows a flooded house in Aboabo.

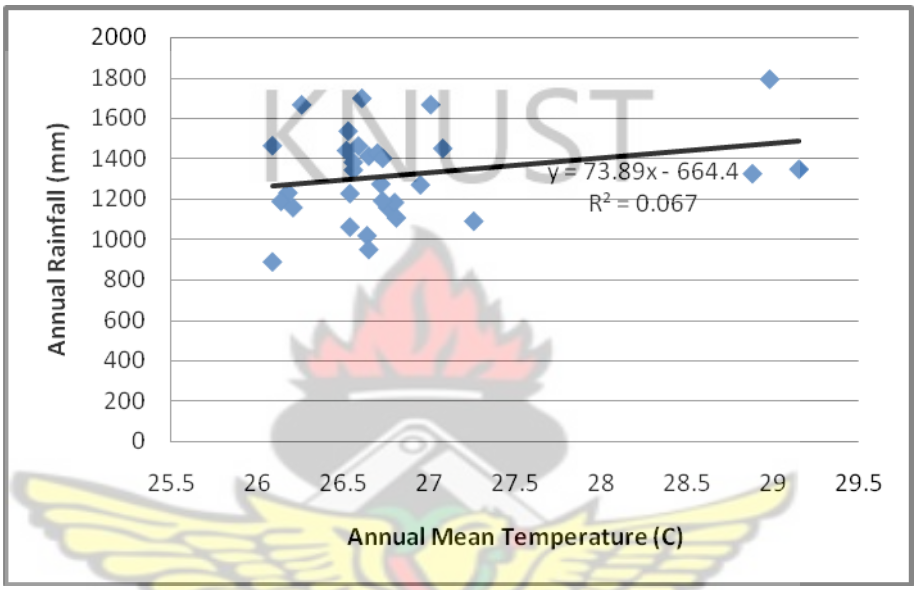
Figure 4.5: Picture showing flooded house in Aboabo.

Source: Field survey, 2008.

4.6 NATURAL CAUSES OF FLOODING

Information obtained from the field was compared with secondary data obtained from the Ghana Meteorological Agency in Kumasi. This was to prove that climate variability and change could be the cause of flooding. The rainfall and temperature figures obtained from the agency spanned over a period of 31 years. These were organised and used to draw graphs which show deviations from average rainfall and temperature respectively over the 31 year period. The calculations for the standard deviations of both rainfall and temperature can be found in appendices 2 and 3 respectively.

Figure 4.6: Scatter plot showing the relationship between annual rainfall and mean annual temperature



Source: Field survey, 2009.

Figure 4.6 clearly shows the relationship between the annual rainfall and mean annual temperatures. The basis of this graph is to test the hypothesis that "local climatic change is responsible for intense rainfall that causes flooding along the Aboabo river". From the graph, it is clear that there is a weak relationship between annual rainfall and mean annual temperature as of now. Even though the relationship is positive meaning that temperature has some influence on rainfall, it is quite weak and may indicate that climate change is not yet a major issue so far as flooding is concerned in the Aboabo river basin. Figures 13 and 14 in appendix 3 show an interesting trend of increasing rainfall over the last 31 years. The average rainfall over this period was 1318.48 mm. Thus, the origins in the graphs represent

the mean annual rainfall figure of 1318.48mm. There are however deviations from this average which peaked in the year 2007 at 476.02mm. This is not surprising and could account for the many floods which occurred in the year 2007. From table 11 and figure 13, it is clear that rainfall patterns have been changing over time. In 1982 and 1983, rainfall values decreased by -427.48mm and -366.48mm respectively. This was far below the average rainfall over the period. This is attributable to the period of drought the country experienced in these years. It can be observed however from the trends in the table 11 and the figures 13 and 14 that the occurrence of above-average rainfall was gradually increasing over time. With more rainfall into the Aboabo basin, the incidence of flooding also increases since excess discharge in channel naturally overflow and inundate adjacent lands. This is one of the reasons why flooding within the Aboabo basin have been occurring more frequently in recent times.

There was the need to consider temperatures trends over a period of at least 30 years in order to discuss the effects of climate change on incidence of flooding in the Aboabo river basin. In appendix 4, the table 12 and figures 15 and 16 generally show an increasing trend of temperatures over the 31 years under scrutiny. Mean annual temperature over this period was recorded as 26.84°C. Deviations were therefore calculated from this average. Thus, the origin of the graph above represents the mean annual temperature.

It was very clear that average temperature changed by -0.75°C in 1978 and 2.14°C in 2007. Temperature has increased slowly over the last 30 years. In 2003 for example, mean annual temperature was as high as 29.15°C, an increase from the 1978 figure of 26.09°C. Rising temperatures could lead to increases in evaporation

from the river as well as evapotranspiration from the basin and thus increased rainfall. The fact that most water bodies including the Aboabo river have been exposed to direct sunlight accompanied by rising average temperatures lead to increased evaporation. Again, the soil upon drying up of its antecedent moisture becomes compact and does not allow easy infiltration and so generates excess runoff in the basin. All these lead to the incidence of floods in general and more specifically in the Aboabo river basin. This is because more rainfall implies more discharge for the Aboabo river, the excess of which inundates the flood plains of the river which unfortunately is inhabited by human settlements.

4.7 EFFECTS OF FLOODING

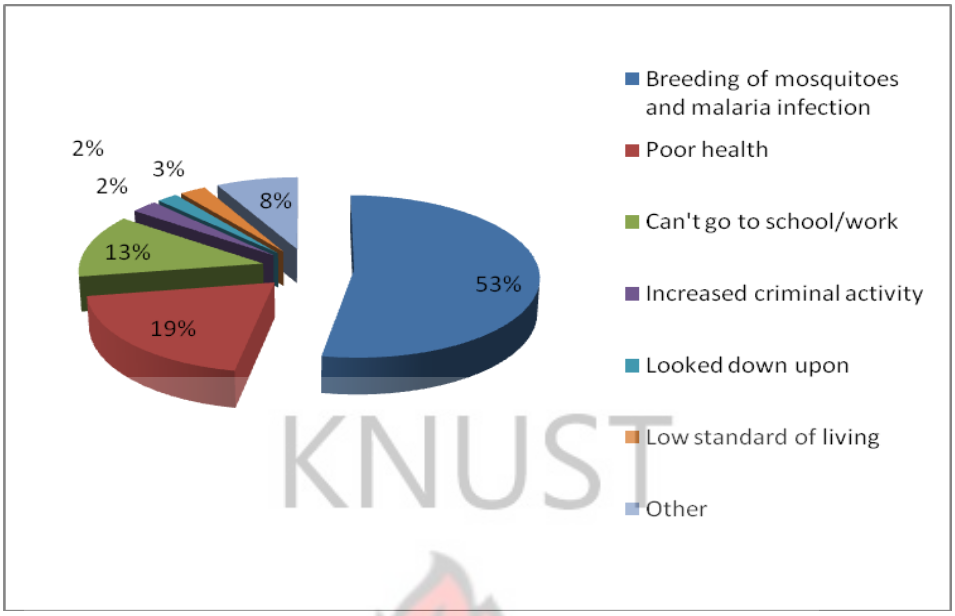
One important objective of the research was to find out the effects of flooding in the Aboabo river basin. The proposition that the causes of flooding in the communities along the Aboabo river are both natural and man-made in nature, was to propose that flooding could be caused by the nature of the river to overflow its banks when the channel capacity is exceeded on the one hand while the activities of humans also contribute to flooding. This section of this chapter will throw more light on the effects of flooding. The effects have been divided mainly into social, economic, housing (structural), and others.

4.7.1 Social Effects

Figure 4.7 indicates the main ways through which communities are affected socially by flooding. The main effect here, according to respondents, is the breeding of mosquitoes and malaria infection (52.91%) followed by poor health (19.49%), inability to go to school or work (12.66%), increased criminal activity (2.53%), low

self esteem (2.03%), low living standards (2.53%) and others. An unhealthy person obviously cannot contribute meaningfully to the development of a society and sometimes becomes a burden to those around him. More money is spent on treatment of water related diseases especially malaria due to the breeding of mosquitoes from stagnant dirty or muddy water which remains after the floods for a while before drying up. The environment thus becomes susceptible to the outbreak of diseases such as malaria and cholera. Students and workers in these communities cannot go to school or work. During this period, crime increases since thieves take advantage of the situation to steal properties belonging to victims of the floods. All these lead to a low living standard in these areas since money is spent annually to repair or replace broken properties or properties carried away by flood waters. Little money is left to maintain a good living standard which is basically living comfortably in a safe, healthy environment and earning enough to provide food, shelter and other basic needs for one's self and the family. Flooding situations have also led to a low self esteem among members of these communities. During floods, the smooth function of society is affected with the direct consequences borne mainly by members of affected communities.

Figure 4.7: Social Effects of Floods



Source: Field survey, 2009

4.7.2 Property Damage

Another unfortunate effect of floods in the Aboabo basin is that of property damage. Properties destroyed by flood waters are mainly household furnishings and appliances such as furniture and electric appliances including television sets, radios and sound systems. Almost sixty percent of respondents made this claim. Other properties are also destroyed as can be seen in table 4.3 and all these bring untold difficulties into the lives of victims.

Table 4.3: Property Damage due to Floods

Property damage	Frequency	Percentage
Cloths, foodstuff and cooking utensils	67	17.0
Interior room properties and electric appliances	235	59.5
Schools books, bags and shoes	56	14.2
Building material	5	1.3
No property damage	14	3.5

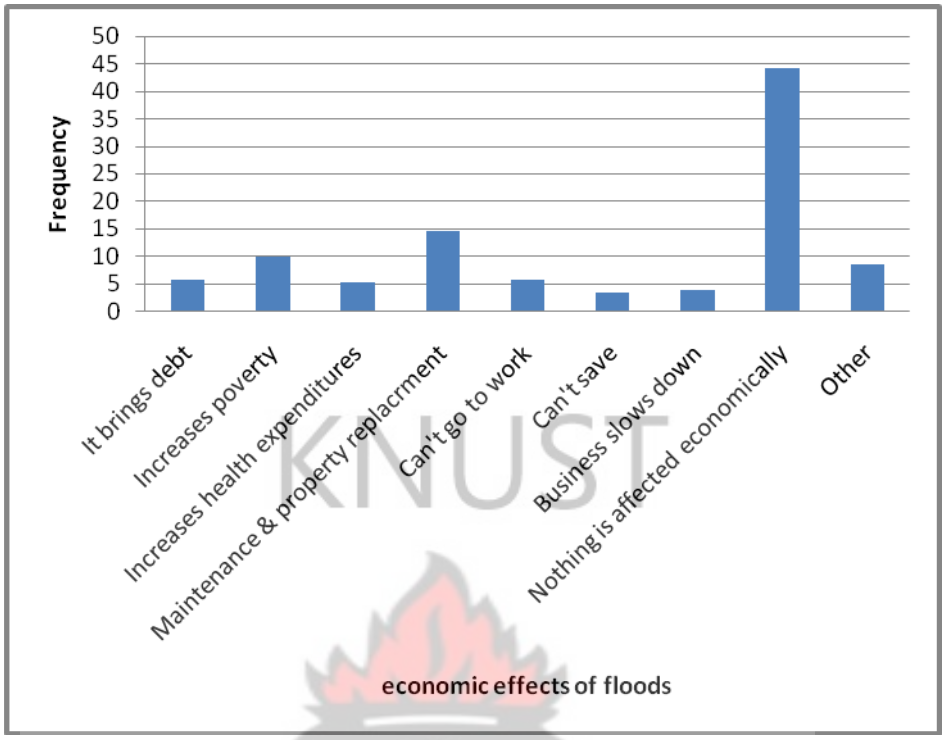
Other	18	4.6
Total	395	100.0

Source: Field survey, 2009.

4.7.3 Economic Effects of flooding

A very interesting assertion was made by respondents so far as economic effects of flooding are concerned. As many as 44.05% of the respondents believed there were no economic effects of flooding in the Aboabo basin at least as far as they are concerned. These respondents are generally those working in the civil service, unemployed or self employed with their businesses located in other parts of the metropolis such as the Central Business District (CBD). Since their livelihoods are not directly affected, they believed that the floods did not have direct economic effects on them though they may have experienced it indirectly. However, more than 50% of respondents believed that they were economically affected at least one way or the other. These effects included increased poverty (9.87%) and increases in health expenditures (5.06%) as well as expenditures on maintenance and replacement of damaged or lost property (14.43%). Also, floods led to loss of productive man hours such that incomes reduced since people could not go to work (5.57%) and so focus and diligently earn their livelihoods and also save part of their incomes (3.29%) or plough back profits to increase productivity since a lot more expenditures have to be made. Economic activities especially among members of communities found in the Aboabo river basin slow (5.57% of respondents) down and in some cases ground to a halt for severely affected areas. Figure 4.8 gives a firsthand impression of economic effects of flooding in the Aboabo basin.

Figure 4.8: Economic Effects of Floods



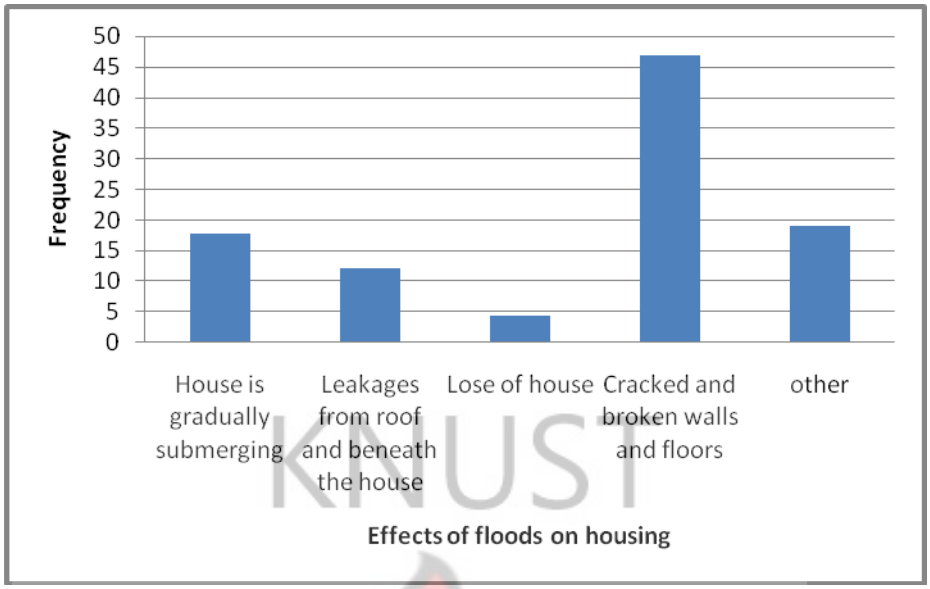
Source: Field survey, 2009.

4.7.4 Effects on physical structures (e.g. housing)

Flooding also affects the built up environment considerably. It was observed in the field that many structures were affected by the floods with the foundations of some buildings exposed and some uncompleted buildings and completed ones as well abandoned as a result of this annual occurrence.

Figure 4.9 shows clearly that floods in the Aboabo basin affected the built up environment in the basin especially in structures like houses in the communities. The main structural effect of floods according to respondents was cracked and broken down walls and floors (46.84%), leaking roofs (12.15%), gradual submergence of houses (17.72%) and in some cases loss of houses (4.30%). These can be observed from figure 4.9.

Figure 4.9: Effects of Floods on Housing



Source: Field survey, 2009.

Figure 4.10: Picture showing abandoned house due to incidence of flooding

Source: Field survey, 2009.

4.7.5 Other types of effects

The other types of effects of floods were mainly physical in nature. The floods caused serious erosion leading to the formation of gullies in some cases. The floods also left the area muddy and filthy leaving behind some of the load it carried in its rushing waters. It also brought along reptiles (such as snakes) and worms among others which could harm people living in the communities along the river Aboabo. All these observations were made during visits to the affected communities.

Figure 4.11: Picture showing filthy and muddy environment leading to the construction of a footbridge by residents.

Source: Field survey, 2009.

4.8 COPING STRATEGIES OF RESIDENTS TO FLOODS

The question of how residents were coping with this phenomenon was inevitable for the study. Only 2% of respondents indicated that some agencies or organisations came to their aid during the floods through rescue efforts to save lives and property. The remaining 98% stated otherwise with residents devising their own coping strategies to survive during and after the floods.

Since no organisation came to their aid, what did the members of the communities do to help themselves before, during and after the floods? Before the floods set in, efforts are made to clear choked gutters (1.3%) while temporal drains and bridges are constructed in some cases (20.3%). 11% of respondents fill sacks with sand and stones putting these at the entrance of their houses to prevent flood waters from entering their homes. Only 2% of respondents just abandon their homes till the floods subside but 41.3% of respondents do nothing before the floods set in. These activities took place before the floods actually occurred.

Thirty-four percent (34%) of respondents claimed they simply stayed indoors when the floods occurred. Forty point three pecent (40.3%) abandoned their houses for their own safety when the floods actually occurred. Nineteen (19%) made efforts to safeguard their most valuable properties with the others (1.5%) climbing up to the roofs and trees to escape the flood waters. 0.8% of respondents simply collected and threw out water as it entered their homes. Unfortunately, others (2.0%) were unable to do anything and just had to bear the brunt of the floods anytime they occurred. This is rather unfortunate since such people (e.g. the aged and the sick) could easily lose their lives or be seriously injured.

After the floods, 59.2% of respondents indicated that they put their homes in order. Those who abandoned their homes (8.9%) return and then clean up the place as best as they can. Less than one percent (0.8%) of respondents searched for lost properties hoping to find them. Far less than one percent (0.3%) of respondents indicated that they sought for funds to undertake repair works, replacement of lost items and generally, return to normal life. There is generally a lot of fixing and drying after the floods. Unfortunately, reptiles and other dangerous animals may remain hiding in homes exposing people to risk of snake bites and other health hazards.

The question then was, how were respondents generally coping with this annual hazard? Table 4.4 is a summary of the coping strategies adopted by people living in the flood prone areas in the Aboabo basin. Are these strategies sustainable? These strategies are more useful in the short term. In the long term however, it would be necessary for government to consider putting up affordable housing to relocate people living in the flood plain of the Aboabo river as a lasting solution to the problem of annual floods.

Table 4.4: Strategies adopted to cope with the danger of floods

Coping with the danger of floods	Frequency	Percentage
Stay with friends and/ or relatives	88	22.3
Build walls/ steps to block the flood waters	134	33.9
Construct temporary bridges to access our property	77	19.5
construct temporary drains	22	5.6
Clear choked gutters	66	16.7
Other	8	2.0
Total	395	100.0

Source: Field survey, 2009.

4.9 FLOOD PREVENTION AND MANAGEMENT

Belief in flood prevention

Only 46.1% of respondents believe that the incidence of floods which occur annually in the Aboabo basin can be prevented while 53.9% believe floods cannot be prevented. Those who believed in flood prevention gave their opinions on how this can be achieved. Table 4.5 is a summary of suggestions made by respondents on how to prevent flooding in the Aboabo basin.

Table 4.5: Flood Prevention

Flood Prevention	Frequency	Percentage
Construct defence wall/big gutter for the river	149	37.7
Demolishing of structures on waterways and along the river bank	8	2.0
Dredging the Aboabo river	2	0.5
Clearing choked gutters frequently	10	2.5
Stop dumping refuse along and into the river	7	1.8
Building houses at the right places	4	1.0
Other	2	0.5
Not applicable	213	53.9
Total	395	100.0

Source: Field survey, 2009.

Clearly, as indicated in the table, majority of respondents making up 37.7% of respondents believed that a defence wall or a big gutter should be constructed around the river. Two percent believe demolishing of structures in water ways and along the river bank would help while 0.5% and 2.5% respectively suggested that the river

should be dredged and choked gutters be cleared. 1.8% of the respondents also believed that people should stop dumping refuse into and on the banks of the Aboabo while 1.0% claimed that houses should be built at the right places to prevent flooding. It is interesting to note that those making these beautiful suggestions were themselves living very close to the water or dumping their waste materials into the river. Thus, most people seemed to know the right things to be done so why were they not doing them to prevent the floods from affecting them and who was responsible for ensuring that the right thing is done?

Table 4.6: Reports made to authorities about annual floods

Flood report to authorities	Frequency	Percentage
Yes	65	16.5
No	330	83.5
Total	395	100.0

Source: Field survey, 2009.

From Table 4.6, it can be seen that only 16.5% of respondents had reported to the authorities in charge. Reports had been made mainly to the Assembly man or Unit committee members of their respective communities with a few people reporting the problem of flooding in the Aboabo basin to KMA. Just 21% of respondents however were aware of efforts made by the KMA to curb the situation. These efforts include dredging of the Aboabo river, clearing of choked gutters and stopping people from dumping refuse into the river. It was observed in the field that sand mixed with refuse dug up from the river basin during the dredging of the Aboabo was dumped just at the river's bank which has raised the banks a bit. Unfortunately however, the refuse in this artificial levee, apart from encouraging people from continually

dumping refuse on the banks of the Aboabo river, also constitute a health hazards to inhabitants of the basin due to the poor sanitation and breeding of mosquitoes and other insects such as houseflies which contaminate food and make people sick.

Table 4.7: Flood prevention

Possibility of preventing floods	Frequency	Percentage
Yes	129	32.7
No	266	67.3
Total	395	100.0

Source: Field survey, 2009.

Some members of the communities (32.7%) also claimed that they had made efforts to prevent flooding in their respective communities by reporting to authorities but to no avail and they contribute money and do discuss proper means of waste disposal and relocating habitants around the Aboabo river. As indicated in Table 4.7, 67.3% of respondents had made absolutely no attempt at flood prevention claiming that there was nobody to talk to since nobody cared about them and the situation was beyond their control. They also claimed the community layout was poor with some simply saying that nothing has been done. The reasons given by the latter are quite lame and only an attempt to blame everybody else except themselves.

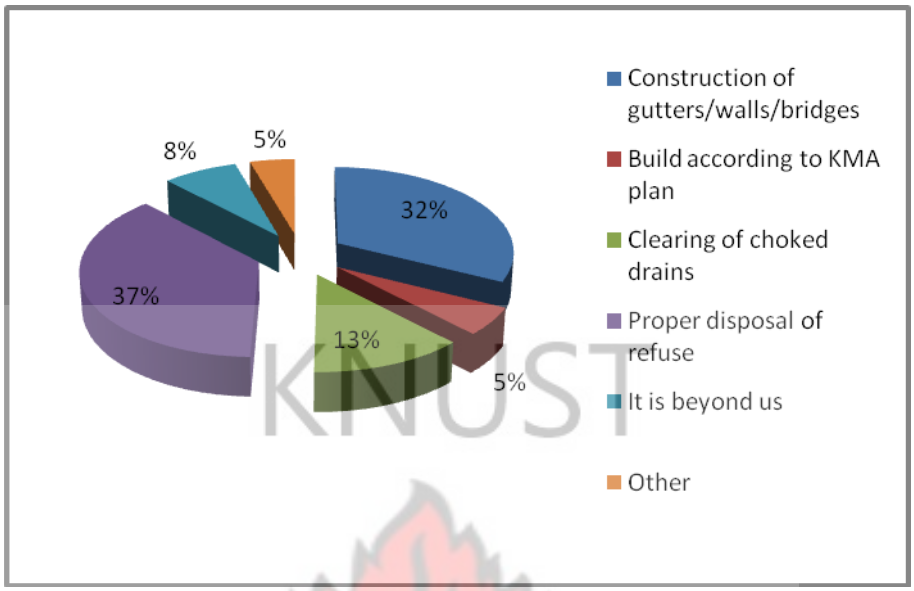
4.10 MITIGATION OF FLOODING

Enquiries were made in the field to find out the various ways in which the problem of flooding could be effectively dealt with. The researcher wanted to know what the various stakeholders such as households, the communities, the Kumasi Metropolitan Assembly and the Central government could do to improve the situation at hand.

4.10.1 Households:

Thirty-four point two percent (34.2%) of the respondents believed that the construction of bridges, gutters and walls would help channel the flood waters appropriately to either prevent or reduce the overflow of discharge from the Aboabo river. Five point three percent of the respondents also indicated that individuals who make up the households should obtain proper permits so that they can ensure that they are following the master plan of the metropolis. Thirteen percent 13% of the respondents also believed that choked gutters should be cleared while 7.59% of respondents claimed that the situation was beyond them. 37.47% of the respondents however believed that households should properly dispose of their waste products. This group clearly indicated that waste disposal was a major contributing factor to the problem of flooding since the Aboabo river is choked with all sorts of waste materials impeding the smooth flow of discharge and causing the excess river water to overflow onto the adjacent land. Figure 4.12 summarise the views of households about mitigating floods.

Figure 4.12: Solving the Problem of Flooding by Households- views from respondents



Source: Field survey, 2009.

4.10.2 Community

Sixty-five point eight percent of the respondents believed that communal labour was needed to clean the Aboabo river as well as the few gutters in the Aboabo basin so that flood waters flow freely through these respective channels thus improving the flood situation. Seventeen point five percent said that refuse should be put at properly designated places in respective communities. All these are necessary in order to ensure proper land use in the various communities in other to ensure that proper sanitation is maintained and the Aboabo as well as the gutters are free of impediment and able to carry flood waters without it spilling over. One point three percent (1.3%) of the respondents indicated that communities should also ensure that houses are not built along or close to the river bank while 2.0% said that people should be educated about the flood problem. 8.6% proposed that defence walls, drains and bridges should be properly constructed to reduce the effect of flooding on

inhabitants of the Aboabo basin. Table 4.8 summarises the views of respondents so far as the contribution of the respective communities to flood mitigation in the Aboabo basin is concerned.

Table 4.8: Mitigation by Communities- views from respondents

Mitigation by Communities	Frequency	Percentage
Communal labour to clean gutters and the river	260	65.8
Put refuse at designated places	69	17.5
Houses should not be built along the river bank	5	1.3
Conscientize people about the flood problem	8	2.0
Construct defence walls/drains/bridges over the river	34	8.6
It is beyond us	8	2.0
Other	11	2.8
Total	395	100.0

Source: Field survey, 2009.

4.10.3 Kumasi Metropolitan Assembly (KMA) and sub metros.

The Kumasi Metropolis is governed by the KMA whose duty it is to ensure the proper planning of land use in the metropolis while ensuring that people are able to live safe and healthy lives. KMA must also ensure that proper sanitation is maintained in the metropolis. These are some of the reasons why various departments under the KMA have been established to undertake specific duties thus ensuring that all is well in the metropolis.

Table 4.9: Mitigation by Kumasi Metropolitan Assembly (suggestions from respondents)

Mitigation by district assembly	Frequency	Percentage
Clear choked gutters	20	5.1
Construction of gutters and walls	159	40.3
Dredging the Aboabo river	23	5.8
Relocate us	6	1.5
Restructure/Replan the area	22	5.6
Pull down houses on water ways and ensure proper permits for building houses	48	12.2
Establish designated place for dumping and provision of dustbins	103	26.1
Other	14	3.5
Total	395	100.0

Source: Field survey, 2009.

Respondents indicated clearly what they expect from KMA in mitigating floods in the Aboabo basin. Almost 6% of the respondents expected KMA to dredge the river Aboabo. Only 1.5% said KMA should relocate those staying on the flood plain with 5.6% suggesting a restructure or replan the area and 12.2% claimed that buildings in the waterways should be pulled down while ensuring that proper permits are obtained such that proper land use practices are encouraged. Residents confirmed that the Kumasi Metropolitan Assembly had facilitated the dredging of parts of the river about three years ago. However, only areas where residents were able to pay monies to help undertake the project were dredged leaving other areas even more prone to flooding. Sediments and debris from the river bed has been deposited on the banks of the river, creating some form of levees to help hold back flood waters. However, the refuse mixed with the sediments on the banks of the river may pose a health threat to residents living very close to the river banks and leaves much to be desired so far as proper sanitation is concerned. On the other hand, these

embankments may be gradually washed back into the river during heavy downpour of rain. One very important suggestion made by respondents was the need for KMA to provide areas and containers for refuse disposal. Even though this suggestion was made by only 26.1% of the population, it is a very critical point. This is because observations made in the field showed that the areas provided were either inappropriate or insufficient. Thus, refuse containers are not emptied often enough and refuse dumps are overflowing. There is no control and KMA has looked on as respondents dumped refuse in and along the banks of the Aboabo river with others even defecating into it. Proper waste disposal will go a long way to curb the problem of flooding in the Aboabo basin.

4.10.4 Central Government

The Central government is represented in by the KMA in the Kumasi metropolis. Table 4.10 summarises what respondents expect from the central government in mitigating floods in the Aboabo basin. 71.9% of respondents believe it is the duty of the central government to ensure that proper gutters and bridges are built to provide proper channels which are big enough to carry flood waters away.

Table 4.10: Mitigation by Central Government- views from respondents

Mitigation by Central Government	Frequency	Percentage

Provision of Financial and other resources	36	9.1
Construction of gutters, bridges and walls	284	71.9
Redevelop the area	5	1.3
Pull down houses without permit and on waterways	4	1.0
Relocate us to affordable housing	29	7.3
Dredging the Aboabo river	7	1.8
Bring us relief items	1	.3
Other	29	7.3
Total	395	100.0

Source: Field survey, 2009.

The respondents (9.1%) also believe that the government needed to provide sufficient financial and other resources to respective department to enable them carry out their mandate well. This was an interesting assertion since interactions with a few institutions indicated that there was not enough resources; financial, logistics or otherwise to function properly and effectively. Seven point three percent (7.3%) of respondents suggested that government's provision of affordable housing for them to relocate would be very helpful. Only 1.0% of respondents believe that pulling down houses without permit and on waterways would help remedy the situation. This is not surprising since a lot of the respondents themselves had no permits and were living rather too close to the Aboabo river. The government however has very meaningful views from respondents to consider when developing appropriate policies to deal with this hazard.

The tables and graphs as well as pictures analysed in this chapter give a clear indication of the severity of flooding in the Aboabo basin and the suggested solutions to the problem.

CHAPTER FIVE

INSTITUTIONAL PERSPECTIVES OF FLOODS IN THE ABOABO BASIN

5.1 Introduction

After obtaining responses from carefully selected individuals in the study area, efforts were made to obtain some explanation to observations made in the field and also to verify the truth of the matter as to the causes and effect of flooding in the Aboabo river basin. Responses from these institutions are briefly discussed below.

5.2 Town and Country Planning Department (TCPD)

According to the TCPD, their functions include the formulation of long term comprehensive plans technically referred to as strategic plan; preparation of land use planning schemes to guide spatial development which is done through revision of planning schemes, rezoning, rectification of planning schemes and regularizing of layouts. They also perform the functions of development management or control, development promotion and research into emerging land use problems in the Kumasi metropolis as well as the provision of advice to the District Assembly.

The department played its role in flood control and prevention in the Aboabo river basin. They indicated that they relied on maps from the Survey department which showed flood levels in respective areas in the metropolis including the Aboabo basin. These areas are to be used as nature reserves according to the plans produced by the TCPD. The nature reserve is made up of vegetative cover which would protect the river Aboabo. The department indicated that it was not their duty to

ensure enforcement of these plans and were not certain whether the Aboabo nature reserve was actually in place. They were aware of a project by city authorities to provide concrete gutters to properly channel the river. They collaborated with agencies such as the Lands Commission, Survey Department, KMA, Utility companies and even the citizenry including landowners when developing land use maps. Unfortunately, they were not satisfied with the level of collaboration because a lot of land owners do not abide by the zoning plans when developing their pieces of lands.

The TCPD indicated that they were poorly resourced and did not have enough human resource with only four planners manning the 10 sub metros of the KMA. Ideally, the number should be about 14. They had no computers for the use of modern software such as the Geographic Information Systems (GIS). There were also only two vehicles available to the TCPD one of which was 30 years old and not working. They indicated also the Act 462 which the department was governed by was inadequate. In an attempt to help itself, they tried to generate funds internally by charging a fee from the members of the public who came to them for plans but were stopped by the auditors in charge and so cannot use the money generated.

The TCPD indicated that people in the Aboabo basin suffer from annual floods due to the buildings situated in nature reserve zones thereby removing vegetative cover and encouraging erosion the process of which leads to the siltation of the Aboabo river and consequent flooding. They indicated that to remedy the situation, households should not farm or build so close to the river, dump refuse or defecate into the river. Unit Committees should also function well by organising members of

the community to check out developments in the Aboabo nature reserve and then report to the Assembly man and authorities in charge. They added that the central government needed to provide adequate policies and resources especially financially and logistically to various departments and agencies to enable them perform their roles and enforce the law to ensure proper land use and sanitation practices in the Aboabo basin. The TCPD itself believe that it should continue providing appropriate plans and the other stake holders such as chiefs and their subjects as well as the KMA should ensure that they are adhered to and trees are planted in the nature reserves, to protect the Aboabo river.

Observation made by the researcher at the TCPD revealed a very inefficient environment and obsolete manner of doing things in general. Plans and other records were not well kept simply because there was no place to keep them. There were also no current copies of plans or even soft copies of them to ensure easy access. Although the nature reserves could be seen around the Aboabo river in the plan made, the situation was very much the opposite in the field and since the department could not make new plans, it was even difficult to tell of the current state of these nature reserves. This is rather unfortunate. The TCPD must be well resourced to enable them effectively play their very important role in ameliorating the problem of flooding in the Aboabo river.

5.3 METROPOLITAN WASTE MANAGEMENT DEPARTMENT (MWMD), KUMASI

According to the mission statement of the MWMD, the department is 'to keep the Metropolis clean and healthy by ensuring the efficient and effective removal and safe

disposal of solid and liquid waste from all premises and public spaces to create an enabling environment for development and recreation'. The functions of the MWMD are as follows:

- Keep the metropolis tidy
- Clear away mess and nuisance
- Develop and continuously update a metropolitan environmental sanitation plan
- Educate the public on how to keep the local environment clean
- Provide conveniently situated refuse disposal points
- Remove solid waste
- Dispose of waste safely
- Identify needs for public toilets
- Manage public toilets
- Manage promotion and subsidy programs for household toilets
- Evacuate liquid waste from homes and public toilets
- License and enforce standards on private liquid waste hauliers
- Manage sullage disposal
- Cleanse and carry out routine maintenance of drains

The question therefore is why is waste disposal such a major problem in the Aboabo river basin and why are people dumping refuse indiscriminately and choking the Aboabo river and other drains in the process?

The MWMD has no special regulations to control activities in flood prone areas such as the Aboabo river basin but believe that improper waste disposal activities are responsible for the annual floods in the Aboabo although it is not the only cause.

The department was however aware of projects aimed at reducing the incidence of flooding in the Aboabo river basin. They were aware of the construction of a 2.5km storm drain from the Airport roundabout to the Anloga junction to reduce flooding. The second phase of the project which will start from the Anloga junction to the High School junction was being evaluated.

MWMD had also taken specific action to prevent flooding in the Aboabo river basin. Granted that improper waste disposal was a major cause, the Kumasi City wide Waste Collection levy scheme was launched. People were supposed to pay for waste collection. 10 Ghana pesewas per head load was charged for communal collection and 3 to 5 Ghana cedis charged monthly for house to house collection. Those in the Aboabo basin usually accessed the former but only very few people paid. The majority dump their waste free of charge into the Aboabo river instead. Decongestion exercises organised by the department from time to time along the banks of the Aboabo river did not help much since people only stayed away for a while and then returned to the same place again since the MWMD could not continue monitoring for very long. The department indicated that it was NADMO's duty so far as flood management in the Aboabo basin was concerned and so they played no role in that.

According to the institution, they were also poorly resourced. Although they had enough human resource to operate, they were in dire need of adequate funds to undertake maintenance and where necessary, purchase new equipment for operation. Due to the inadequacy of logistics and equipment, the department was forced to hand over the 20% of contracts they were entitled to handle to private operators. There

was also a problem with enforcing the law because of the human face of the department and the political climate in the country. For instance, decongestion exercises and prosecution of those who break sanitation rules in the metropolis fail because the offenders go free since they always find influential people to plead on their behalf and set them free. MWMD however indicated that efforts were being made to address these challenges. For example; the Urban Environmental Sanitation Project which is a World Bank project is funding the Aboabo storm drain project and the re-equipping of the mechanical section of the department. Also, the Kumasi City wide Waste Collection Scheme was another effort to address the financial challenges of the department but the effect of the political season (electioneering period of 2008/2009) brought everything to a halt.

The department collaborated with the Town and Country Planning Department (T. & C.P.D.), Urban Roads Department and the Public Works Department (PWD) through regular meetings to manage and prevent flooding in the Aboabo river basin. They also involved the residents by holding community meetings to inform the public of major projects. For example, some settlers will be moved from the banks of the Aboabo river for the construction of the storm drain. Eighteen buildings will be affected (pulled down). These people had been informed and would be duly compensated. The residents participated fully in the activities of the department since they are able to freely approach the MWMD whenever the need arises.

The causes of flooding identified by the department include indiscriminate dumping of refuse into and around the Aboabo river, encroachment of the flood plain and increased run-off due to the built up environment being so close to the river which

causes flooding. The MWMD believed that the laws must work and be enforced and people should just stop dumping refuse into the Aboabo which blocks it if the problem of flooding is to be solved. The MWMD itself pointed out that it must enforce its rules and regulations and deal with offenders according to the law. KMA must also motivate the Building Inspectors to make them work hard. According to the MWMD, the central government should employ more Building Inspectors and pay them well so that they would not take bribes and allow people to build in the nature reserve around the Aboabo.

The MWMD has been making efforts to ensure that people do not dump refuse in and around the Aboabo river but their efforts have been woefully inadequate hence the annual floods in the area. They must think of better alternatives to ensure that the right thing is done especially in the Aboabo basin since their inactions may lead to the total destruction of the stream and the outbreak of water related diseases.

5.4 NATIONAL DISASTER MANAGEMENT ORGANISATION (NADMO), KUMASI

Among the functions of NADMO is to coordinate activities of all stakeholders in disaster management and educate the public on prevention of man-made disasters. The department did not have any special policies or activities for flood prone areas including the study area and also had financial, logistics and equipment as well as legal challenges which the KMA had tried to solve but to no avail. NADMO believed that pollution of the river was the main cause of flooding and so people should stop dumping refuse into the river to block it and communities should clean up the river and its surroundings through communal labour. NADMO was also to

call on the MWMD to desilt the river and educate the people to stop polluting it while the Central Government through the TCPD was to zone the area to ensure that people did not stay there and also provide resources for this to be done.

Observations made by the researcher at the NADMO office were quite shocking. The building they were occupying was inappropriate for an office. It was poorly maintained. There were no computers in the place for serious work to be done. NADMO also seemed to have no records at all and could hardly provide any information requested for. There were no available records on the Aboabo floods which was unbelievable since the situation was so serious that abandoned completed and uncompleted buildings could be found along the Aboabo with residents in the study area even alluding to the fact that they sometimes find dead bodies after the floods. It was clear that the department was not serious with its mandate and needed a lot of motivation to perform their functions with seriousness. The department was simply not concerned enough to help solve the flooding problem in the Aboabo basin.

5.5 GHANA METEOROLOGICAL AGENCY (GMA), KUMASI

The functions of the GMA include observation of the weather, compilation of meteorological information observed, analysis of data based on which forecasting is done and serving the general public, i.e. providing information/data to all who need it e.g. farmers, contractors, shippers, etc.

The agency had no special schemes or regulation for flood control in flood prone areas but believed that giving prior warning of heavy rainfall alerted people in such areas as well as NADMO to prepare for the floods instead of them being taken

unawares exposing them more directly to the danger of the floods. To help manage floods in the Aboabo basin, the GMA meets with NADMO periodically to discuss issues concerning flooding to give their input towards education and cautioning for example; by informing to them to educate people living in low lying areas. These meetings usually took place before the rainy and dry seasons respectively.

The agency is really under staffed with no opportunities for further training by the few staff it has. They are unable to obtain adequate funds for training and to buy modern equipment to replace obsolete ones. The GMA is sometimes forced to borrow equipment to use depending on the benevolence of others to carry out certain operations. GMA used to be a department and is yet to have the legal backing to function effectively as an agency. They were waiting on the new government to set a board of directors who can help remedy the situation. The past board made some plans to help but were unable to carry them out.

Asked what they thought were the causes of flooding in the Aboabo river basin, they indicated that human activities such as dumping of refuse to choke the river and its culverts and building in the flood plain were key. The GMA however involves the citizenry in their activities. For example, they host many students on educational trips to their facility and also provide weather reports/forecasts to everybody. The citizenry also participate fully by coming to them from time to time for advice concerning the weather. For example, building contractors do so to be able to set out their working schedules taking the weather into consideration.

The GMA advised that to solve the flooding problem in the Aboabo basin, people should stop choking the river and other drains with refuse and stop building in the

water ways, communal labour should be organised to clean up the river's environs, desilt gutters and especially burn rubber waste, the agency must always give warning ahead of time to allow people prepare for the floods while central government enacts and enforces laws to prevent haphazard development in the area.

Observations made by the researcher at the GMA shows that the agency has been given a face lift. Unfortunately however, the agency needs more equipments and resources especially human resource to be able to function properly. The agency was unable to give rainfall data on specific areas in the metropolis such as the study area. They should probably be resourced to enable them set up more weather stations in the metropolis and specifically in the study area.

The institutional perspectives are important in understanding the flooding problem in the Aboabo basin. It is clear that they would like to play their roles in salvaging the situation but for lack of adequate resources. Even though work is on going to make the river bed concrete, there is still the problem of settlements in the nature reserve and the possibility of transferring the problem of flooding further downstream to other areas. The views of the institutions have proven useful in the further understanding of the problem of flooding in the Aboabo basin and how to solve it.

CHAPTER SIX

SUMMARY OF FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

6.1. SUMMARY OF FINDINGS

Interesting observations were made from the research undertaken. The major findings of the study are summarised below with reference to the objectives set for the study.

6.1.1. Causes of flooding

It is clear that flooding is indeed a phenomenon that occurs annually in the Aboabo river basin. This would not have been a problem if the flood plains around the river were uninhabited because evidence from physical geography shows that rivers and streams overflow their banks from time to time. However, the Aboabo river basin is occupied by human beings and clearly, their activities have led to and also increased the frequency of floods in the study area. The major cause of flooding identified is the indiscriminate dumping of refuse into and on the banks of the Aboabo river. This impedes the free flow of discharge of the river so the excess overflows to inundate its floodplain.

Climate change on the other hand has led to increases in average temperature and rainfall over the last thirty years. Even though there is a positive relationship between rise in temperature and increased rainfall, this relationship is not very

strong. This means that though climate change is one of the factors which causes heavy rainfall and hence flooding in the Aboabo basin, other factors also play a significant role. With more rain, the Aboabo river is supplied with excess discharge which overflows to submerge adjacent lands. Unfortunately, these lands are occupied by human beings who have to suffer the consequences of this hazard any time it occurs.

Another cause of flooding which was ascertained in the Aboabo basin is the building of all sorts of structures, from churches to houses and business structures very close to the river. Thus, the flood plains of the Aboabo which has been zoned as a nature reserve has been occupied depriving the river of the protection of vegetation which would slow down erosion and the consequent siltation of the river.

Also, the inadequacy of drains in communities within the study area is a major contributing factor. Many of people have constructed temporary drains connected to the Aboabo. Both solid and liquid waste is dumped into the river killing it gradually. It is now difficult to find any type of fish in the river although this was not the case in the past.

The inactions of institutions responsible for controlling land use have also been a major contributing factor to the incidence of flooding in the Aboabo basin. Even though the laws are there, the institutions are unable to enforce them and so the people in the river basin behave anyhow to the detriment of the Aboabo river and the environment as a whole.

Attempts are being made to dredge the drain but this has not helped to reduce sedimentation of the river. The river was dredged not too long ago. However, the

soil and refuse removed from the river bed was dumped along the banks forming man made levees to reduce flooding. Unfortunately, rain water is gradually washing the soil back into the river. Residents are also dumping refuse on the banks thinking that they are helping to build the levee. The health and environmental consequences of this activity could be harmful.

6.2 Effects of flooding

The effects of flooding are both natural and man-made in nature. The people of Aboabo, Anloga, Dichemso and Amakom have suffered a lot from the annual floods in their respective communities.

6.2.1 Natural Effects of flooding

The natural effects of flooding include erosion caused by the flood waters. Observations made in the field showed deep gullies created by the floods. Thus, the physical nature of the land is continually altered. The top soils are being washed away and this has led to the exposure of the foundations of some buildings in the area. These structural effects on buildings in the Aboabo river basin have created lots of problems for residents with some people abandoning their buildings. These buildings are located so close to the Aboabo river that during floods, the buildings are partially submerged in water for long periods. Other natural effects of the floods on structures around it include cracked floors and walls. All these affect the socio economic activities of residents. A lot of vulnerable people especially children and the aged are traumatised by these flooding bouts leading to the separation of family units in some cases since children may have to stay with friends and relations during incidence of floods. A lot of people also live in fear because their buildings are so damaged that they could cave in on them any time.

6.2.2 Man-made Effects

Man-made effects arise due to the fact that people live in these areas, sometimes right next to the Aboabo river. These include the modification of buildings by residents to cope with the floods. Walls and steps are erected to protect buildings and the people living in them. By virtue of the fact that people inappropriately live in the flood plain of the Aboabo river, other socio economic effects including increased expenditures on such things as building maintenance and modifications, health, food and water. The normal flow of life is thus affected. Some respondents indicated that they often have to borrow money to cope with the situation. Others claim that their businesses are affected while some are unable to report to work during the floods. Continuous stay in the Aboabo river basin by people who suffer from flooding annually is unbelievable. Although most of these people would like to leave, they are unable to do so because of socio economic reasons such as the attachment to family and their inability to afford accommodation elsewhere.

6.3 The role of the related institutions

The various institutions the researcher interacted with generally fall under the authority of the KMA. The activities of some of these institutions leave much to be desired. Institutions are generally under resourced especially the Town and Country Planning Department and the National Disaster Management Organisation. They are simply unable to work effectively in the Aboabo basin which is our area of interest and this has simply led to the persistence of the problem. Even though the area around the river has been zoned as a nature reserve, people have put up all sorts structures in the reserve and continue to dump refuse into and along the banks of the river with impunity. Unfortunately, the authorities concerned are not enforcing the

law as they should to the letter for various reasons and so the wrong thing is done all the time. Efforts to dredge the river and clean it up have all proved futile because after these activities, people just go back to create the same problem exacerbating the flooding problem as time goes on.

6.4 CONCLUSIONS

The problem of flooding in the Aboabo basin has gone unnoticed for some time now. It is important to note that the environment and the people who live in it must interact meaningfully to be able to coexist. Unfortunately, people in the Aboabo river basin are living their lives without regard to the river which flows through their communities. All forms of waste material are dumped in and around the river threatening the survival of flora and fauna in the river. Indiscriminate buildings in the area zoned for a nature reserve around the river have exposed the river to direct sunlight and encouraged erosion and siltation of the river. All these, plus the inability of concerned institutions to enforce rules and regulations to protect the river as well as the lives of people living in the river basin have led to the incidence of annual floods in the Aboabo river basin and the exposure of the people to such an environmental hazard. People have to endure danger of the floods and the related high cost and insanitary conditions of living; all of which lead to a vicious cycle of poverty. Also, climate change has led to increases in average temperature and rainfall thus supplying the river Aboabo with excess discharge which overflow to inundate its flood plain.

It is the responsibility of the authorities in the metropolis as well as the people living in the Aboabo basin to ensure that the Aboabo river basin and its occupants coexist harmoniously in the complex system they form without hindering the survival of each other.

6.5 RECOMMENDATIONS

From the findings of the research, the following recommendations to solve the problem are being made. The problem cannot be solved in a day and so the recommendations have been divided into the short term and long term solutions.

6.5.1 Short term mitigation measures

In the short term, the central government should make conscious effort to provide adequate funding to the relevant institutions to be able to perform their duties to the letter. For example, the MWMD should be enabled to properly collect and dispose of waste in the study area.

The laws protecting lives as well as the environment must also be enforced and those who break them appropriately punished to serve as a deterrent to others. If this is done, people will stop building in the nature reserve in the Aboabo river basin and also make a conscious effort to properly dispose of their waste. Regular and effective removal of refuse from the Aboabo basin is essential in solving the flooding problem.

Lastly, appropriate drains which are wider and deeper should be constructed to properly channel the river's discharge through the city. For example culverts should

be big enough and clean to allow the free flow of excess discharge so that streets and other parts of the city are not flooded. Regular dredging of the Aboabo river would be very helpful in checking the flooding problem.

6.5.2 Long term mitigation measures

In the long term, the KMA should develop a program to gradually and effectively pull down buildings and relocate residents in the Aboabo river basin especially those in the nature reserve. This should be based on a well funded program. This is because people may need to be compensated and the alternatives provided should be adequate in order not to make life difficult for people. As the relocation takes place, the nature reserve should be gradually developed by tree planting and maintenance of these plants. If this is done, the nature reserve will be put in place in the long run and the place can be used as a recreational park while still protecting the Aboabo river and the living organisms which live in it.

BIBLIOGRAPHY

Abbott, P. L. (1996). Natural Hazards, Wm. C. Brown Publishers, USA

ActionAid (2006). Climate Change, Urban Flooding and the Rights of the Urban Poor in Africa, Key findings from six African cities, retrieved on 16th February, 2008 from www.actionaid.org

Adams, Augustine Ganiyu (2008). Perennial Flooding in the Accra Metropolis: The Human Factor, unpublished MSc Thesis submitted to the School of Graduate Studies, Kwame Nkrumah University of Science and Technology, Kumasi, Ghana.

Adu S. V. (1992.). Soils of the Kumasi Region, Ashanti Region, Ghana; Memoir No. 8. Soil Research Institute, Kwadaso, Kumasi, Ghana.

AFP: Flooding caused 210 deaths in West Africa, said UN. www.google.com/googlenews. Accessed 19/10/ 2007, 22:48.

Akosomobo Dam, accessed on 18th November, 2008 (1137hrs) from http://en.wikipedia.org/wiki/Akosombo_Dam.

Ayoade, J. O. (1988). Tropical Hydrology and Water Resources. Macmillan Publishers Limited, London.

Bolt, B. A.; Horn, W. L.; Macdonald, G. A. and Scott, R. F (1975). Geological Hazards: Earthquakes, Tsunamis, Volcanoes, Avalanches, Landslides, Floods, Springer-Verlag, New York Heidelerg, Berlin.

Briefing Session for Diplomatic Corps on the flood situation in Upper East, Upper West, Northern and Western regions, Mr Kwamena Bartels, Minister of the Interior, Accra, Ghana; 3rd September, 2007.

Causes of flooding accessed on 17th November, 2008 (1313hrs) from http://hk.geocities.com/ka_kit_one/causes2.htm

Cities Alliance: Kumasi metropolitan Assembly, City Development strategy (2003) http://www.citiesalliance.org/cdsdb.nsf/20b02ca1ee230bd3852568560050ec42/7e7d0a7a39d6491c86256d3d0069bca6!OpenDocument accessed on 20/11/08 (1336hrs).

Daily Graphic: NADMO Damns Bureaucracy, story by Vinokor Mark – Anthony, June 7, 2006 edition

Geology Labs On-line: What is Flooding, accessed on 13th November, 2008 (1330hrs) from http://www.mountain.org/education/multimedia/novag02a.cfm

Geography Drawing Room, Map of Aboabo Basin, Drainage Map of Kumasi, Soil Map of Kumasi, Faculty of Social Science, KNUST, Kumasi

Ghana News Agency publication on the floods in Upper East region in 2007 accessed on 18th November, 2008 (1610hrs) from http://www.ghanaweb.com/GhanaHomePage/NewsArchive/artikel.php?ID-130516.

Ghana Statistical Service, Census Reports on Population, Household and sex statistics of Kumasi Metropolitan Area, Kumasi, Ghana, 2000.

Gold: The Link between Ancient and Modern Ghana, accessed on18th November, 2008 (1520hrs) from http://www.crvp.org/book/Series02/II-5/chapter xii.htm.

High Tidal Waves Cause Havoc in Keta, accessed on 17th November, 2008 (1137hrs) from www.kwavic.blogspot.com/2008/0/high-tidal-waves-cause-havoc-in-keta.html.

Hugget R., Lindley S. Gavin H and Richardson K. (2004). Physical Geography: A Human Perspective, Arnold, London.

Hydrological Services Department: Aboabo Drainage Basin sub-catchment area map accessed in March, 2008.

Hydrological Services Department, Statistics on Aboabo river, Kumasi Metropolitan Area, Kumasi.

Kumasi Metropolitan Assembly, Development Plan 2006 – 2009.

Kumasi Metropolitan Assembly, Profile of KMA, 2007.

Kumekpor T. K. B., Research Methods and Techniques of Social Research, SonLife Press and Services, Accra, Ghana.

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

McGall, G. J. H.; Laming, D. J. C. and Scott, S. C.: Geohazards: Natural and Man-made, Chapman, 1992.

Microsoft Encarta Dictionary (2007)

Nelson, A. Stephen (2008). River Systems and Causes of Flooding, EENS 204, Physical Geoglogy Lecture Notes, Tulane University, accessed on 16th November, 2008 (1400hrs) from http://www.tulane.edu/~sanelson.

Nelson A. Stephen (2007): Flooding Hazards, Prevention and Human Intervention, EENS 204, Physical Geology Lecture Notes, Tulane University, accessed on accessed on 20/11/08 (1745hrs) from http://www.tulane.edu/~sanelson/geol204/floodhaz.htm

Plummer, Charles C. and McGeary, David (1993). Physical Geology, 6th edition, Wm. C. Brown Publishers, USA.

Smith, Keith (2004). Environmental Hazards: Assessing Risk and Reducing Disaster, Routledge Publishers, New York.

The Growth and Poverty Reduction Strategy (GPRS II) 2006 – 2009, National Development Planning Committee (NDPC), Ghana, November 2005.

T.V. 3 News on Flash floods in Turkey read by Roland Walker at 7:55pm on 9th September, 2009.

Wikepedia Free Encyclopedia: List of Cities in Ghana accessed on 13th November, 2008 (1330hrs) from http//en.wikepedia.org/wiki/List_of_cities_in_Ghana

APPENDIX 1

Calculation of sample size

Calculating Sample Size:

$n = N / 1 + N(\alpha^2)$

where n = sample size

N = sample frame = 26,621

α = Standard Error = 5% = 0.05

$n = 26{,}621 / 1 + 26{,}621 (0.05^2)$

= 394.0786

Calculation for stratified sampling:

Total Sample Size / Total Number of Households.

394.0786 / 26621 = 0.0148

Sample from each community:

0.0148 × total number of households in the community

Anloga: 0.0148 × 7694 = 114

Dichemso: 0.0148 × 4156 = 62

Amakom: 0.0148 × 8145 = 121

Aboabo: 0.0148 × 6626 = 99

APPENDIX 2

Calculation of Standard deviation for rainfall.

Standard Deviation = $X - x$

$$x = \sum X / N$$

Where X = Total Annual rainfall

and x = Mean total rainfall

N = total number of years.

Calculating mean annual rainfall:

$x = \sum X / N$

$\sum X = 40873$

N = 31

Therefore,

$x = 40873 / 31$

$= 1318.48$

Calculating Standard Deviation for 2008

Standard Deviation = X – x

= 1452.3 – 1318.48

= 133.82 mm

APPENDIX 3

Table and graphs showing the standard deviations of rainfall

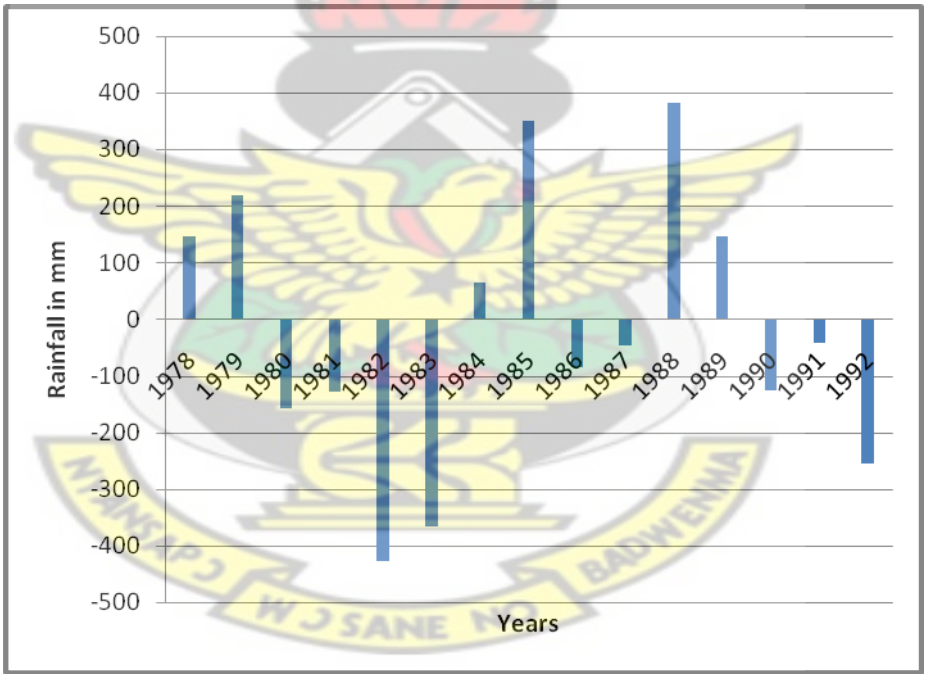
Table 11: Table showing standard deviations of rainfall

YEAR	TOTAL ANNUAL RAINFALL (MM)	STANDARD DEVIATIONS
2008	1452.3	133.82
2007	1794.5	476.02
2006	1159.8	-158.68
2005	1229.3	-89.18
2004	1414.4	95.92
2003	1349.2	30.72
2002	1668.4	349.92
2001	1185	-133.48
2000	1345.2	26.72
1999	1428.9	110.42
1998	1092.3	-226.18
1997	1403.7	85.22
1996	1020.9	-297.58
1995	1327.2	8.72
1994	1109	-209.48
1993	1442	123.52
1992	1063.5	-254.98
1991	1275.8	-42.68
1990	1192.7	-125.75
1989	1464.6	146.12
1988	1700.4	381.92
1987	1272.4	-46.08
1986	1232.6	-85.88

1985	1668.2	349.72
1984	1383.6	65.12
1983	952	-366.48
1982	891	-427.48
1981	1190.4	-128.08
1980	1159.8	-158.68
1979	1538.2	219.72
1978	1465.7	147.22
Totals	**40873**	

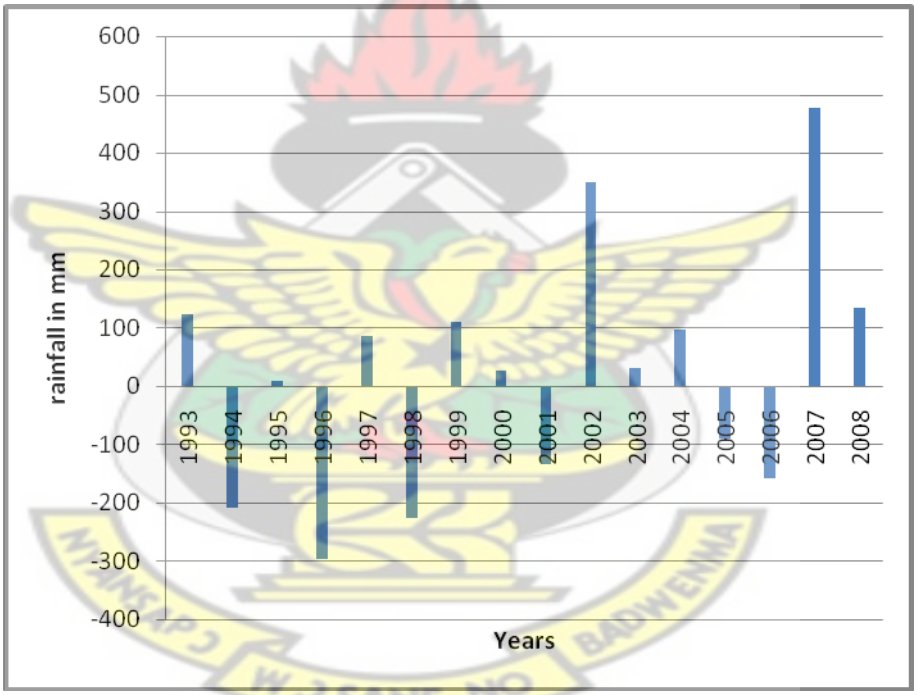
Source: Meteorological Agency, Kumasi.

Figure 13: Graph showing deviations from annual average rainfall (1978-1992)



Source: Field survey, 2009.

Figure 14: Graph showing deviations from annual average rainfall (1993-2008)



Source: Field survey, 2009.

APPENDIX 4

Calculation of Standard deviation for temperature.

Standard Deviation = X - x

$$x = \sum X / N$$

Where X = Total mean annual temperature

and x = Mean total temperature

N = total number of years.

Calculating mean annual rainfall:

$x = \sum X / N$

$\sum X = 831.91$

N = 31

Therefore,

x = 831.92/31

= 26.84°C

Calculating Standard Deviation for 1978

Standard Deviation = X – x

= 26.09 – 26.84

= -0.75°C

APPENDIX 5

Table and graphs showing the standard deviations of temperature (1978-2008)

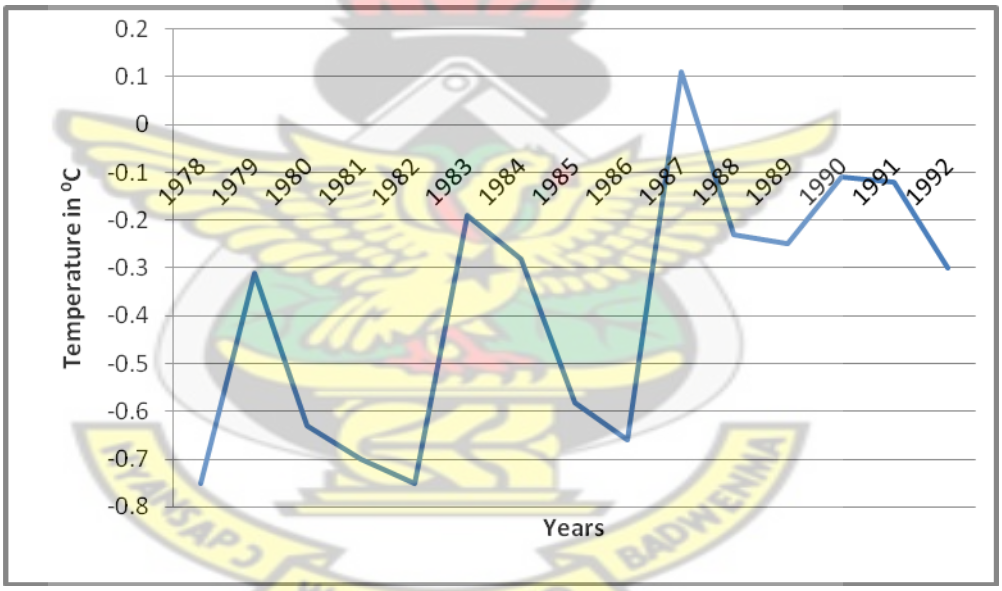
Table 12: Table showing standard deviations of total annual mean temperature

YEARS	TOTAL ANNUAL MEAN TEMPERATURE (°C)	STANDARD DEVIATION
1978	26.09	-0.75
1979	26.53	-0.31
1980	26.21	-0.63
1981	26.14	-0.7
1982	26.09	-0.75
1983	26.65	-0.19
1984	26.56	-0.28
1985	26.26	-0.58
1986	26.18	-0.66
1987	26.95	0.11
1988	26.61	-0.23
1989	26.59	-0.25
1990	26.73	-0.11
1991	26.72	-0.12
1992	26.54	-0.3
1993	26.52	-0.32
1994	26.81	-0.03
1995	28.88	2.04
1996	26.64	-0.2
1997	26.73	-0.11
1998	27.26	0.42
1999	26.7	-0.14

2000	26.56	-0.28
2001	26.8	-0.04
2002	27.01	0.17
2003	29.15	2.31
2004	26.65	-0.19
2005	26.54	-0.3
2006	26.76	-0.08
2007	28.98	2.14
2008	27.08	0.24
Total	**831.92**	

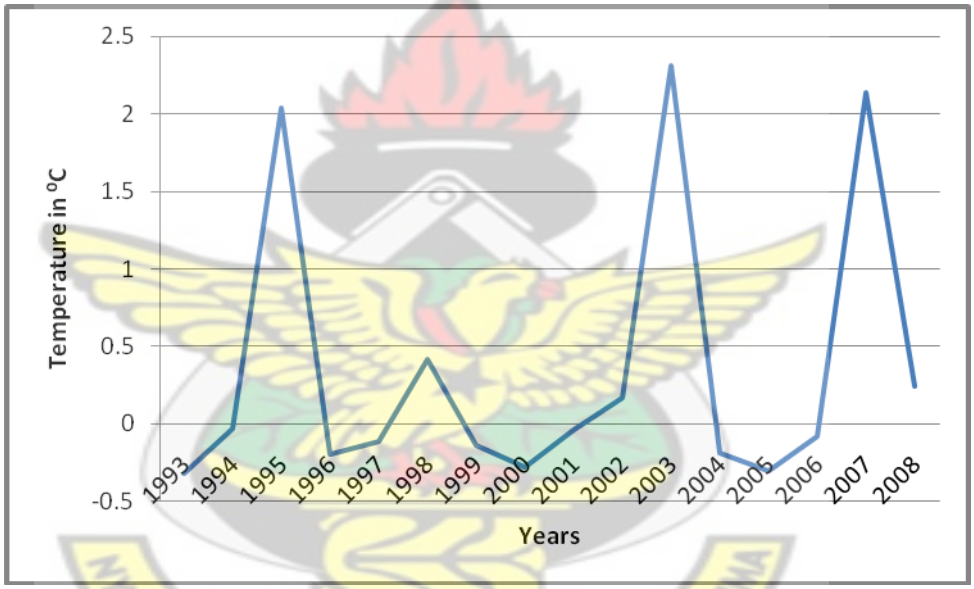
Source: Field survey, 2009

Figure 15: Graph showing deviations from total annual mean temperature (1978-1992)



Source: Field survey, 2009.

Figure 16: Graph showing deviations from total annual mean temperature (1993-2008)



Source: Field survey, 2009

APPENDIX 6

DEPARTMENT OF GEOGRAPHY AND RURAL DEVELOPMENT

FACULTY OF SOCIAL SCIENCES

KWAME NKRUMAH UNIVERSITY OF SCIENCE AND TECHNOLOGY

ENVIRONMENTAL HAZARDS IN GHANAIAN CITIES: THE CASE OF INCIDENCE OF ANNUAL FLOODS ALONG THE ABOABO RIVER IN THE SUBIN AND MANHYIA SUB-METRO AREAS OF KUMASI.

HOUSEHOLD QUESTIONNAIRE

This research aims mainly at investigating the causes of flooding in the Aboabo river basin and the effects as a hazard on life, property and socio-economic activities of residents. It also aims at suggesting recommendations to remedy the problem. This is a purely academic research and the anonymity of respondents is assured. Information given will be used purely for academic research purposes.

1. (a) Name of Respondent:
……
(b) Sex: Male [ ] Female [ ]

(c) Age: .....
(d) Ethnicity: ……..
(e) Household status……
(f) Occupation: …….
(g) Educational attainment: (i) Primary [ ] (ii) Secondary [ ] (iii) Tertiary [ ] (iv) None [ ]
(g) Length of stay in the community (i) 0 – 5 years [ ] (ii) 6 – 10 years [ ] (iii) 11 – 15 years [ ] (iv) 16 – 20 years [ ] (v) Above 20 years [ ]
(h) Residential status: Free occupant [ ] Tenant [ ] Owner-occupant [ ]

2. Has your household experienced flooding before?
Yes [ ] No [ ]

3. If yes, why do you still live here?
a. proximity to work [ ]
b. affordability of housing [ ]
c. did not face problems before [ ]
d. other [ ] , specify .....

4. What do you think are the causes of these floods?
Building in water courses [ ] Bad refuse Disposal [ ] Building Designs [ ]
Hard Landscaping [ ] Lack of Drains [ ] Poor design of Drains [ ]
Choked drains [ ], low lying nature of relief [ ], other [ ], specify …….....

5. Are you willing to move out of this area in view of the floods?
Yes [ ] No [ ]

6. How often do floods occur in this area?
Once a year [ ] Twice a year [ ] Several times a year [ ]
7. When do floods occur during the year? .....

8. How long do the floods usually last?
(i) .....Hours (ii) .....Days (iii) .....Weeks (iv).....Months
(v) Other [ ],
specify.....

9. Which agency (ies) or organisation (s) comes to your aid during the floods?
a. National Disaster Management Organisation (NADMO) [ ]
b. Subin Sub-metro [ ]
c. Manhyia Sub-metro [ ]
d. None [ ]
d. Other [ ], specify.....

10. What did they do to help?
a. Provision of relief items (food, building materials, blankets, medicine, etc) [ ]
b. Rescue Effort [ ]
c. Other [ ], specify.....

11. Do you think the procedure involved in locating any activity (land use) on land in this area / community are followed?
Yes [ ] No [ ]

12. How do you dispose of waste in this area?
(i) Public Dump [ ] (ii) Door to Door [ ] (iii) Dumping in the Aboabo river [ ] (iv)Dumping at the banks of the Aboabo river [ ]
(v) Burning [ ] (vi) Burying [ ] (vii) others [ ] specify.....……..

13. How much do you pay to dispose of waste in this area?
(i) 0 – 0.99 Ghana cedi [ ]
(ii) 1 – 1.99 Ghana cedis [ ]
(iii) 2 – 2.99 Ghana cedis [ ]
(iv) Above 3 Ghana cedis [ ]
(v) Nothing [ ]

14. How often do you pay this levy to enjoy the service and properly dispose of your waste?
a. Daily [ ]
b. Weekly [ ]
c. Monthly [ ]
d. Other [ ], specify.....

15. What do you do when the floods occur?
.....
.....
.....
.....

16. In what ways are you affected by the floods?

i. Social (Education, Health etc)
…….....
.....
.....
ii. Property Damage
……
.....
.....
iii. Economically
……
…….....
.....

iv. Housing (structure)
……..
.....
.....
v. Others (specify)
……
.....
.....

17. Do you think these floods can be prevented?
Yes [ ] No [ ]

18. If yes, how can this be achieved?
.....
.....
.....

19. Have the members of this community made any efforts to prevent flooding?
Yes [ ] No [ ]

20. Give reasons for your answer.
.....
.....
.....
.....

21. What do you do before the floods set in?
.....
.....
.....
.....

22. What do you do when the floods actually occur?
.....
.....
.....
.....

23. How do you cope with the danger of incidence of annual flooding in your area?
(i) Stay with friends and/or relatives [ ]
(ii) Build walls/steps to block the flood waters [ ]
(iii) Construct temporary bridges to access our property [ ]
(iv) Construct temporary drains [ ]
(v) Clear choked gutters [ ]
(vii) We just hope and pray the floods do not occur [ ]
(viii) Other [ ], specify.....

24. What do you do after the floods?
.....
.....
.....

25. Do you usually report the incidence of flooding any authority?

Yes [ ] No [ ]

26. If yes, which authorities did you report to?
(a) Subin sub-metro [ ]
(b) Manhyia sub-metro [ ]
(c) Kumasi Metropolitan Assembly [ ]
(d) Assemblyman/Unit Committee Member [ ]
(e) Other [ ], specify.....

27. Are you aware of the city authorities' (KMA) efforts to solve this problem?
Yes [ ] No [ ]

28. If yes, what exactly have these efforts been?
.....
.....
.....
.....

29. What do you think the following should do to solve the problem of flooding in this area?
Households:
.....
.....
.....
Community:
.....
.....
.....
Kumasi Metropolitan Assembly (Subin and Manhyia sub-metros):
.....
.....
.....
Central Government:
.....
.....
.....

Additional Comment/Observation (if any):

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

APPENDIX 7

DEPARTMENT OF GEOGRAPHY AND RURAL DEVELOPMENT

FACULTY OF SOCIAL SCIENCES

KWAME NKRUMAH UNIVERSITY OF SCIENCE AND TECHNOLOGY

ENVIRONMENTAL HAZARDS IN GHANAIAN CITIES: THE CASE OF INCIDENCE OF ANNUAL FLOODS ALONG THE ABOABO RIVER IN THE SUBIN AND MANHYIA SUB-METRO AREAS OF KUMASI.

SAMPLE INSTITUTIONAL QUESTIONNAIRE

1. (a) Name of Respondent
……
(b) Name of Institution
.....
.
(c) Official position Held
……
2. Major functions of institution
(i)……
……
.....
(ii)……
……
.....
(iii)……
……
.....
(iv)……
……
.....

3. (a) Do you have any special regulations to control activities in flood prone areas of the Metropolis such as the Aboabo river basin? Yes [ ] No [ ]
(b) If yes, are they being enforced? Yes [ ] No [ ]
(c) Do you think improper waste disposal activities are responsible for the flooding of communities in the Aboabo river basin? Yes [ ] No [ ]
Give reasons for response
……
...
……
……
.....
……
.....

4. (a) Are you aware of any programmes/projects aimed at reducing the incidence of flooding in the Aboabo river basin? Yes [ ] No [ ]
(b) If yes, which one(s)
……
……
……
……
.....

5. (a) What specific actions do you take in flood prevention and in the Aboabo river basin?

……
……
.....
……
……
.....

(b) What specific actions do you take in flood management and in the Aboabo river basin?

……
……
.....
……
……
.....

(b) Is the institution adequately resourced to carry out its responsibilities?

Yes [ ] No [ ]

If No, in what areas are you challenged?

i. Human

……
……
.....

ii. Financial

……
……
.....

iii. Logistics & Equipment

……
.....
.....

iv. Legal

……
……
.....

v. Others (specify)

.....……
……

(c) What steps are being taken to address them?

……
……
.....
……
……
.....

8. (a) Do you collaborate with any agencies in flood management and prevention with specific reference to the Aboabo river basin?
Yes [ ] No [ ]

(b) If Yes, which one(s)?
……
……
.....
……
……
.....
(c) Are you satisfied with the level of collaboration? Yes [ ] No [ ]
(d) If no, why?
……
……
.....
……
……
.....

9. What do you think are the causes of flooding in the Aboabo river basin in Kumasi?
……
....
.....
.....
.....
……
…
.
10. (a) Do you involve the citizenry in the Aboabo river basin in the activities of the institution?
Yes [ ] No [ ]
(b) If yes, at what level?
……
…
(c) How do you rate their level of participation?
High [ ] Average [ ] Low [ ] Nil [ ]
(c) What do you think accounts for this level?
……
……
.....
(d) If No, why?
……
……
.....
11. What do you think the following should do to solve the problem of flooding in the Aboabo river basin?

Households

.....

.....

.....

Communities

.....

.....

.....

Metropolitan Waste Management Department, KMA.

.....

.....

.....

Central Government

.....

.....

.....

Additional Observation/Comments (if any):

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