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MINIMISING THE RISK OF FLOODS THROUGH RESILIENT DESIGN AND CONSTRUCTION: A CASE STUDY OF TAMALE METROPOLIS

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DECLARATION

STUDENT'S DECLARATION

I Gabriel Amponsah Owusu, declare that this Dissertation, with the exception of quotations and references contained in the published works which have all been identified and duly acknowledged, is entirely my own original work, and it has not been submitted, either in part or whole, for another degree elsewhere.

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SUPERVISOR'S DECLARATION

I hereby declare that the preparation and presentation of this work was supervised in accordance with the guidelines for supervision of Dissertation as laid down by the University of Education, Winneba.

NAME; MR. BOUR FRIMPONG

SIGNATURE: .....

DATE ……

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ABSTRACT

This study examined how to minimize the risk of floods through resilient design and construction with Tamale Metropolis as a case study. Perennial floods constitute a major challenge to humanity due to the socioeconomic implication for individuals and government. The outcome of floods results in destruction of facilities ranging from buildings to civil infrastructure. It is in this light that designers have a major role to play through resilient designs that can withstand the effects of floods. The study employed a quantitative approach with questionnaires administered to design consultants in the Tamale Metropolis. The survey findings suggest the major causes of floods to include; lack of adequate provisions in the design of facilities to counter the effects of floods, lack of sufficient vegetative cover to wither the metropolis, lack of regard for the topology (ordinance bench mark) of residential lands, lack of adherence to zoning laws with the results that houses are built on water ways. The study findings on key design features that could offer sufficient resilience to the effects of floods include; adequate landscaping in and around properties, enforcement of building codes bordering on design of facilities and enforcement of same by municipal engineers, ensuring that designs take into consideration the spots of developmental lands above sea level (Temporary Bench Marks and correctly transferring datum marks during construction) and incorporating design features to accommodate flood waters (quality materials, adequately designed storm water drainage, effective maintenance of facilities designed to encounter the effects of floods.

CHAPTER ONE

INTRODUCTION

1.1 Background of the Study

Floods cause significant economic loss and social strife, particularly in cases involving loss of human life. “Disasters do not cause effects; the effects are what we call a disaster” (Dombrowsky, 1995). This quotation from Dombrowsky conveys a message that a disaster is an effect of an event that brings vulnerability in environment. It does imply that there is a need to study the effects of disasters such as those arising out floods. Natural disasters are common nowadays in today’s world. They are a result of sudden change in state of natural elements due to natural forces. Most of the natural disasters are beyond control of human beings and cannot be predicted accurately when it occurs. Major natural disasters like floods, earthquakes, landslides and droughts when they happen, result in threat to human life, loss of property, affect infrastructure, agriculture and environment. The impact of disaster is different due to its intensity and coverage area.

According to Hewitt (1997), floods are the most common occurring natural disasters that affect human and his surrounding environment It is more vulnerable to Asia and the Pacific regions, and also, most African countries. It affects social and economic stability of a country. There are many occurrences of flood in China, the worst flood in China in 1998 affected 223 million people, 3004 people reported dead, 15 million were homeless and the economic loss was over US$ 23 billion for that year. Due to heavy floods in Cambodia and

Vietnam during year 2000, 428 people were reported dead and estimated economic loss of over US$250 million. In 1991, 140,000 people across the world were reported dead and in 1998, it affected 25 million lives. For the last 10 years due to frequent occurrences of floods thousands of people have been affected due to flood in India, Pakistan, Korea, China, and Bangladesh with their agricultural field, residential areas i.e. livelihood and food. An effect of floods in less developed countries is more vulnerable. It has a lot of problems with emergency response and early warning preparation (Chorley, 1978). It occurs when a river or stream or drain breaks out through their natural or artificial bank due to heavy rainfall, melting of snow, dam failure etc. Floods are of mainly three types: flash flood, river flood and coastal flood (Christiane and Beverley, 2011). Such kind of flood occurrence is influenced by natural phenomena and human involvement like deforestation, land management (timber harvest, reforestation and forestation, herbicide application and controlled burning), industrial development, agriculture, regulation of rivers. However, the recent causes for frequent flooding of some areas are mainly due to un-planned land use, construction, operation of dams in upstream and heavy rain fall. If a hydraulic structure is not designed properly then it could even lead to catastrophe, the dam can fail, the highway can be flooded and bridge can collapse thus increasing the risk for flood (Gebeyehu, 1989). In spite of all this, it includes human involvement to control flood disaster by immense use of different technology. The use of technology can facilitate stakeholder to have an early warning for flood and know what impact is likely to be caused by flood (Chorley, 1978).

1.2 Statement of the Problem

Tamale Metropolis is located in Northern part of Ghana, with more than 30% of the communities experiencing perennial flooding which has become a topic for the day. Flood is an overflow of huge amount of water on to the normally dry land. It occurs when the overflowing water submerges land and causes deluge. It is cruel and violent expression of water. Floods are often deadly, damaging and devastating. Floods kill lots of people, damage houses and crops, and cause extensive destruction. It also retards development. Most often, floods are caused by heavy rain fall. For example in Chitwan district, Nepal during the floods, the extended family system collapsed, leaving the women and elderly without support (Ariyabandu and Wickramasighe, 2005). In addition, more than 440 people lost their lives and 55,337 families were affected along with a huge amount of property destroyed or damaged by the rains and flood in Nepal this year. Death toll of Thailand Flash Floods recorded 78. The floods and landslides triggered by monsoon rains in Nepal have claimed at least 257 lives. Similarly, in Vietnam, Mekong flood death toll is more than 27. The floods that occurred in Sarlahi district in Nepal left a lot of houses damaged washed away and uninhabitable. The type of construction (thatched homes) influenced the extent of flood damaged (Kimbrough, et al. 2007).

Flood is a widespread natural risk. A research by Douben (2002) indicates that during the period of 1973 and 1997, an average of 66 million people a year suffered flood damage. He further alleged that in 1998 the death toll from floods hit almost 30,000. Savenije et al (1996) also describes the studies made by different scientist to find the cause of recent

extreme floods in Europe. The paper concludes that recent extreme flood is caused due to human intervention and global climate change affecting normal hydrological system.

The impact of disasters is usually measured in quantifiable ways, such as adding up the number of the dead and injured, and estimating the physical damage to housing, land, livestock, agriculture, stores and infrastructure. But attention is not necessarily paid to how disasters impact on different categories of people, men, women, children, aged people, etc. Disasters affect men and women differently because of the different roles they occupy and the different responsibilities given to them in life and because of the differences in their capacities, needs and vulnerabilities. Family size may change at household level due to disasters.

Hardly can men survive without rainfall. Many countries including Ghana depend mostly on rains for its survival. Most people in Ghana rely on rains for their farming, washing, cooking, drinking etc., and the Northern part of Ghana is no exception. When the rain falls a bit heavier, houses are flooded and properties get damaged, when it fails to rain for some time too, droughts occur and farms are destroyed. Man has no control over rains, and hence, is bound to face these problems if measures are not properly taken against flooding. Many areas particularly in Tamale metropolis suffer from perennial flood. Flood in Tamale metropolis has caused loss of life and properties. Regular cleaning and de-silting of drains are some of the interventions made by residents, yet the problem still persists. Support from Government and non- Governmental agencies after flood do not heal the pains suffered by residents and yet year after year the problem keep recurring. To minimize the risk of flood it

is essential that built environment consultants responsible for the design of infrastructure take into consideration the risk of floods in areas prone to floods.

The aforementioned arguments underscore the aim of this research to examine strategies that built environment consultants could adopt to ensure resilient design and construction of infrastructure that could minimize the risk of floods in Tamale Metropolis.

1.3 Purpose of the Research

The purpose of this research is to examine strategies that built environment consultants adopt to minimize the risk of floods and to find possible solutions to flooding in the Tamale Metropolis. The specific objectives of the research are as follows:

- to identify the underlying causes of floods in the Tamale Metropolis;
- to examine strategies that built environment consultants could adopt to minimise the risk as well as mitigate the effects of floods in the Tamale Metropolis;
- to assess the impact of floods in the Tamale Metropolis;
- to make suggestions for the resilient designs of infrastructure that can withstand the effects of floods in the Tamale Metropolis.

1.4 Research Questions

The following questions serve as a guide to which the questionnaire items were developed to find out the opinion of respondents;

i) What are the major causes of flooding in Tamale Metropolis?

ii) What are the possible ways by which floods can be minimised as well as mitigated?

iii) What role do consultants play in flood disaster mitigation at the design phase of infrastructure?

iv) What are the impacts of floods on the socio-economic livelihoods of the people in Tamale?

1.5 Significance of the Study

The significance of this study is to potentially contribute to both academia and management practices and inform strategic groups and other people living in similar areas. More importantly, the study assesses and estimates the effects of floods on the residents of Tamale Metropolis socio-economic livelihoods. The study also endeavors to establish the underlying causes of vulnerability of people in the Metropolis. In addition, it is envisaged that the outputs of the study will be key inputs in the design of sustainable mitigation measures to minimize the impact of floods and associated risks.

1.6 Limitations

This study was limited to the Tamale Metropolis. Survey respondents were consultants operating in the Tamale Metropolis only. Therefore any generalization of the findings to other flood prone metropolis must be done with caution. The restriction in the scope of the

study arose as a result of lack of sufficient time, funds, and material resources to enable the researcher carry out in full, or to cover the entire nation.

Additionally, some consultants were not co-operative in the course of the conduct of the study. Thus, some questionnaires were not returned leading to lower response rate than the response rate envisaged by the researcher.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter reviews the different streams of strategic management of flood theories. First, it explores general strategies in flood management concept and theories including different schools of thought in strategy, it then focuses on theories and past research on strategies that is related to flood control/management (remedies) and construction in general construction industries in particular. Finally, the chapter reviews those theories that provide a theoretical foundation for conceptual model to be constructed later in this research.

2.2 Concept of Flood

Research has shown that human beings exist in this world in an adapted ecological relationship with the surrounding environment and have to live with a variety of natural hazards, which threaten life and property. River flood is the most common type of global hazard, encompassing a wide range of events from largely unpredictable and localized flash flood to anticipated widespread floods. Sheehan and Hewitt (1969) reported that floods accounted for about 30 percent of all natural disasters and 40 percent of the fatalities.

Rashed (1998) also reported that during the monsoon of 1998, due to excessive and intermittent rainfall in the country and in the upper catchment areas from July to September,

all the rivers in Japan experienced significant increase in flow far above the danger level. The flood situation turned worse from the middle of July and by this time the low-lying areas of the country had already gone under water. At that time, about 45,000 sq. km of 37 districts of the country was affected by flood. Although flood situation started improving in early August, the flow of the two main rivers of the country- Padma and Brahmaputra-Jamuna increased significantly during the middle of August. This was caused by heavy rainfall in the upper catchment areas. By the end of August flood situation became worse and about 60,000 sq.km area of 42 districts were affected. During the early September the flow of the major rivers increased abruptly, worsening the condition. The flood situation became worst during the second week of September and about 75,000 sq.km areas of 52 districts were affected during that time. The flooded condition existed for about three months, from early July to the last week of September, in different magnitudes at different places. Thus flood of 1998 became the most prolonged flood in the history of Japan. The total flood inundated area was about 1, 00,250 sq.km (68 percent of the total area of the country) affecting 53 districts. The implementation of any flood alleviation scheme has four basic aims – (i) to reduce flooding, (ii) to reduce damage, (iii) to save lives, and (iv) to save property. A particular scheme may cover all four of these e.g., building embankments to protect vulnerable areas. On the other hand, small-scale projects such as flood shelters may help in saving lives and properties. These shelters can be used to manage relief and rehabilitation activities in an organized way. The shelters can also be used as schools and community centers when there is no flood. Clearly, floodplain evacuation is neither socially desirable nor economically viable, particularly in densely populated and large areas.

The study area selected in this research is an area that is struck by flood every year. The geography of the area is such that any measures, such as building embankments, are not economically or technically feasible. Considering the fact, the local people, administration and Non-Governmental Organizations (NGOs) have taken steps to build shelters for the affected people. These shelters are used as school, community center, medical center and offices of charity organizations during periods other than flood. During flood these shelters store emergency medicine and relief materials other than providing shelter. In the present study, the advantages and disadvantages of these flood shelters are investigated so that it can be improved further and implemented in other areas of the country.

2.3 Causes of Floods

Flood is an overflow of huge amount of water on to the normally dry land. Flood occurs when the overflowing water submerges land and causes deluge. It is cruel and violent expression of water. Floods are often deadly, damaging and devastating. It has killed lots of people, damage houses and crops, and cause extensive destruction. Flood may either be natural or catastrophical. (Morrison, 2010)

According to Nott (2006), the causes of floods can be broadly divided into physical, such as climatological forces, and human influences such as vegetation clearing and urban development. The most common causes of floods are climate related, most notably rainfall. Prolonged rainfall events are the most common cause of flooding worldwide. These events are usually associated with several days, weeks or months of continuous rainfall. Human

impacts on river catchments influence flood behavior. Land use changes in particular have a direct impact on the magnitude and behavior of floods. Deforestation results in increased run-off and often a decrease in channel capacity due to increased sedimentation rates.

During flood events, large volumes of water and debris move downstream. By definition, floodwaters are those waters that, at some interval, overtop the river or stream bank and flow onto the floodplain and also along smaller-sized side-channels. Flooding therefore acts to provide connectivity between the river or stream, its riparian soils, vegetation, and the hypothetic and perithecium zones. Floodwaters transport sediments and nutrients that replenish floodplain lands. Floodwaters move and distribute large woody debris that builds structure and creates the physical characteristics of the main channel and side-channels. Floods most often occur when water ways are obstructed by structures, debris, or when there are no sufficient drains to carry water to a suitable discharge point. Also, when an area is not properly arranged in terms of layout, and again when there are lack of regular cleaning/ desilting of drains in an area. (Nott, 2006)

Gippel et al. (1992, 1996) also said the introduction of large woody debris into streams, drains, and water ways will result in a slight rise locally in the base flood elevation. They again indicated that the discharge of debris indiscriminately will cause blockage in water ways and cause flooding during rains.

Furthermore, Bolton and Shellberg (2001) argued that flood hazard coincide with other critical areas such as wetlands or aquatic areas which are regulated for the protection of critical species and their habitats. Flood hazard area if not regulated to provide protection for habitat may cause flooding. Their emphasis boils to the fact that habitat benefits do accrue as a secondary benefit, and that habitat protection should be considered when planning, designing, installing and maintaining flood facilities. Furthermore, they stated that floodplain analysis provides information about flood frequencies, magnitude and timing, flow depths and velocities, channel slope and channel cross-section geometry that is useful in understanding the existing and potential habitat conditions along a river or stream.

Also, a research by Rienk et al. (1999) indicates that flooding can also be produced from storm water runoff draining from developed land areas. Storm water runoff from impervious surfaces can increase the volume of water and the timing and size of the peak flood. The report states that storm water runoff has greater impact on urban streams than major rivers, which are affected more by heavy rainfall events and rapid snowmelt.

2.4 Effects of Floods

"Impact" means change –whether positive or negative, direct or indirect, short-term or long term and intermittent or continuous from a reference standpoint (Jain, et al. 1981). Flood has great negative effect on the health of human, animals and the environment, and this if not managed well would cause health hazard. Whenever floods occur, heavy metals, such as copper, lead, mercury, and selenium, get into water from many sources, including industries,

automobile exhaust, mines, and even natural soil. Like pesticides, heavy metals become more concentrated as animals feed on plants and are consumed in turn by other animals. When they reach high levels in the body, heavy metals can be immediately poisonous, or can result in long-term health problems similar to those caused by pesticides and herbicides. For example, cadmium in fertilizer derived from sewage sludge can be absorbed by crops. If these crops are eaten by humans in sufficient amounts, the metal can cause diarrhea and, over time, liver and kidney damage. Lead can get into water from lead pipes and solder in older water systems; children exposed to lead in water can suffer mental retardation (Microsoft ®Encarta®2009). Flooding impacts is directly on both physical and psychological health, with a strong interaction between the two.

Also, Albering et al. (1999) in their research realized that at the end of December 1993 and also the end of January 1999, the river Meuse, one of the major rivers in Europe, flooded and riverbanks were inundated. Their study detected a possible human health risk of exposure to heavy metal concentrations in riverbank soil resulting from the flooding of the river Meuse at the end of 1993. They evaluated the heavy metals (e.g. arsenic, cadmium, copper, palladium, and zinc) of the top soil and flood deposits and the corresponding flood and feed crops. They used two different methods to estimate human exposure in relation to the soil pollution in the floodplain. First the general multiple pathway exposure mode (HESP) was used to estimate potential human exposure in relation to soil contamination. This model relates the soil concentration of the pollutant to various environmental media and predicts the concentration of pollution in vegetation, beef, and dairy products.

In addition, Albering et al. (1999) carried out research on human exposure by taking into account the location specific data of heavy metal in vegetation grown in the established experimental gardens. They however concluded that although the soil of the floodplain of the river Meuse appeared to be enriched with heavy metals, the metals content in crops grown on this soil were within normal background values. They further made a note that incidentally high cadmium values were observed in wheat, lettuce and potatoes. The human health risk association with the heavy metal contamination of soil and indirectly the food chain seemed very low. The most important exposure risks were associated with cadmium and lead levels in soil that have a flooding frequency of once every two years. In the case of lead, the most important pathway was ingestion of soil, whereas for cadmium, ingestion of locally grown vegetables was the predominant exposure. Flood hazard areas often coincide with other critical areas such as aquatic areas or wetlands, which are regulated for the protection of critical species and their habitats. They further alleged that utilized by these modern day practitioners are based upon the pioneering efforts over the last two centuries of hydrologic and hydraulic experts, such as Manning, Basin, Darcy, and Wisbech.

Furthermore, Ariyabandu and Wickramasinghe (2005) observed that some groups are more vulnerable to floods than others. Vulnerability is not just poverty, but the poor tend to be the most vulnerable due to their lack of choices. The influences of both poverty and development process on people's vulnerability to disaster are now well established. Class, ethnicity, gender, disability and age are some of the factors affecting people's vulnerability. They further noted that because vulnerability plays such an important part in why natural hazards become human disasters, it is worth spending time to examine the characteristics of

vulnerability. Conditions of vulnerability are a combination of factors that include poor living conditions, lack of power, exposure to risk and the lack of capacity to cope with shocks and adverse situations. As noted earlier, poverty does not equal vulnerability but being poor makes people more vulnerable to disasters because poor people lack the resources (physical, social and knowledge based) to prepare for and respond to such threats and shocks as natural hazards. Poor people often get locked in a cycle of vulnerability. Because they are poor, they become vulnerable. Because they are vulnerable, they are at great risk in the face of a natural hazard, leading to disaster. Close analysis of disaster impact shows that the vulnerability of men and women to disaster, their capacities, and the options available to them differ in character and scale to their gender.

Ariyabandu and Wickramasighe (2005) further suggested that although women are often more vulnerable to disasters than men (owing to conventional gender responsibilities and relations) they are not just helpless victims as often represented. Women have valuable knowledge and experience in coping with disasters. Yet these strengths and capabilities of women are often ignored in policy decisions and in mitigation, thereby, allowing these valuable resources to go to waste and sometimes creating dependency situations. Thus ignorance of gender differences has led to insensitive and ineffective relief operations that largely bypass women's needs and their potential to assist in mitigation and relief work.

Again, Nott (2006) correctly points out that a flood event is not considered to be a natural hazard unless there is a threat to human life and/or property. The most vulnerable landscapes for floods are low-lying parts of flood plans, low-lying coasts and deltas, small basins

subject to flash floods. Rivers offer human populations transport links, a water source, recreational amenities, fertile plains and are an attractive place for settlements. Floods then become a major natural hazard because of the high human population densities that inhabit these lands. He indicated that the direct impacts of a flood are closely related to the depth of inundation of floods water. The extent of a flood has a direct relationship for the recovery times of crops, pastures and the social and economical dislocation impact to populations.

Floods are the most costly and wide reaching of all natural hazards. They are responsible for up to 50,000 deaths and adversely affect some 75 million people on average worldwide every year. Disease outbreak is common especially in less developed countries. Malaria and Typhoid outbreaks after floods in tropical countries are also common. It has been estimated that in India and Bangladesh 300 million people live in areas that are affected by floods (Nott, 2006).

2.4.1 Floods Impact on Health

Tahateru (2005) observed that the economic impact of natural disasters shows a marked upward trend over the last several decades. The hazards tend to hit communities in developing countries especially the least developed countries, increasing their vulnerability and setting back their economic and social growth, sometimes by decades. The floods have led to loss of human life, destruction of social and economic infrastructure and degradation of already fragile ecosystems. The study indicates that social impacts include changes in people's way of life, their culture, community, political systems, environment, health and wellbeing, their personal and property rights and their fears and aspirations. The study

undertaken in Scotland suggests that social impacts are linked to the level of well being of individuals, communities and society. It includes aspects related to the level of literacy and education, the existence of peace and security, access to basic human rights, systems of good governance, social equity, positive traditional values, knowledge structure, customs and ideological beliefs and overall collective organizational systems. Some groups are more vulnerable than others mainly those less privileged in society. Different population segments can be exposed to greater relative risks because of their socioeconomic conditions of vulnerability. Because of this, disaster reduction has become increasingly associated with practices that define efforts to achieve sustainable development. The links between disaster and the economic system, another pillar for sustainable development are essential for disaster reduction. Risk Management planning should, therefore, involve an estimation of the impacts of disasters on the economy, based on the best available hazard maps and macroeconomic data.

Also, a research by Yeo (1998) reveals that emotional behavior of many flood victims was shocking. The emotional cost of flooding was long lived. Follow-up studies found that about one-quarter still had not recovered from the emotional trauma of the event. Factors that contributed to the non-recovery included the severity of the flooding, the degree of the resulting financial hardship, age and socio-economic status. Elderly people on low incomes whose houses were deeply flooded were the most ill- affected, thus, a severe flood can impose a range of emotional costs on flood victims, many of them quite severe. Moreover the emotional strain may linger for years after the event. Flood aware communities can be

expected to suffer less social and financial disruption than communities with a low level of flood awareness.

Furthermore, Smith and Ward (1998) are of the view that there is more evidence that the flood problem is getting worse in terms of the damage caused by flooding. Despite massive expenditure on flood defense, flood damage losses continue to rise in many countries. Although most floods are more or less natural phenomena (albeit intensified by human action such as land use change), the flood hazard is largely of human origin. Most floods result from moderate to large events, occurring within the expected range of stream flow. Floods constitute a "hazard" only where human encroachment into flood prone areas has occurred.

2.4.2 Intangible Losses and Health

During the post flood phase, that is the clean up stage, many other environmental impacts can become apparent. Personnel involved in clean up hazard workers may be exposed to infectious agents and chemical hazards, fungal disease, asbestos hazards, hazards of lead poisoning. Seasonal flooding of the natural environment can be regarded as a natural feedback mechanism whereby the fertility of floodplains can be replenished and natural lifecycles continued; many fish species, for example, reply on seasonal flooding to spawn on the flood plain (Gardiner, 1992). Changes on the flood magnitude, frequency or duration will clearly have an impact on the flood plain as a habitat, hence on wildlife and other natural resources on which human may rely. Consideration of the environmental impacts of

flood regime should then include not only the direct but also the indirect impacts, including those associated with human activities.

Furthermore, McDowell (2006) also points out that the cumulative impact of human activities without regard for nature has turned the floods from a natural phenomenon into a man-made disaster of epic proportions. When severe floods occur in areas occupied by humans, they can create natural disasters which involve the loss of human life and property plus serious disruption to the on-going activities of large urban and rural communities. Flood losses are therefore essentially human interpretations of the negative economic and social consequences of natural events. The impact of the flood hazard will, in part be determined by the magnitude of the events and the duration of the event. But the true significance of the flood disaster will depend primarily on the vulnerability for the local community. The relationship between physical exposure and human vulnerability is highly dynamic and can change through time (Smith and Ward 1998).

Also, Smith and Ward (1998) further argued that direct losses to floods occur immediately after the event as a result of the physical contact of the flood waters with humans and with damageable property. However, indirect losses which are less easily connected to the flood disaster and often operate on long-time scales, may be equally, or even more important. Depending on whether or not losses are capable of assessment in monetary values, they are termed tangible and intangible. Some of the most important direct consequences of flooding such as loss of human life or the consequent ill health of the survivors are intangible. Indirect and intangible consequences of flooding are probably greatest in Least Developed

Countries (LDCs), especially where frequent and devastating floods create special impacts for the survivors. They further argued that despite the negative effects of floods, flood plains act as important corridors for road and rail communications. Floodwaters themselves can bring advantages, particularly with respect to common property resources. Maintenance of high biological diversity in the flood plain ecology is another benefit of floods. Regular annual floods provide abundant water resources to replenish lakes and ponds which, in turn, support irrigation or fish farming. Many rivers carry minerals and nutrients which support the more intensive agricultural production on flood plains. Primarily losses can be high in rural areas where most of the damage is sustained by crops, livestock and the agriculture infrastructure, such as irrigation system, levees, walls and fences. In other words primary losses relate mainly to the disruption of economic and social activities, especially in urban areas, immediately after a flood (Smith and Ward 1998).

2.4.3 Community and Housing Impacts

Flooding impacts on communities and housing are complex and varied. Flood risk poses a significant threat to many communities and, whereas measures can be taken to reduce the likelihood and important of flooding, the risk can never be eliminated altogether (Crossman, et al. 2006). They point out that in the United Kingdom (UK), flood risk represents a significant threat to many communities. Around 1.8 million households and 140,000 commercial properties in England and Wales are located in floodplain areas, affecting at least 4-5 million people. They further point out that a range of flood risk management activities are undertaken by operating authorities. These include emergency planning,

awareness raising, provision of flood warning and creation of flood storage areas as well as the construction and maintenance of both conventional and innovative flood defenses.

Crossman et al. (2006) further suggests that in the face of such increases in risk, the provision of reliable information and public awareness is essential. There is a clear need for a continental and deepening partnership between the public and private sectors in managing flood risk and the potential to extend to it to other areas. Also, Lind et al. (2008) are of the view that the loss in case of flooding has many dimensions. In addition to economic loss and loss of life and injury, there may be irreversible loss of land, of historical for cultural valuables and loss of nature or ecological valuables. Furthermore, Kundzewicz et al. (2002) argues that floods are natural phenomenon for which the risks of occurrence are likely to continue to grow; increasing levels of exposure and insufficient capacity are among the factors responsible for the rising vulnerability. Water related events such as floods have been a major concern since the dawn of human civilization. They continue to hit every generation of human beings, bringing suffering and death as well as immense and still growing, material losses. They observed that although the 21st century is predicted to be an age of water scarcity, the flood losses worldwide continue to rise to tens of billions of United State (US) dollars in material damage and thousands of fatalities per year. For thousands of years, people have settled in flood plains attracted by fertile soils, flat terrain appropriate for settlements, and they have access to safe water. They further observed that floods are natural phenomenon that has always existed and people have tried to use them for their advantage to the extent possible. However, increased population density, urbanization and agricultural expansion in flood prone areas have steadily increased society's vulnerability to the negative effects of floods. As a consequence, floods have become more

and more disastrous to human settlements. Economic development of flood prone areas is a factor that increases flood risk. Population pressure and shortages of land cause encroachment into flood plains. Mushrooming informal settlements often form enlargement zones around mega cities in developed countries (Kundzewicz, et al. 2002).

Bankoff (2003) states that in Philippines, flooding is not a recent hazard but one that has occurred throughout the recorded history. On the one hand, it is related to a wider global ecological crisis to do with climate change and rising sea levels but on the other hand, it is also the effect of more-localized human activities. A whole range of socio-economic factors such as land use practices, living standards and policy responses are increasingly influencing the frequency of natural hazards such as floods and the corresponding occurrence of disasters. In particular, the reason why flooding has come to pose such a pervasive risk to the residents of Metropolitan Manila has its basis in a complex risk of inter-relating factors that emphasize how the nature of vulnerability is constructed through the lack of mutuality between environment and human activity over time. Statistical trends suggest that floods have become more numerous and more devastating in recent years. Certainly the frequency of events and the number of people affected have increased steadily as human related activities such as deforestation, overgrazing and urbanization aggravate environmental conditions, making communities more vulnerable (Bankoff, 2003).

Social scientists expanded the focus of disaster reduction to include questions about the characteristics of vulnerable populations that went beyond the infrastructural/location and behavioral aspects of exposure to certain catastrophic events. Are the objective risk

perceptions of geophysicists, hydrologists, engineers and planners who do not live in hazard zones really representative of the subjective perceptions and capacities of people, communities and decision-makers? How do socioeconomic differences among populations affect the ability to respond and recover from hazardous events? These dimensions have rarely been addressed in institutional forms of disaster reduction despite their potential impact on community coping capacity (Palm, 1990). A view of disaster as a process has broadened the scope of disaster management, primarily as a result of the high degree of uncertainty and complexity involved in responding to long-term risk. The definition of vulnerability within the modern disaster community, for example, now seeks to integrate the set of conditions and processes resulting from physical, social, economic, and environmental factors, which increase the susceptibility of a community to the impact of hazards United Nation International Strategy for Disaster Reduction UNISDR (Rajib et al. 2004). The term coping capacity adds to the conceptualization of vulnerability from the perspective of those who are exposed to hazardous regions, and their ability to cope with a range of negative impacts. More specifically, coping capacity is defined in the disaster community as the means by which people or organizations use available resources and abilities to face adverse consequences that could lead to a disaster. “In general, this involves managing resources, both in normal times as well as during crises or adverse conditions. The strengthening of coping capacities usually builds resilience to withstand the effects of natural and human-induced hazards” (Bogardi, et al. 2005). The climate change community reflects a similar understanding of vulnerability that shifts attention to long-term and adaptive efforts to avoid risk, and assumes that there is a need to live with a degree of risk. The Intergovernmental Panel on Climate Change (IPCC), for example, has defined vulnerability as the degree to

which a system is susceptible to, or unable to cope with, adverse effects of climate change, including climate variations and extremes (McCarthy et al., 2001). In this definition, vulnerability and coping capacity are considered in relation to extreme hazards and climate change as a risk itself. A holistic understanding would be gained by integrating the starting point interpretation of vulnerability from the disaster management community with the end point interpretation from the climate change community (O´Brien et al., 2004; Kelly and Adger, 2000):

1. The starting point interpretation - views vulnerability as a general characteristic of societies generated by different social and economic factors and processes.
2. The end point interpretation - proposes vulnerability as the residual of climate change impacts minus adaptation, that is, the remaining segments of the possible impacts of climate change that are not targeted through adaptation.

Adopting an end point interpretation would focus risk reduction efforts on factors that enhance adaptive capacity and limit the overall vulnerability in society to a range of risks. Adopting the starting point interpretation would focus on reducing the known environmental, social and economic conditions that increase vulnerability to a range of hazards, thereby enhancing adaptive capacity. What is important is that vulnerability and adaptation are conceptualized in relation to the capacities of the people at risk, and the conventional institutional arrangements that legislate risk management. This conceptualization is more sophisticated than estimating societal deficiencies and the probability of loss to known hazard events common in traditional disaster management. It addresses the social and political capacities available to adapt within established

management systems. Failure to address the sophistication of vulnerability, coping capacity and adaptation, however, could result in the underestimation of society's risk to natural extremes, climate change and development issues.

2.4.4 Floods Impact on Agriculture

Smith and Ward (1998) argued that despite the negative effects of floods, flood plains act as important corridors for road and rail communications. Floodwaters themselves can bring advantages, particularly with respect to common property resources. Maintenance of high biological diversity in the flood plain ecology is another benefit of floods. Regular annual floods provide abundant water resources to replenish lakes and ponds which, in turn, support irrigation or fish farming. Many rivers carry minerals and nutrients which support the more intensive agricultural production on flood plains. Primarily losses can be high in rural areas where most of the damage is sustained by crops, livestock and the agriculture infrastructure, such as irrigation system, levees, walls and fences. In other words primary losses relate mainly to the disruption of economic and social activities, especially in urban areas, immediately after a flood (Smith and Ward, 1998).

Mirza et al. (2003) also state that flood disaster have different impact on individuals, households and communities. People cope in different ways. Those who have the capacity after being hit by a disaster emerge faster while those without such capacity sink deeper into the spiral of impoverishment. Coping strategies include actions such as migration from floods affected areas, flood forecasting, flood insurance of animals and crops, food stockpiling, providing emergency health services and building flood shelters. They have,

however, not been woven systematically into the approach to achieve security from flooding. If the approaches build on coping strategies and seek to identify new ones, they could address the social impacts of flood problems affectively at a lower social, economic and environmental cost than approaches that attempt to manage or control the resource base itself.

Rashid (2000) described the floods that hit Bangladesh in 1998 as the worst in the last century. Almost two-thirds of the country was submerged under water and millions were affected. A total of 33 million people were marooned of whom 18 million needed emergency food and health services in 52 districts. The floods continued for more that 65 days. They destroyed basic infrastructure like roads and bridges as well as houses, crops, animals and cattle. The most damaging aspect of the flood was the destruction of people's means of livelihood. The response to the floods included distribution of food, medicine and clothing for the poor. In the severely affected areas, boats became the principal means of communication and many slum dwellers coped by living in shelters and relief camps while others made arrangements in their own homes to deal with the rising flood waters. They refused to move, as they did not want to leave their household belongings behind. The 1998 floods clearly illustrated the people's despair and utter helplessness, with no homes, all the property destroyed and no money to buy food. Their lives were completely crushed by the onslaught of the floods. Ninno et al. (2003) further stated that the 1998 floods in Bangladesh caused severe damage to the rice crop and threatened the food security of tens of millions of households. Government food transfers to the affected people helped limit the impact of the flood on household access to food. The flood led to major crop losses, losses of other assets

and lower employment opportunities and thus affected household income as well as market prices.

Du Plessis (1988) is of the view that in South Africa, the farming sector had been particularly hit by the successive floods of 1983, 1984 and 1985. Various farming products had to be imported to supply the domestic market. Further, grazing capacity had been so reduced that some stock had to be thinned until only the studs remained. The outcome had been that in certain areas, farmers obtained no income and inexorably built up debt. The shrinking income of farmers had meant that they had invested less in farming implements, reduced their sowing and purchased less fertilizer. This in turn had led to the over production of certain farming requisites and chemicals which had necessitated rationalization in those industries. In 1986/87, floods hit again and had an adverse direct impact on both the farmer and the consumer and had also seriously damaged the infrastructure of riverside towns. Farmers suffered losses in stock and irrigation land while farming implements, plantations and sheds alongside rivers had been damaged as well as houses, bridges roads railways lines, telephone connections and dams. In many places the supply of drinking water had been affected and apart from the special measures that had to be taken in this regard, it was also necessary to introduce preventive health measures (Du Plessis, 1988).

2.5 Minimising the Effects of Floods

A research by Paul (2006) indicates that within the Flood Risk Management (FRM) policy literature the terms ‘urban’ and ‘rural’ are used frequently. Although making space for water

has no explicit definition of what constitutes 'urban' and 'rural', its definitions would seem to relate to the type of flooding and the type of measures that can be taken to prevent flooding rather than to the communities who might be affected by that flooding.

Early government efforts to reduce disaster impacts are "more likely to deal with the concept of disaster than the concepts of hazard or mitigation" (Bogard, 1988). Disaster is seen as a product of nature rather than a process resulting from the interaction of socio-ecological systems (Lavell, 1998). Measures should therefore be taken by all, thus, individual, Government, Non-Governmental Organizations (NGOs), etc to prevent disaster i.e. flooding rather than waiting for it to occur before assisting victims. Causal reasoning in disaster reduction allowed for attention to focus solely on the physical attributes of natural events that we have good reason to believe will occur (the causes) and are systematically related to the events that result (the effects). The study of environmental risk and hazards in the natural sciences applied causal relationships to the study of physical phenomenon and hazardous events that trigger disaster (Alexander, 1993).

Innovations in science and technology gave natural scientists (e.g. hydrologists, meteorologists, geologists and geophysicists) the ability to quantify and understand the parameters of natural events (i.e. floods, hurricanes, earthquakes) and to provide advanced warnings and planning for a given event (cause) and its characteristics (effects).

Also, according to Kuei-Hsien (2014), the Flood Hazard Reduction Policy (FHRP) policy and direction is moving King County away from past practices of flood control to flood

hazard reduction through sound floodplain and watershed management practices. The FHRP includes floodplain management policies, floodplain management regulations, program guidelines and recommendations on floodplain mapping, flood warning, facility maintenance and operations and public outreach and awareness. In addition, it contains a capital improvement program that recommends retrofitting and removing old flood protection projects that are environmentally harmful or are not cost effective to maintain. The FHRP also establishes policy guidance for public buy-out of homes and structures that are persistently flooded and for reclaiming those lands for permanent flood storage, conveyance, and riparian values. The FHRP includes design guidelines for constructing new flood protection facilities with bioengineering and habitat features consistent with watershed management practices.

Furthermore, Johnson and Stypula (1993) are of the view that these Guidelines, named Guidelines for Bank Stabilization Projects in the Riverine Environments of King County, were adopted by reference as part of the 1993 FHRP and have been used by King County in the design and construction of major river maintenance and repair projects for the past decade. To add to that, a report from Poff et al., (1997) indicates that if floodplain areas are properly protected or managed, storage of floodwaters can reduce local and downstream peak flood discharges and also decrease highly erosive flood velocities. They further alleged that protecting, restoring, and managing floodplain areas provides for a more natural flow regime by minimizing floodplain modification and limiting development within floodplains. This not only reduces the potential for flood damage but also provides an improved condition for the fish and wildlife species dependent upon viable riverine corridors.

Lavell (1998) also suggested that disaster reduction be re-conceptualized as a process through the integration of four essential components; compensatory and prospective anticipatory management efforts and preparedness and disaster response activities. These components broaden risk reduction to an activity that can occur before an event is known (prevention and mitigation), and after the emergency response to a catastrophic trigger event (preparedness and response):

- **Prevention and Mitigation** - activities that reduce the probability of primary disaster impacts. These activities should be in the form of compensatory measures to address unacceptable risk as well as ongoing risk reduction measures to address emerging problems
- **Preparedness and Response** -strategies to reduce 'secondary' impacts and preexisting hazards and vulnerabilities not reduced by prevention and mitigation. This phase is forward looking so that future disaster is less probable and sustainable development is more probable.

Flood hazard areas are delineated by conducting floodplain analyses that use accepted engineering standards and practices (Mark and Steve 2014). These floodplain analyses include detailed hydrologic and hydraulic computer modeling as well as computational techniques for shallow and pounded areas of inundation. These models and techniques must be acceptable to the Federal Emergency Management Agency (FEMA) and computations must follow FEMA guidelines and specifications. Observations of flood conditions, stream flow measurements, channel and overbank dimensions, aerial photographs and mathematical computations are the types of base data used in completing a floodplain analysis. Flood hazard areas are regulated to reduce the risk to people and property. This is achieved by

limiting subdivision of land within the floodplain, requiring elevation of structures above the Base Flood Elevation (BFE), safeguarding critical facilities, such as hospitals and fire stations, requiring compensatory storage of floodwater, establishing construction standards and other standards designed to protect people and property. See appendix 3.

Bolton and Shellberg (2001) are of the view that flood hazard area should be regulated to provide for habitat protection. They were of the view that habitat benefits do accrue as a secondary benefit if habitat protection is considered when planning, designing, installing and maintaining flood protection facilities. They claimed that flood hazard areas often coincide with other critical areas, such as aquatic areas or wetlands, which are regulated for the protection of critical species and their habitats. Flood hazard areas are not regulated to provide for habitat protection. Also, information gathered and developed in a floodplain analysis provides information about flood frequencies, magnitude and timing, flow depths and velocities, channel slope and channel cross-section geometry that is useful in understanding the existing and potential habitat conditions along a river or stream.

2.6 The Role of Design Team in Minimising the Risk of Floods

Government policies in the UK do not advocate the building of dwellings in areas with a significant risk of flooding. However, where development is, exceptionally, necessary in such areas, national flood risk management policy requires that such developments are safe, do not increase flood risk elsewhere and, where possible, reduce flood risk overall. It is critical that new buildings in these areas are designed appropriately to cope with floodwaters

and minimize the time for re-occupation after a flooding event. Time to reoccupy properties is a principal consequence of flooding which can have a profound impact on the health and livelihoods of those affected.

A research by Carina and Keskitalo (2010) and the associated Practice Guide takes a hierarchical approach to locating developments in the most appropriate location. This sequential approach (and the associated exception test) allows for resistance and resilience measures to be considered as part of this hierarchical approach. The project supporting the development of the present guidance has also proposed changes to the Building Regulations for England and Wales (Approved Document C) to incorporate flood resistance and resilience. Once these changes are brought into effect, the links between planning and building control systems will be stronger. This guidance offers a way in which planners and building control officers can assess the suitability of proposed resilience measures. However, this is not a checklist but a framework as there is no standard solution appropriate for all cases.

In line with the sequential approach to planning, the following are the range of construction measures that can be used to reduce the flooding risk at a site.

Flood avoidance: Constructing a building and its surrounds (at site level) in such a way to avoid it being flooded (e.g. by raising it above flood level, re-siting outside flood risk area etc)

Flood resistance: Constructing a building in such a way to prevent floodwater entering the building and damaging its fabric.

Flood resilience: Constructing a building in such a way that although flood water may enter the building its impact is reduced (i.e. no permanent damage is caused, structural integrity is maintained and drying and cleaning are facilitated).

Flood repairable: Constructing a building in such a way that although flood water enters a building, elements that are damaged by flood water can be easily repaired or replaced. This is also a form of flood resilience.

Also, Miklas (2011) suggest that landscaping the land surrounding individual or groups of buildings to encourage drainage away from a property is an effective measure. In some locations it may be possible to re-contour the land at the edges of flood plains to allow for new development without increasing flood risk, by carrying out flood plain compensation works as part of a development. A conventional low-cost earth bund (hipped earth) may provide an effective local flood defense to floodwater around the site or building curtilage where practical and acceptable to the planning authority. There may be a need to provide pumping arrangements to remove potential rainwater or floodwater seepage. An assessment should be carried out during the design stage to ensure that any earth bund does not increase flood risk elsewhere. They further alleged that the site drainage system and the management of surface water runoff are important considerations in reducing the flood risk to people and property. Consideration needs to be given, in both the Flood Risk Assessment/ Family Caregiver Alliance (FRA/FCA) and for the site layout, to the surface water and foul drainage systems.

Furthermore, the formation of the Urban Task Force chaired by Lord Roger (1999) Towards an Urban Renaissance (Urban Task Force), the Department of the Environment, Transport and the Regions (DETR), strategy Our Towns and Cities: The Future Office of Disaster Preparedness and Management. (Keeble, 2000), the ODPM strategy Living Places: Cleaner, Safer, Greener (Keeble, 2000) together with the Sustainable Communities programme (Keeble, 2000) firmly placed regeneration and urban issues on the political agenda. A fundamental message that comes from these strategies is the importance of the interrelationship between the physical and social environments and the need to plan spaces in order to create places that support communities. This message is coupled with an acknowledgement that the issue of planning places has been neglected over the past two decades in favour of a more market-led, piecemeal approach to urban design and planning.

The strategies includes holistic planned urban design, which is an acknowledgement that urban design has not had a large role to play in the development of urban areas which has led to: 'poor quality design and layouts and poor building practices which in turn create poor quality places' (Keeble, 2000).

The message that comes through in these strategies is that the urban environment needs to be planned and designed at a scale larger than that of individual buildings. This attention to the design of the physical environment, especially the design of connecting spaces, links with two changes within Flood Risk Management (FRM): firstly, the move towards looking at solutions at the level of a catchment (manifest through Catchment Flood Management Plans) and, secondly, the development of a wider range of FRM solutions that are designed not

only to alleviate flooding but also to provide well-designed spaces with a range of benefits (e.g. biodiversity, recreation).

Linked to the above is the emphasis that is put on the role of public spaces, and, more specifically, green spaces. In the Lord Roger (1999) report there is discussion of the creation of a network of public spaces and this is reinforced in the Department for Environment, Flood and Rural Affairs (DETR) strategy Office of Disaster Preparedness and Management (ODPM) where there is a focus on parks, play areas and public spaces. There is the recognition that 'they are therefore vital to enhancing the quality of urban environments and the quality of our lives'. (Keeble, 2000).

There is an emphasis in the urban policy literature on the development of places, neighborhoods and communities. What this means is a focus not only on the physical environment, but recognition of the inextricable link between the physical and social within a defined space. The aspiration is that more than buildings will be created, and that communities with all the associated positive attributes of cohesion and neighborliness will be developed. 'It [the urban environment] can be impersonal and make contact between people difficult or it can foster a sense of community.' (Keeble, 2000).

In addition, a literature review by Gill (2004) provides some important comments on the likely impacts of climate change on urban areas, and within that considers the impacts from increased flooding. The publication suggests that the increase in flooding will be the most serious direct impact of climate change. Factors of concern for flooding include: sea level

rise (combined with severe storms and wave heights); more frequent, severe or prolonged rainfall events; the large size of urban catchments; an increasingly built-up environment which increases surface water run-off and, in particular, the rate of development on floodplains; the age, condition and lack of capacity of existing drainage and infrastructure; the impact of rising groundwater in conjunction with surface flooding.

CHAPTER THREE

METHODOLOGY

3.0 Introduction

This chapter outlines the research design and methodology. The methods and techniques through which the research was conducted are spelt out in this chapter. It presents the target population, study design, sample selection and size. The chapter further presents the methods of data collection and data analysis. It also presents the reliability of instruments used in the collection of data and outlines the procedures involved in accessing the study's respondents. The key sections of the chapter are as follows:

1 The target population.

2 The research design.

3 The techniques used to sample the population.

4 The instrument for data collection.

5 The data collection procedure.

6 The analysis of data.

7 Questionnaire design.

8 Pre-test of questionnaire.

9 Summary of the chapter

3.1 The Target Population

Population is referred to as the whole number of people or inhabitants in a country or region. The target population for this research is on built environment consultants in the Tamale Metropolis. Built environment consultants comprised structural engineers, architects, quantity surveyors, services engineers, geodetic or land surveyors, physical planners, and land economists. However, the population of the study comprised professional architects, construction managers, quantity surveyors and structural engineers. These professionals are mainly in public sector practices with a few working as private consultants. A list of all these professionals in the Tamale Metropolis revealed 236 consultants who were members of their respective professional bodies. The list constituted the sampling frame of the study. These professionals are consultants in Tamale who are involved in the design and construction of buildings in the metropolis.

3.2 The Research Design

A research design is a plan or blue print of how you intend conducting the research (Strydom, et al, 2005). They further alleged that research design focuses on the end product, formulates a research problem as a point of departure and focuses on the logic of research.

Huysamen (1993) also offers a closely related definition of design as the plan or blue print according to which data is collected to investigate the research hypothesis or question in the most economical manner. Other scholars refer to research design as all decisions made in planning the study, including sampling, sources and procedures for collecting data, measurement issues and data analysis plans.

Strydom et al. (2005) argue that the research design used differs depending on the purpose and the study, the nature of the research questions and the skills and the resources available to the researcher. However, each of the possible designs has its own perspective and procedures, the research process will also reflect the procedures of the chosen design. The qualitative research design is that it does not usually provide the research with a step by step plan or a fixed recipe to follow. In quantitative research the design determines the researcher's choice and action, while a qualitative research the researcher's choices and actions will determine the design or strategy. Put more simply qualitative research will during the research process create the research strategy best suited to the research or even design their whole research around the strategy selected. In selecting the appropriate research design for this study, therefore, the above approaches were taken into consideration.

3.3 The Techniques used to Sample the Population

Strydom et al. (2005) view sampling as means of taking a portion of a population or universe as representative of that population. It is generally stated that the larger the population, the smaller the percentage of that population the sample needs to be and vice versa. If the population itself is relatively small, the sample should comprise a reasonably larger percentage of the population. Large samples enable researchers to draw more representativeness and accurate conclusions and to make more accurate predictions than in smaller samples. They further state that the major reason for sampling is feasibility. A complete coverage of the total population is seldom possible and all the members of a population of interest cannot possibly be reached. Even if it were theoretically possible to

identify, contact and study the entire relevant population, time and cost considerations usually make this a prohibitive undertaking. The use of samples may therefore result in more accurate information than might have been obtained if one had studied the entire population. This is so because, with a sample, time, money and effort can be concentrated to produce better quality research, better instruments and more in-depth information. The target population, therefore, for the study is consultants in Tamale who are involved in the design and construction of buildings in the metropolis. These consultants are mostly found in the government / private institutions, departments and the communities.

Tamale, the capital town of Northern Region has most of its areas, over (30%) of the township experiencing regular flooding during rainy seasons, notable among the areas are; Gumani, Gbanyamni, Taha, Kanvilli, Zogbele, Kukuo, Tsogu- yapalsi, Gumbihene, etc.

Built environment consultants comprised structural engineers, architects, quantity surveyors, services engineers, geodetic or land surveyors and land economists. However, the population of the study comprised professional architects, construction managers, quantity surveyors and structural engineers. These professionals are mainly in public sector practices with a few working as private consultants. A list of all these professionals in the Tamale Metropolis revealed 236 consultants who were members of their respective professional bodies. The list constituted the sampling frame of the study.

3.4 The Instrument for Data Collection

The study employed quantitative approaches. The literature review in chapter two (2) indicated that the various writers conducted their research through survey by the use of questionnaires. In this study, the researcher used the survey method as the overall approach to gather main (primary) data to provide answers to the research questions raised in chapter one. The sampling technique adopted was simple random sampling. As a rule of thumb one third of the population is generally considered as an adequate sampling size (Clegg, 1990). Polit and Beck (2006), on the other hand suggest up to fifty percent of the sample size is needed to participate if a response bias is to be avoided.

The study used quantitative approaches. According to Strydom et al. (2005) qualitative data collection methods often employ measuring instruments. Measurements refer to the process of describing abstract concepts in terms of specific indicators by the assignment of numbers or other symbol to the indicators while in qualitative research, the researcher's choices and actions will determine the design or strategy.

As stated above, the study employed quantitative approach for the purpose of assumption that any bias inherent in a particular data source, investigator and method would be neutralized when used in conjunction with other data sources, investigator and methods. The following data collection methods were used:

The survey includes questionnaires which were directed to consultants within Tamale metropolis. The research revealed a total of 236 consultants who are members of their respective professional bodies in the metropolis. Act of this number, 160 of them are in the

public sector whiles the remaining 76 are also in the private sector. The questionnaires were administered to 130 consultants through sampling. It was directed to consultants in both public and private sectors within the metropolis since this class of people are involved in the design and constructions of structures, to know the design strategies being adopted to mitigate the effect of floods in the metropolis.

Another method used for collecting data was through a non structured interview, were information was gathered through physical experience/observation by the researcher. Data was collected from both residents, and victims of the metropolis. The researcher who happens to be a resident of Gumani in Tamale has also experienced it personally on several occasions. Find attached flood pictures on the 19th August 2013 in Gumani in Appendix 2.

3.5 The data Collection Procedure

As a results of time, materials and financial constrains, it was not possible for the researcher to deal with every member of the targeted population. The study had discussion with randomly sampled consultants in the metropolis. A random sampling ensures that every possible member of the target group had an equal chance of being selected for the study to relatively small portion of the entire population. 130 'Yes' and 106 'No' was written on pieces of papers and folded given a total of 236 and put in a box. Each of the 236 consultants visited was asked to pick one, and anyone who picked 'Yes' was selected for the survey whiles those who picked 'No', were eliminated from the survey. Those who were selected were given questionnaires and guided on how to answer them.

According to Babbie and Mouton (2001), the basic objective of a Questionnaire is to obtain facts and opinions about a phenomenon from people who are informed on a particular issue. In this particular study, primary data was obtained by directly issuing questionnaires to Consultants at work places and household level. Data was therefore collected from consultants through Questionnaire as in appendix 1, from one hundred and thirty (130) consultants who were randomly sampled from Tamale Metropolis. The 130 consultants comprised of 28 Architects, 11 Structural Engineers, 27 Quantity Surveyors, and 64 Construction Managers. The consultants were given the Questionnaires from their individual work places and homes, and were guided as to how to answer them. The researcher started retrieving the questionnaires after a week of issued, and found out if the Consultants had difficulties in answering them. For those who had difficulties, the researchers discussed the problems with them and gave them additional time to answer the questionnaires and went back for them later.

3.6 The Analysis of Data

According to Strydom, et al. (2005), data analysis means finding answers by way of interpreting the data and results. To interpret is to explain and find meaning. It is difficult or impossible to explain raw data, one must first describe and analyze the data and then interpret the results of the analysis. Analysis means the categorization, ordering, manipulating and summarizing data to obtain answers to research questions. The purpose of analysis is to reduce data to an intelligible and interpretable form so that the relations of research problems can be studied tested and conclusions drawn. Interpretation takes the

results for analysis, makes inferences pertinent to the research relations studied and draws conclusions about these relations.

For this study, Data Entry Screens were developed in Statistical Package for the Social Sciences (SPSS) for Data Entry Version 6. This is applied to the quantitative data collected. The quantitative data was then analyzed using descriptive statistics such as summary tables, means, range and graphical plots. Inferential statistics was used as well as correlation analysis. The qualitative data set was analyzed using coding, analyzing relationships and developing themes.

3.7 Questionnaire Design

According to Babbie and Mouton (2001), the basic objective of a Questionnaire is to obtain facts and opinions about a phenomenon from people who are informed on a particular issue.

Questionnaires are probably the most used general instrument of all. In this particular study, primary data was obtained by directly talking to Consultants at work places and household level to get very reliable and accurate information. Data was therefore collected from consultants through Questionnaire as in appendix 1, from one hundred and thirty (130) consultants who were randomly sampled from Tamale Metropolis. The consultants were given the Questionnaires from their individual work places and homes.

The consultant's questionnaire covered the following topics: -

- Household demographics

- Current job title in construction industries
- Flood Impact on agriculture, health, infrastructure, education, water and sanitation and housing and property
- Extent of threat caused by flood
- Underlying causes of floods
- Minimizing the effects of floods
- Design to mitigate floods

3.8 Pre-test of Questionnaires

Strydom, et al. (2005) states that credibility is the alternative to internal validity in which the goal is to demonstrate that the inquiry was conducted in such a manner as to ensure that the subject was accurately identified and described. In order to assess the intentionality of respondents, to correct for obvious errors and to provide additional information and accuracy, the questionnaire was pre-tested to ensure the fair reflection of the problem being studied. The questionnaire was designed by the researcher with the help and guidance of an expert. It was later given to 5 (five) experts in the field to try it and this proved successful. It was further given to 10 (ten) experts in the university for retry at the field and in the school, which also proved successful hence the credibility of the test.

Again, the researcher applied findings to other respondents, he generalized sample to its target population, and it was established that there was some uniformity and consistency in their responses. This gave way for the researcher to have confidence in the consultant's response, hence the transferability of the test.

Furthermore, Strydom, at el. (2005) suggests that dependability is alternative to reliability in which the researcher attempts to account for changing conditions in the phenomenon chosen for the study as well as changes the design created by increasingly refined understanding of the setting. The research therefore provides its audience that if it were to be repeated with the same or similar respondents (subjects) in the same (or similar) context, its findings would be similar. This therefore ensures the dependability of the survey.

3.9 Summary of the Chapter

In conclusion, a quantitative approach was employed for the study. Structured and open-ended questionnaires were used to collect primary data. However, the analysis took into account both primary and secondary data especially for meteorological data. The next chapter presents the discussion of results.

`CHAPTER FOUR

PRESENTATION AND DISCUSSION OF RESULTS

4.1 Introduction

This chapter presents the results of the research based on the primary and secondary data collected. The chapter also discusses the results of the study. The second section of the chapter presents the response rate of the questionnaires administered. The third section presents demographic characteristics of the respondents. The rest of the sections presented in the chapter are listed in the order in which they are presented as follows:

- Consultant's perception about construction industries involvement in emergency responds to floods in Ghana;
- Consultants' perception about flood risk reduction in Tamale Metropolis;
- Consultants perception about the causes of floods in Tamale Metropolis;
- Consultants perception about impact/effects of floods in Tamale Metropolis;
- Measures taken by consultants to mitigate flood risk;
- Practical steps by design team to mitigate the effects of climate change.

4.2 Response Rate

A total of one hundred and thirty (130) questionnaires were distributed in direct proportion to the various professionals as given in Table 4.1.

Table 4.1 Response Rate

TYPE OF CONSUTANT	TOTAL NUMBER	QUESTIONNAIRES ADMINISTERED	QUESTIONNAIRES RETURNED	USEABLE QUESTIONNAIRES	RESPONSE RATE
Architects	50	28	9	8	32.1%
Structural Engineers	20	11	6	6	54.5%
Q/S	49	27	15	14	55.6%
Construction Managers	117	64	30	29	46.9%
T OTAL	**236**	**130**	**60**	**57**	**46.2%**

4.4 Discussion of Results

4.4.1 Age Distribution of Sampled Consultants for Survey

Fig. 1 below shows a chart with the age group of respondent consultants for the survey. Out of the 57 respondents for the survey, majority of them thus 33 consultants belong to the age group of 41-50 years representing 57.9%. The next age group falls between 31-40 years, which is also 12 consultants representing 21.1%, followed by age group of 51-60 years which is also 11consultants representing 19.3%. The age group of 21-31 years had only 1 consultant which also represents 1.8%. The following age groups however, had zero percent (0%) representatives; under 20 years, and above 60 years as indicated in the chart below.

The statistical distribution as shown in the chart below is as result of the sampling being non statistical (random sampling) and the age of the sampled consultants not predetermined.

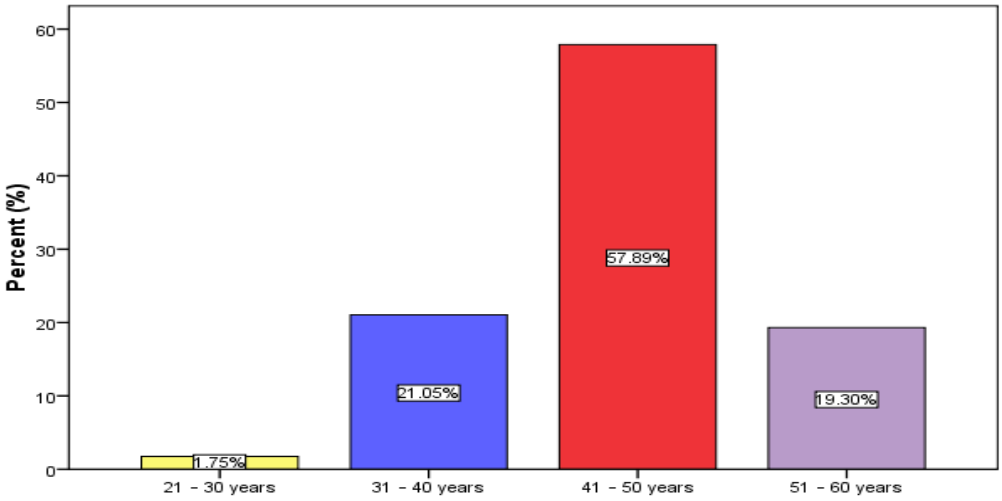

Fig. 1 **Comparative Analysis of Age Groups of Consultants**

With regard to gender, the demographic distributions are such that all the fifty-seven (57), thus (100%) of the respondent consultants for the survey in the metropolis were males. This is due to the fact that the construction industry is a male dominated industry.

4.4.2 Job Titles of Respondents

Fig. 2 shows a chart indicating the current job title of respondents for the survey. Out of the fifty-seven respondent consultants for the survey who returned their questionnaire, twenty three (23) of them representing 40.4% are site managers. This indicates that majority of consultants are mostly found on the field and would ensure that construction principles are implemented based on their rich experience. Fourteen (14) of them representing 24.6% are

also quantity surveyors. Since 24.6% of the consultants represent quantity surveyors, adequate estimate to ensure quality work is anticipated. This is followed by eight (8) of them representing 14% who are also architects. Project managers were six (6) representing 10.5%, and service engineers had two (2) peoples, also representing 3.5%. There was no representative for managing directors in the survey.

The implication is that once these classes of consultants are involved in the planning, designing and maintenance of buildings in the Metropolis, a resilient design to mitigate the effect of floods and adequate material in construction together with proper planning of the Metropolis should be carried out as stated in Planning Policy Statement (PPS) 25 Development and flood risk as stated by Carina and Keskitalo (2010) so that floods impact will be minimized.

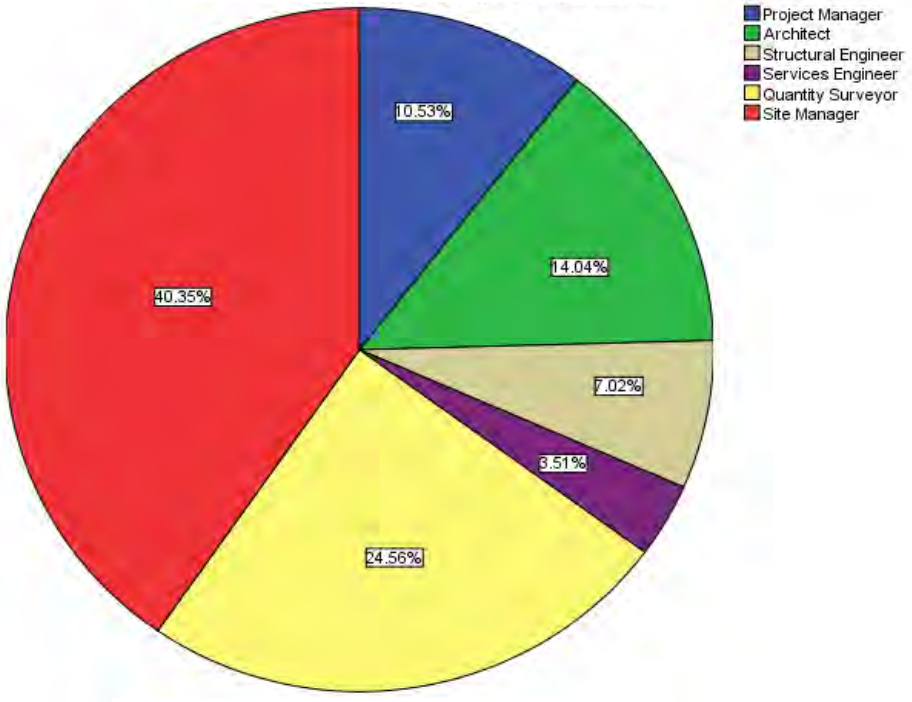

Fig. 2 **Comparative Job Title of Consultants**

4.3.3 Years Served by Respondents in Construction Industry

The research reveals that out of the fifty- seven (57) consultants who responded to the survey, twenty two (22) of them (i.e. 38.6%) have served for fifteen to twenty (15-20) years. Fourteen (14) of them i.e. 24.6% have also served for ten to fifteen (10-15) years. This is followed by eleven (11) of them 19.3% who also served for five to ten (5-10) years. Above twenty but less than thirty (20-30) years of service respondents had six (6) people which represent 10.5%, while respondents who have served below five (< 5) years were only four (4) representing 7%. This is an indication that majority of the consultants are experienced for having served for between (5-30) years, the least experience group are only 7% for having served for (< 5) years. Based on their experience as a result of the number of years served and with their rich experience, a good work is anticipated. Fig 3 shows the years served by consultant.

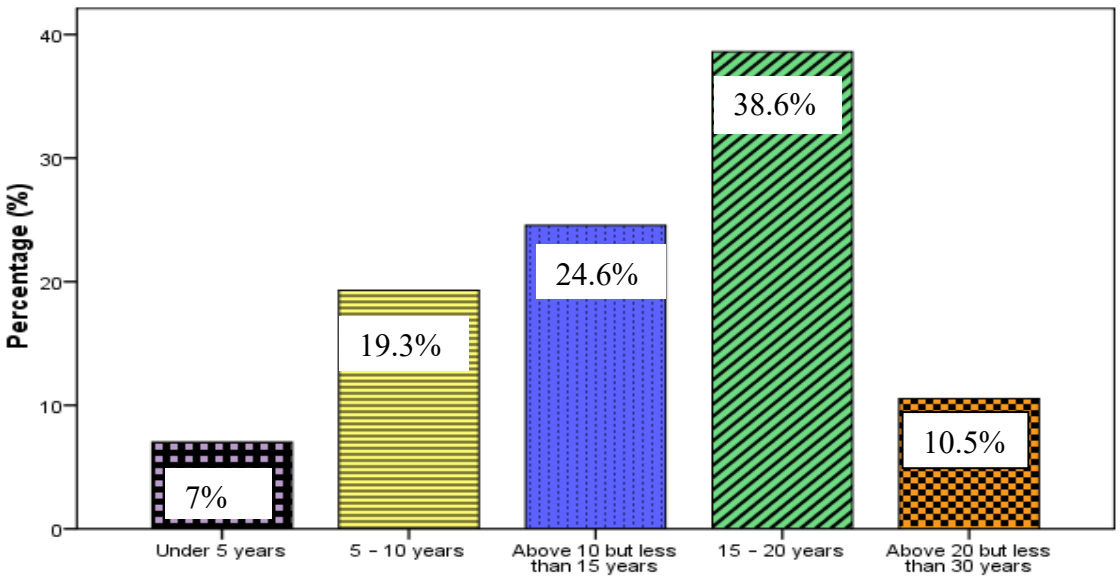

Fig. 3 **Comparative Years served by Consultants**

4.4 Construction Industries Involvement in Emergency Response to Floods in Ghana

The study reveals that out of the fifty-seven (57) consultants for the survey, majority of them representing (70.2%) are of the view that construction industries were involved in emergency response on ad-hoc bases. This was followed by (24.6%) of the consultants who are also of the view that construction industries are not, but should be involved in emergency response to floods in Ghana. The research in addition revealed that (5.3%) of the consultants are of the view that construction industries are regularly involved in emergency flood response in Ghana. None of the consultants were of the view that construction industries are not involved or do not know of the involvement of construction industries to flood response.

The views of consultants indicate that construction industries are not regularly involved in emergency floods response but are set up solely in response to a specific situation. If construction industries are regularly involved, a better design could be made to mitigate emergency situations as stated by Lavell (1998) who is of the view that disaster reduction be re-conceptualized as a process through the integration of essential components.

Fig 4 shows a chart indicating the comparative views of consultants on construction industries involvement to emergency floods response in Ghana.

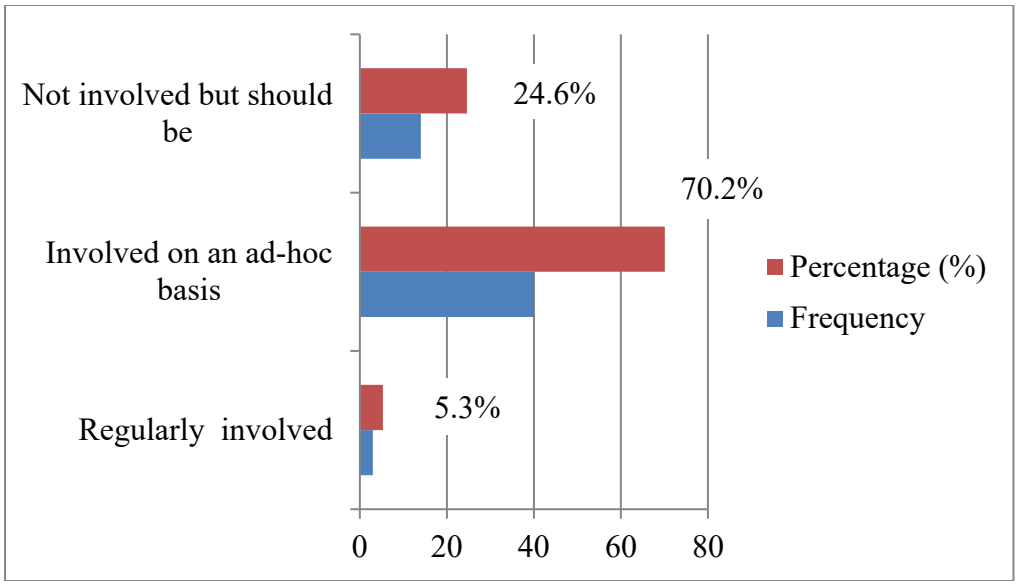

Fig. 4 **Views of Consultant on Construction Industries Involvement in Emergency Flood Responds**

The study further establishes that all 57consultants, thus (100%) sampled for the study are of the view that floods poses major threat in terms of their cost to, and effect on the long-term resilient of the built environments in Ghana. A better resilient design is therefore recommended based on their experience as established by Planning Policy Statement (PPS) 25 Development and flood risk as suggested by Carina and Keskitalo (2010) and the associated Practice Guide to mitigate threat posed by floods.

4.4.1 Extent to which Flood Risk Reduction is Included in Training

Fig. 5 shows a chart with the views of consultants on flood risk reduction in the construction industries. Most of the sampled consultants in the survey (80.7%) indicate that flood risk reduction is an issue which is already integrated in training provision. This was followed by (12.3%) of the sampled consultants who also indicated that flood risk reduction is an issue

which is increasingly being integrated into training provision. From this evidence it was clear that flood risk reduction is part of professional training in construction industry, but only little attention is given to it.

However, (7%) of the respondents/consultants indicate that flood risk reduction is not part of the training provision. None of the respondents indicates that flood risk reduction was not applicable, or may become part of the training provision. An early government effort and planning to reduce disaster impacts are more likely to deal with the concept of disaster than the concepts of hazard or mitigation the impact of floods as indicated by Bogard, (1988). From all indication, flood risk reduction which is already integrated in training provision is very important and must be given the needed attention during the design stage rather than wait for the communities to be affected by floods as indicated by Paul (2006).

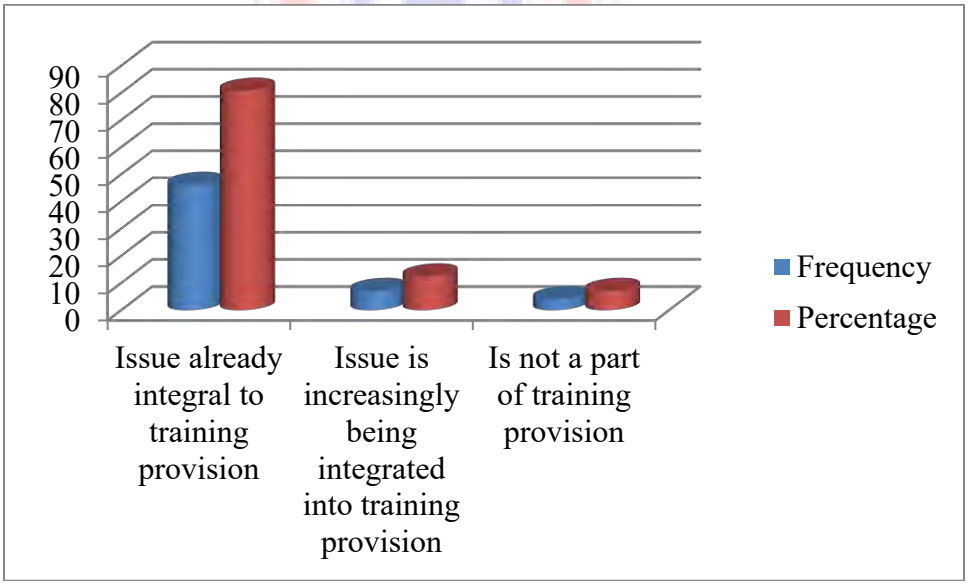

Fig. 5 **Comparative Views of Respondents on Flood Risk Reduction**

4.5 Causes of Floods in Tamale Metropolis

The comparative views of consultant on causes of floods in Tamale metropolis are as indicated in fig. 6. The research reveals 57% of the consultants are of the view that flood is caused as a results of indiscriminate disposal of refuse. This refuse they alleged terns to block our drains and increase water level during rains which leads to floods as alleged by Gippel et al. (1992, 1996). This is followed by 40% of the consultants who are also of the view that floods occur as a result of building on water ways. These groups of consultants are of the view that improper arrangement of houses and improper drainage system within the houses lead to flooding within the metropolis. A proper planning of an environment is therefore required as indicated by (PPS) 25 Development and flood risk as indicated by Carina and Keskitalo (2010) in the associated Practice Guide. In addition, 3% of the remaining consultants believe that flood occurs naturally. They attribute floods to natural cause. They believe that floods come as a result of heavy rains (prolonged rain falls) which cannot be controlled by man as proposed by Nott (2006).

The general impression is that, if all houses are well planned and built with the needed facilities and sufficient drainage system with properly disposed refuse as indicated by Balmforth et al. (2006), flood effects and its impact will be minimized in the metropolis.

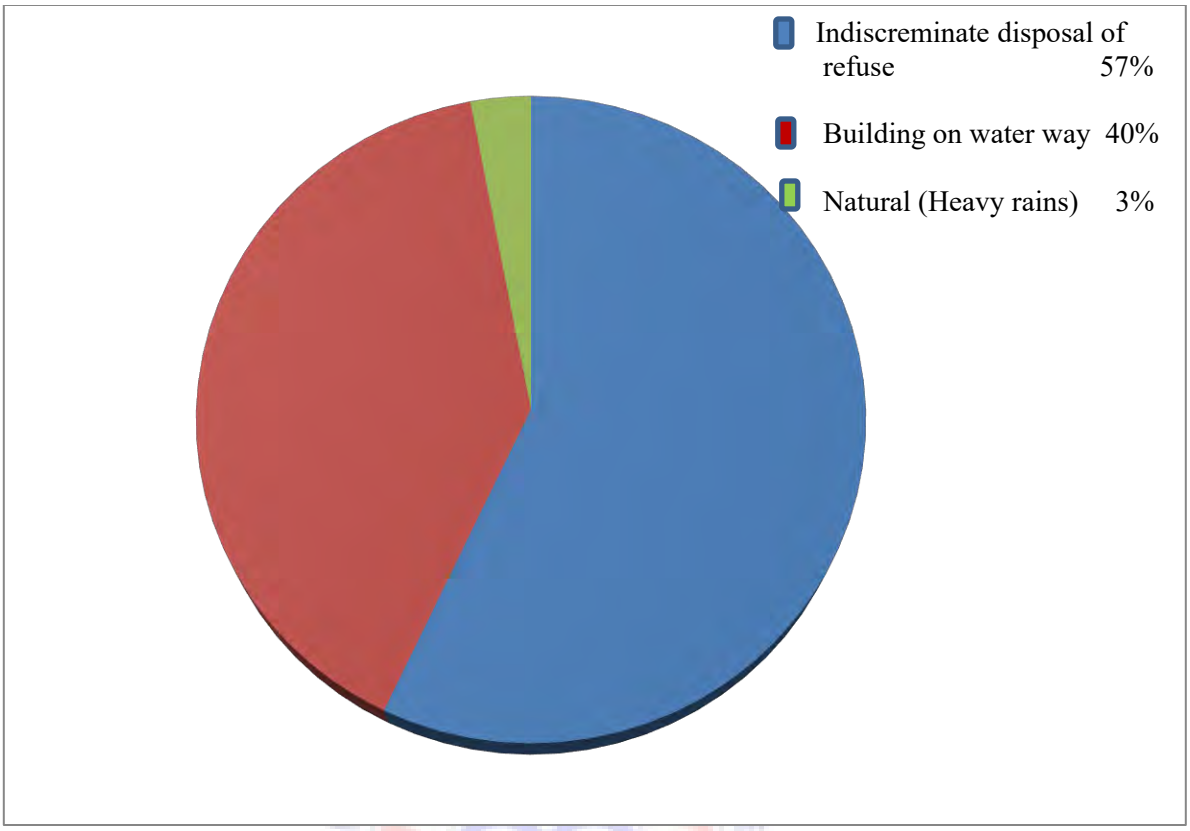

Fig. 6 **Comparative Views of Consultants on Causes of Floods**

4.6 Effects (Impacts) of Floods in Tamale Metropolis

4.6.1 Floods Impact on Health

The research revealed that all respondents sampled for the research (100%) indicated that floods pose major threat to residents. This is in agreement with Jain et al. (1981) who are of the view that flood has great negative effect on the health of human, animals and the environment, and this if not managed well would cause health hazard. They concluded that sicknesses such as typhoid, diarrhea, cholera, and other strange diseases do occur as results of floods. Chorley (1978) is also of the view that children are the most vulnerable group.

This is an indication that floods pose major threat to human health and must be handled with all seriousness.

However, (56.1%) of the consultants disagree that Government should always give free medical care to flood victims. They said a solution should be found to floods rather than regularly giving free medical treatment. Prevention measures according Keeble (2000) include planning spaces in order to create spaces that support communities. On the other hand, (36.8%) agree, and (7.0%) also strongly agree that free medical care should be giving to flood victims as indicated by Flood Management in Australia, (1998) who were of the view that elderly people on low incomes whose houses are deeply flooded were the most ill-affected. With this in mind, short and long term measures should be provided with the short term measures being support for flood victims and the long term measures being proper and resilient design to mitigate floods. The views of consultants on support to flood victims are as indicated in Fig. 7.

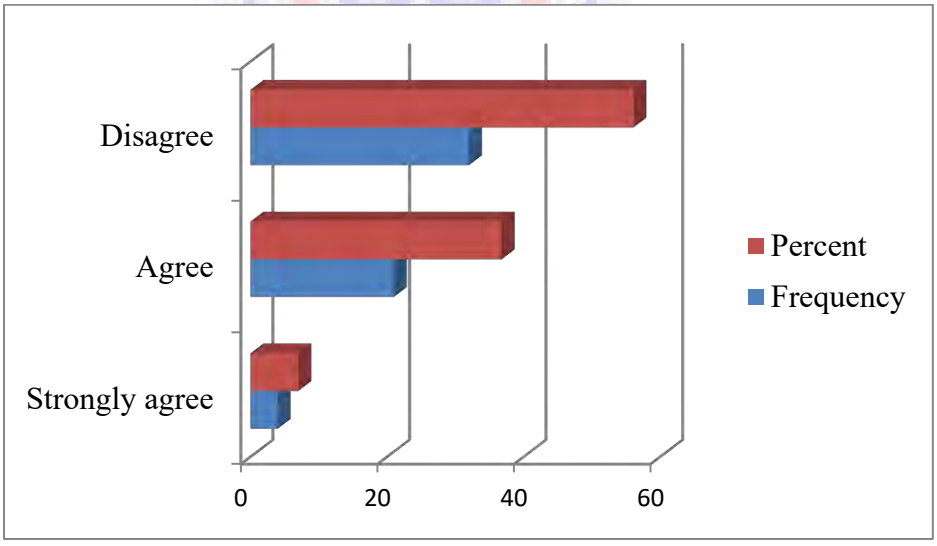

Fig. 7 **Comparative Views of Consultants on Support to Flood Victims**

Furthermore, all the consultants agree that residents in flood prone areas should be encouraged to take warm rather than cold foods. They in addition agree that health protection agencies should be formed to ensure the good health of everyone in flood prone area. They were of the view that environmental hygiene should be included in school curriculum to educate people on how to keep their environments clean so as to prevent the outbreak of diseases during flood events.

To add to that, the research reveals that all consultants were of the view that residents should wash their hands with soap and clean water after visiting the private (toilet/urinals) which is in accordance with Gardiner (1992). He further indicates that during the post flood phase, many people are exposed to infectious agents and chemical hazards, fungal disease, asbestos hazards, hazards of lead poisoning, etc. This therefore calls for the need to wash hands with soap and clean water in order to prevent outbreak of diseases.

4.6.2 Intangible Losses and Health

Fig. 8 below shows the views of consultants on whether floods can lead to sexually transmitted diseases which is part of the intangible losses on health. The research reveals that majority of the consultant sampled for the survey (65%) are in agreement that floods can lead to teenage pregnancy and other sexually transmitted diseases. Gardiner (1992) indicates human exposure during flood events and think that consideration of the environmental impacts of flood regime should include not only the direct but also the indirect impacts, including those associated with human activities. When floods occur houses are demolished and people are compared to sleep in congested rooms and

classrooms. The aftermath effect is teenage pregnancy and other sexually transmitted diseases. The research also indicated that (31.6%) disagree that floods can lead to teenage pregnancy and other sexually transmitted diseases. According to them, they do not see how floods can have such impact on residents. The remaining (3.5%) neither agree nor disagree. When floods occur so many losses are made that are not direct. These include cost by government to take care of victim, support from National Disaster Management Organization (NADMO) and Non-Governmental Organization (NGO), etc which are made from the tax payer money which otherwise would have been used for other developmental works. There is therefore the need for us all to put in effort in mitigating floods.

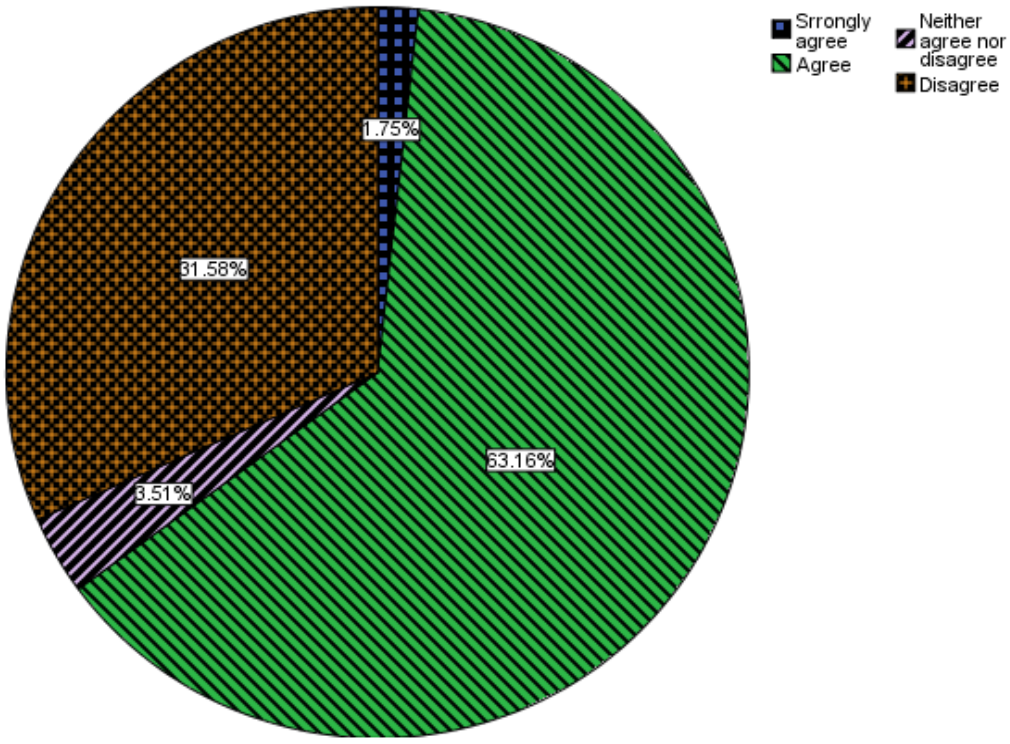

Fig.8 **Comparative Views of Consultants on Intangible Losses and Health**

Furthermore, the research reveals that (94.8%) agree that floods can lead to disruption of classes. They alleged that when there are floods, students cannot learn, teachers are compared to allow student to go home to help salvage properties in their houses. These also express part of the indirect impact of floods as indicated by Gardiner (1992). The remaining (5.2%) however, neither agree nor disagree to the assertion. There is therefore the need to minimize floods through adequate planning and resilient design.

4.6.3 Community and Housing Impact

Figure 9 is a chart showing the views of consultants on floods impact on communities. The research reveals all respondent consultants (100%) indicate that floods can have massive impact on our communities. Out of the 57 consultants, (86%) agreed while (14%) strongly agreed. This is an indication that when floods occurs, the community source of water is affected including their farms, houses, children's education, health, and all other businesses in the community are affected as alleged by Gardiner (1992). Also, according to Palm (1990), social scientists expanded the focus of disaster reduction to include questions about the characteristics of vulnerable populations that went beyond the infrastructural/location and behavioral aspects of exposure to certain catastrophic events. It is therefore necessary to minimize flooding through good planning of an area by avoiding building on water ways and making a resilient design to mitigate floods.

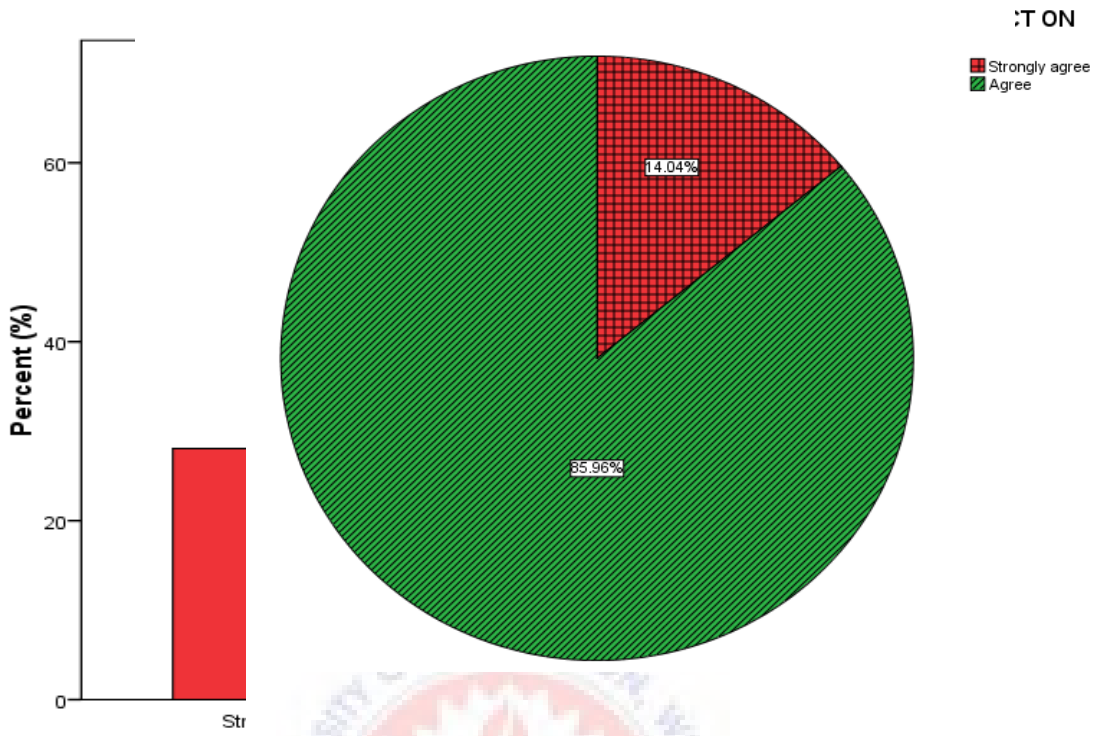

Fig. 9 **Comparative views of Respondents on Floods Impact on Communities**

4.6.4 Floods Impact on Agriculture

The research reveals that most of the respondents 54 out of 57 consultants (94.8%) are of the opinion that floods can have impact on agriculture, especially vegetable crops (Fig 10). Out of this, 89.5% agree and 5.3% also strongly agree that floods can have impact on vegetables crops as indicated by Rashid (2000) in the literature review. The remaining 3 out of 57 consultants i.e. (5.3%) however, neither agree nor disagree that floods can have impact on agriculture (fig 10). Since the region's main source of livelihood is farming, therefore, if this is affected, the whole country will be affected and government will be compelled to import more food in to the country instead of relying on the country's agricultural produce. This

will also affect businesses and their source of income will be curtailed. It is therefore necessary to support farmers by constructing dams to trap rain and surface water for agricultural purposes which otherwise would have cause flooding.

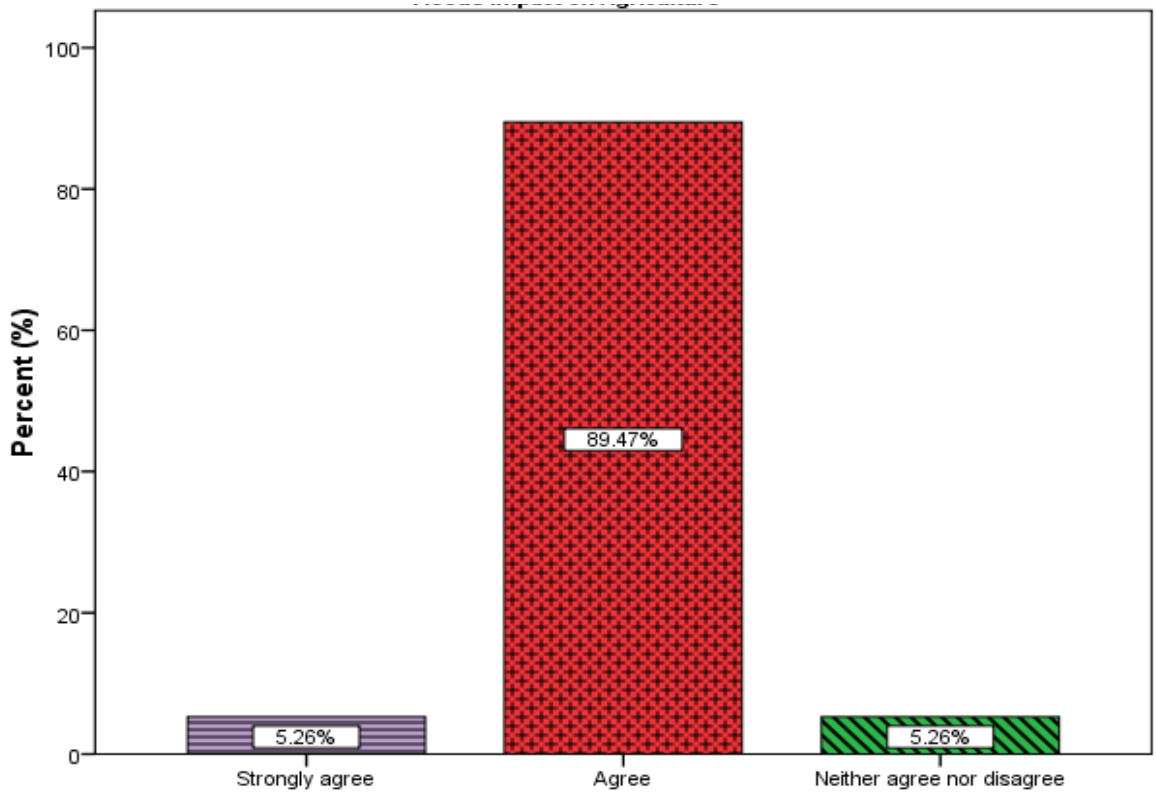

Fig. 10 **Comparative Views of Consultants on Flood Impacts on Agriculture**

4.7 Minimising the Effects of Floods

Fig. 11 indicates that out of the 57 respondents, (87.7%) indicate that government agencies should construct sufficient drains for residents. This is in view of the fact that if government agencies should construct sufficient drains in the metropolis, it will go a long way to reduce floods during heavy rains. This is in accordance with the views of Kuei-Hsien (2014) who also suggests the inclusion of design guidelines for constructing new flood protection

facilities with bioengineering and habitat features consistent with watershed management practices. This view was supported by Balmforth et al. (2006) who also encouraged landscaping the land surrounding the individual or group of buildings. The remaining (12.3%) however disagree. They were of the view that if residents should keep their surroundings clean and follow adequate construction practices, floods and other epidemics would be reduced. The inclusion of environmental hygiene in school curriculum was agreed by all consultants.

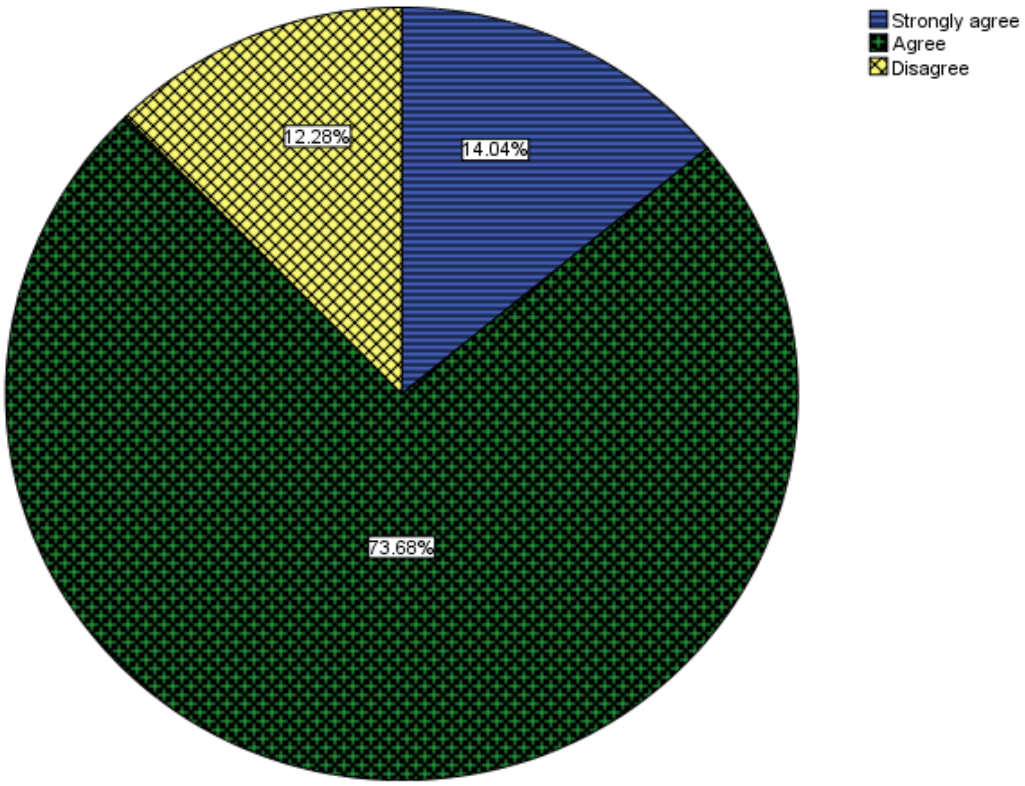

Fig. 11 **Comparative Views of Consultants on the Need for Government Agencies to Construct Drains for Residents**

Also, all 57 respondents agree that all houses should have sufficient drainage system to help minimize the effects of floods as suggested by Kuei-Hsien (2014). They further agree that people who throw refuse indiscriminately should be arrested and punished to serve as deterrents to others to keep their surroundings clean so as to minimize the effects of epidemics.

Furthermore, all the consultants agree that all roads should have sufficient side drains to convey run off and foul water to suitable discharge points. This will also reduce road surface water floods. With regard to the covering of drains to prevent dropping of solid substances, (94.7%) of the consultants are in agreement (that is 68.4% agree and 26.3% strongly agree); (3.5%) of them disagree, while (1.8%) neither agree nor disagree as indicated in figure 12. It has been observed that when drains are desilted, the silted materials are left at the sides of the drains. These silted materials drop back into the drain in no time and cause blockage, subsequently, leading to floods as observed by Gippel et al. (1992, 1996). The covering of roadside drains is therefore recommended to prevent solid materials from dropping in to cause blockage.

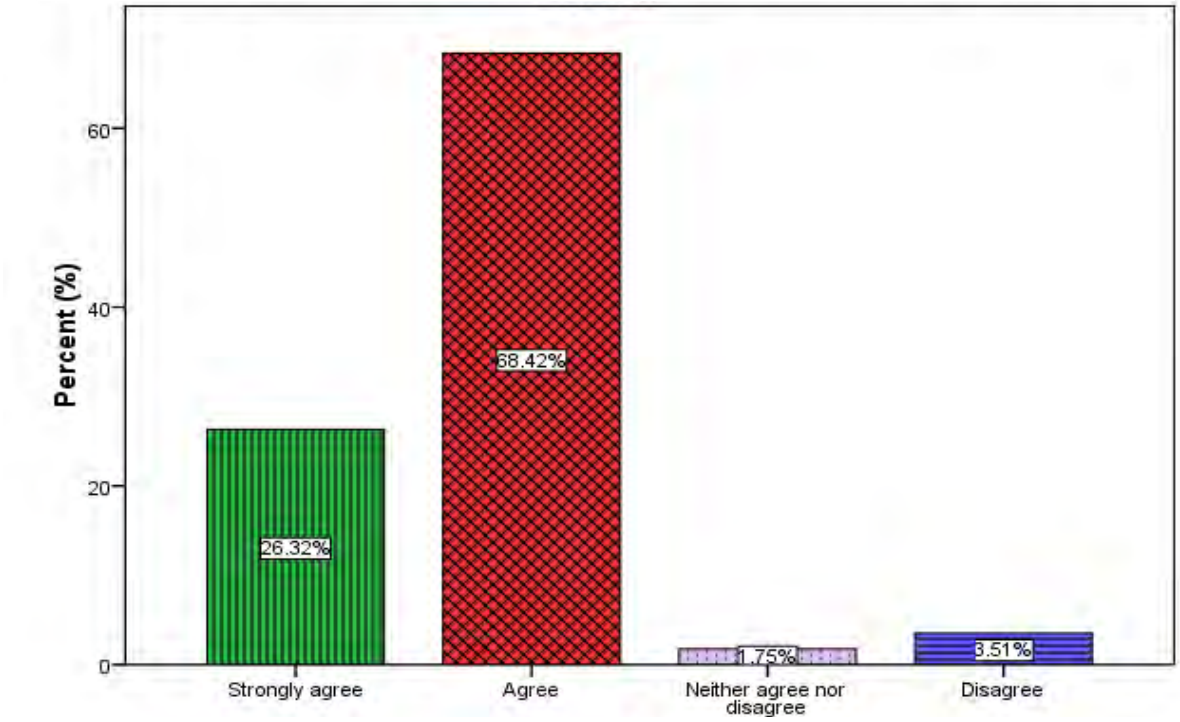

Fig. 12 **Comparative Views of Consultants on the Covering of Roadside**

4.8 Role of Design Team in Minimizing the Effects of Floods

The research reveals that all respondents sampled for the survey were of the view that construction industries should ensure that the floors of all structures in flood prone areas are raised above ground level. They are of the view that when ground floors of structures are related to Temporary Bench Mark (TBM), i.e. a height related to the mean sea level as indicated in Appendix 3, the effects of floods will be reduced. This is in accordance with Miklas (2011) who suggest that in construction buildings, the Basic Floor Elevation should be observed. They further recommended the use of suitable materials for building structures, and strongly advised residents against building on water ways. This is in accordance with

Planning Policy Statement (PPS) 25 Development and flood risk as indicated by Carina and Keskitalo (2010) and the associated Practice Guide.

4.9 Practical Steps by Design Team to Mitigate the Effects of Climate Change

Table 4.1 shows the views of respondent consultants on the practical steps needed by design teams to mitigate the effect of climate change. (33.3%) of the consultants indicated that sensitization programs should be organized to educate residents on the need to plant and preserve trees to mitigate the effects of climate change. When there are enough trees, the effect of dry wind which affects the weather is minimized, clouds are easily formed and normal rain fall pattern is maintained as suggested by Gill (2004) who also suggested three exposure units such as building integrity, human comfort and urban green space. This shows the important of trees in the environment. This was followed by (29.8%) who were also of the view that sensitization programs should be organized to educate residents on the effects of atmospheric pollution. When the atmosphere is polluted and there are floods, the flooded water is polluted and this affects plants and our source of water bodies as posited by Smith and Ward (1998). Emphasis is therefore given to the use of environmental friendly materials. Also, (14.0%) of the sampled consultants were of the view that education programs should be organized to acknowledge residents on the effects of encroaching water sources. They said when water source is encroached, the water dries up and this brings about climate change. Furthermore, (8.8%) also believe that residents should be educated on the need to avoid bush burning. The burning of bush kills life stock, insects and trees which can protect human beings from diseases. These livestocks fight against diseases and are very important. (5.5%) of respondents also indicated that government should construct more

dams and irrigation to ensure farming throughout the year. If more dams are built, surface and flooded waters can be impounded to support irrigation as suggested by Smith and Ward (1998) who were of the view that flood water themselves can bring advantages particularly with respect to common property resources and that regular annual floods provide abundant water resources to replenish lakes and ponds which, in turn, support irrigation or fish farming. The remaining (5.5%) were of the view that residents should be educated on the need to keep their environment clean.

Table 4.1 **Comparative Views of Consultants on Practical Steps to Mitigate Climate**

Views of consultants	**Frequency**	**Percentage**
Organize sensitization programmes to educate residents on the need to plant enough trees.	20	35.1
Educate residents to avoid encroaching water source.	8	14.0
Educate residents on the need to keep environment clean.	3	5.3
Encourage government to build more dams.	3	5.3
Educate residents to avoid bush burning.	5	8.8
Organize sensitization programmes to educate residents on the effects of atmospheric pollution.	17	29.8
Educate residents on the need to clean drains regularly.	1	1.7
Totals	**57**	**100**

CHAPTER FIVE

SUMMARY OF FINDINGS, CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

This chapter presents the summary, conclusion and recommendations that arose from the study. The research reviewed a wide range of literature and collected primary data on which the summary of findings, conclusion and recommendations are based. The study was conducted to investigate in to the impact of floods in Tamale Metropolis, and means of minimizing the risk through Resilient Design and Construction, a Disaster Risk Reduction conceptual framework which emphasizes a proactive approach to disaster management. It is imperative that communities adopt a risk reduction approach towards effects of floods. The research endeavored to answer the following questions:

i) What are the major causes of flooding in Tamale Metropolis?

ii) What are the possible ways by which floods can be minimised as well as mitigated?

iii) What are the impacts of floods on the socio-economic livelihoods of the people in Tamale?

iv) What are the recommendations by consultants in the design of building infrastructure to mitigate floods?

The summary of findings, conclusion and recommendations are outlined below;

5.2 Summary of Findings

It has been observed through the research that many houses within the metropolis are without the necessary facilities such as toilet and refuse discharge points in the metropolis. Some residents therefore put their refuse inside polythene sheets and dump them haphazardly. This causes blockages and leads to floods during rains. It again contributes to outbreak of diseases such as malaria, diarrhea and other strange diseases. It will therefore be appropriate if such residents are assisted with such facilities.

Furthermore, many structures are put up without due regard to "Bench Mark" (a height related to the mean sea level) during construction stage. When the floor levels of structures are below the floor level, then residents are bound to suffer flooding in time of heavy rains. Residents are therefore advised to raise the floor levels of their buildings, and relate them to the Temporary Bench Mark (TBM) as indicated in Appendix 3.

Also, it has been observed that after communal labour by residents to desilt drains, the silt from the drains is left by the drains, and this, with time drops back into the drains. This also contributes to the blockage of drains during rains to cause flood. Residents should therefore be encouraged to clear all materials (silt) from the sides of drains after general cleaning.

Finally, there are not enough trees in the metropolis and residents therefore suffer the least storm that occurs. Residents are therefore encouraged to plant enough trees, preserve water bodies and avoid building on water ways in order to minimize the effects of disaster.

5.3 Conclusion

As discussed under various sections in this research, it is clear from the study that floods have adverse impact on the socio-economic status of livelihoods on people in Tamale Metropolis. To a large extent, the study has established that resilient design and construction, and livelihood patterns play an important role in settlement patterns. It is also evident that construction industries (consultants) be made to supervise all buildings during construction to ensure that safety measures are met. Tree planting should be encouraged, and water source be preserved to mitigate the effects of climate change in the metropolis. The study has further demonstrated that effects of floods in one sector can affect other sectors of society. For instance, as discussed under the health section, the outbreak of disease incidences (malaria, diarrhea and other strange diseases) was attributed to the impact of floods.

a) There appears to be lack of research on short and long term environmental impacts of flooding and also, limited studies on chemical hazards due to flooding and inundation.

b) Traditionally, assessment of environmental loss is not considered important. Therefore, systematic and scientific environmental impact assessment of flooding, investigations, records, and publications are very rare.

c) Normally, intangible losses are not taken into account while calculating flood losses; on the other hand most of the environmental consequences cannot be evaluated in the monetary term.

d) There are several models which can simulate the flooding event. Similarly, there appears to have several environmental modelling programmes, which can simulate the environmental problems. However, this research indicates that there is the need for developing an integrated model, which can simulate environmental problems along with the hydraulic modelling of a flood event.

e) There should be a deliberate policy to compel communities especially in rural areas to build house using durable materials and away from the flood prone areas.

f) There appears to be flood management plans of each flood prone country. Some countries appear to have protocols of safety and evacuation of chemical plants in case of flooding. However, official protocols are not in the public domain that can be easily accessed, for example by searching in the internet or in the database.

g) Community initiated mitigation measures should be promoted so as to build community resilience.

This research deals with minimizing the risk of floods through resilient design and construction in the Tamale Metropolis. It emphasizes a proactive approach to resilient design and construction to mitigate floods and disaster management, and also suggests measures by which residents and people living in similar flood prone areas could follow in managing, if not prevent, flood in such events. It further deals with challenges that residents

face after flood events and how they cope with such situations. Finally, it educates residents on how to regularly clean their surrounding so as to prevent the outbreak of certain sicknesses after flood events.

5.4 Recommendations

The following recommendations are made in order to minimize the numerous problems that residents of Flood prone areas in Tamale Metropolis and other people living in similar areas do encounter during rainy seasons. These include short term and long term planning:

(1) There is the need to relate the floor levels of all structures to "Temporary Bench Marks" (a height related to the mean sea level) during construction stage in order to minimize flooding during heavy rains. (See Appendix 3).

(2) There should be a deliberate policy to compel communities especially in rural areas to build houses using durable and suitable materials and away from water ways and flood prone areas.

(3) There is the need for the introduction of environmental cleanliness, health protection, tree planting and flood management in to the school curriculum starting from the basic to tertiary level to educate people on health, i.e. how to keep their environment clean, where to eat, what to eat, measures to be taken during outbreaks and also what to do during flood events.

(4) There is a need for a systematic publication on flood environment so that researchers, scientists and policy makers are encouraged for publication of their works on a regular and

systematic manner. For example starting a publication of a journal on "Flood and Environment" would be an ideal.

(5) There is the need to organize workshops for people living in flood prone areas to educate them on the need to plant trees, preserve water bodies, avoid bush burning, clean drains and surroundings regularly and establishing a precious environmental impact assessment methodology to mitigate the effects of climate change. In order to promote and encourage scientific research as well as to assist decision making process, workshop/seminar/symposium/conferences with special topics on "Environmental Impact Assessment of Flood" is recommended. Such a gathering may help to streamline and generate future strategies. Such a forum should invite the multidisciplinary research contributors such as Chemical Engineers, Environmental Engineers, Agricultural Scientists, and Economists along with the Civil/Hydraulic Engineers.

(6) In order to prevent people from littering any how within the environment to cause blockage of drains during rains, there is the need for government agencies, Non Governmental Organization (NGO^{s}), National Disaster Management Organization (NADMO), etc to support each house to built toilet facilities, provide refuge containers at vantage points to enable residents dump their refuse inside. This will go a long way to minimize flooding and help control the outbreak of strange deceases during flood events.

(7) Road side drains should be covered to prevent the dropping of solid substances which might cause blockage leading to flooding after rains.

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APPENDICES

Appendix 1

A QUESTIONNAIRE FOR BUILT ENVIRONMENT CONSULTANTS

The questionnaire is designed to collect data on the opinions of consultants on how effects of floods could be minimized through appropriate design of infrastructure.. Please read the statement carefully and tick (✓) the option(s) which you think are applicable or provide your opinion which best answers the question.

All responses will be confidential and will not be connected in any way to you or your organization, but solely for research purposes required in partial fulfillment of Master of Science in Construction Technology Education.

SECTION A: PARTICULARS AND GENERAL INFORMATION ABOUT RESPONDENTS

1.0 What is the age category you belong? *(Please tick).*

Under 20 years	□	21 – 30 years	□
31 – 40 years	□	41 – 50 years	□
51 – 60 years	□	Above 60 years	□

2.0 Please indicate your gender. *(Please tick)*

Male	□
Female	□

3.0 What is your current job title? *(Please tick).*

Project Manager	□	Architect		
Structural Engineer	□	Services Engineer		
Quantity Surveyor		Managing director		
Site Manager		Other please state		

Q 4.0 What is the number of years you have been working in the construction industry? *(Please tick)*

Under 5 years	□	5 – 10 years	□
Above 10 but less than 15 years	□	15 – 20 years	□
Above 20 but less than 30 years	□	Above 30 years	□

SECTION B: TAKING FLOOD DISASTERS INTO CONSIDERATION IN THE DESIGN OF INFRASTRUCTURE.

The section seeks your expert opinion on how floods could be prevented and/ or the effects of floods minimized in Tamale metropolis.

Q5.0 To what extent do you believe the construction industry, as a whole, is involved in emergency response to floods in Ghana

Regularly involved	□	Involved on an ad-hoc basis	□	Not involved but should be	□	Not involved	□	Don't know	↑

Q6.0 To what extent do floods pose threats, in terms of their cost to, and effect on, the long-term resilience of the built environment in Tamale Metropolis? ***(Please tick the appropriate box)***

(a) No threat ☐

(b) Minor threat ☐

(c) Major threat ☐

(d) Significant threat ☐

(e) Don't know ☐

Q7.0 To what extent does your professional training include flood risk reduction?

(a) Issue already integral to training provision ☐

(b) Issue is increasingly being integrated into training provision ☐

(c) May become part of training provision ☐

(d) Is not a part of training provision ☐

(e) Not applicable ☐

Q8.0 To what extent do you agree with the statements below? (Please tick the appropriate box)

Statement(s)	**Strongly agree**	**Agree**	**Neither agree nor disagree**	**Disagree**	**Strongly disagree**
Flood prevention should be part of school curriculum					
Government agencies should construct sufficient drains for residents					
All houses should have sufficient drainage system					
People who throw refuge indiscriminately should be arrested and punished to serve as deterrence to others					
Government should always support flood victims					
Flood victims should always be provided with free medical care					
People who dump refuge anyhow are illiterates					
Environmental hygiene should be included in School Curriculum					
People throw refuge anyhow because there are no refuge points					
Health protection agencies should be formed to ensure the good health of everyone in flood prone area					
Everybody should keep his/her environment clean					
All roads should have sufficient drains at the sides to convey rain and foul water to a suitable discharged point					
All drains should be covered to prevent the dropping of solid substances					
Residents in flood prone areas should be encouraged to take warm food rather than cold foods					
People who sell food at unhealthy environment should be arrested and find					

Residents should wash their hands with soap and clean water after visiting the private (toilet/urinal)					
Flooding can lead to teenage pregnancy and other sexual transmitted diseases.					
Floods can lead to disruption of learning in school					
Floods can have impact on vegetables and other food crops					
Our source of water can be affected by floods					
Construction industries should ensure that the floors of all structures are related to temporary bench mark i.e. (mean sea level)					
Most houses in Tamale Metropolis lack sanitary facilities					

Q9.0 What practical steps do you think your profession should pursue to mitigate the effects of climate change? *(Please use a separate sheet if necessary)*

Appendix 2

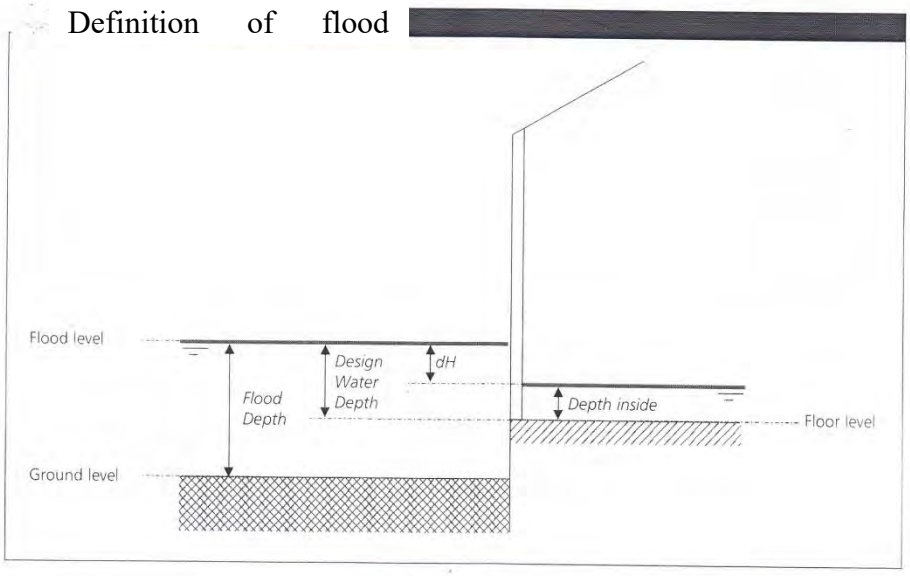
FLOODS IN GUMANI AFTER HEAVY DOWN POOR ON THE 19TH SEPTEMBER 2013

SCHOOL CHILDREN MANAGING THEIR WAY TO SCHOOL AFTER DOWN POUR

Appendix 3

IMPROVING THE FLOOD PERFORMANCE OF A NEW BUILDING

Definition of flood



CONCEPTUAL ILLUSTRATION OF FLOOD WATER DEPTHS