UNIVERSITY OF GHANA

SMALLHOLDER FARMERS' VULNERABILITY TO FLOODS IN THE TOLON DISTRICT, GHANA

BY

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DECLARATION

I hereby declare that this thesis is as a result of my own work towards the award of Master of Philosophy in Geography and Resource Development. To the best of my knowledge, it contains no material previously published by another person nor material which has been accepted for the award of degree at any University, except where due acknowledgement has been made in the text.

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DEDICATION

I dedicate this piece of work to the almighty God for granting me wisdom, strength and ability to complete this thesis successfully.

I also dedicate this work to my parents Mr Samson M. Jakpa, Madam Charlotte V. Seidu and to my siblings. I owe them a debt of gratitude for their love, motivation and support they showed me throughout my M.Phil. study.

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LIST OF ACRONYMS

CBO	Community Based Organisations
DFID	Department for International Development
E.L	Executive Instrument
EPA	Environmental Protection Agency
FBO	Farmer Based Organization
GIS	Geographic Information System
GPS	Geographic Positioning System
GSS	Ghana Statistical Service
IFAD	International Food and Agricultural Development
IPCC	Intergovernmental Panel on Climate Change
LVI	Livelihood Vulnerability Index
MoFA	Ministry of Food and Agriculture
NGO	Non-governmental organisation
SLF	Sustainable Livelihood Framework
SLVI	Sustainable Livelihood Vulnerability Index
SPSS	Statistical Package for Service Solution
UN/ISDR	United Nations International Strategy for Disaster Reduction
UNFCC	United Nations Framework on Climate Change Conference
VA	Vulnerability Assessment.

ABSTRACT

Flooding is by far the most destructive type of weather conditions that strikes humans and their livelihoods around the world. Smallholder farmers in rural communities are predominantly dependent on rain-fed agriculture which exposes them to the vagaries of floods. Flood extremes have become more unpredictable and smallholder farmers are more vulnerable to them as a result of their limited adaptive capacity. Local level assessment of flood vulnerability is thus necessary in order to formulate policy measures towards strengthening their adaptive capacity. This study investigated the spatial pattern and factors that trigger floods in the study communities in the Tolon District. It also assessed the degree of smallholder farmers' vulnerability to floods in the district. The assessment was conducted in four rural farming communities in the district.

The study finds that location of farms is the principal determinant of flood vulnerability and as such households in communities such as Tampia and Kpalisogu- Kura which are closer to the valley of the White Volta River are highly vulnerable to floods as compared to Yoggu and Kpalgun which are inland. Flood occurrence in the study areas are the direct result of continuous heavy rainfall episodes over many days; this triggers floods around the floodplains in communities near the river and in low-lying areas of inland communities. Again, there are little efforts at planning and developing measures that will help reduce farmers' losses from floods in study communities, this is attributed to limited knowledge, financial and material resources to adapt. Policy measures and development efforts should focus on improving adaptive capacities of smallholder farmers including providing livelihood options like food processing and craft work, and access to financial and technical assistance.

KEYWORDS: Floods, smallholder farmers, vulnerability, exposure, sensitivity, adaptive capacity.

CHAPTER ONE: BACKGROUND OF THE STUDY

1. 1. Introduction

Flooding is by far the most destructive type of weather extremes that strikes humans and their livelihoods around the world (Dhar & Nandargi, 2002). Over the years, there has been catastrophic flooding experienced worldwide in China, India, Bangladesh, Germany, Poland, Mozambique, South Africa, Zimbabwe, Malawi, Botswana, Namibia, Ghana and many other places but a high proportion of people that suffer its negative impacts live in rural areas in Less Developed Countries (LDC). Rural communities in developing countries are gravely affected by flood extremes due to their high dependence on rain-fed agriculture and their limited capacity to respond to climate-induced disasters (United Nation Framework on Climate Change Conference (UNFCCC), 2009).

International Fund for Agricultural Development (IFAD) statistics show that 50% of less developed countries' (LDCs) rural population are smallholders (cultivating on a crop land of 3 ha or less per farmer). The segment of smallholder farmers in sub-Saharan Africa is higher at 73% (IFAD 2012). In addition, rural smallholder farmers produce 80% of food locally consumed in Asia and Sub-Sahara Africa with women farmers constituting a significant percentage (Adejuwon, 2006). Ironically, smallholder farmers have been discovered undoubtedly to have an important role in producing adequate food for present and future generations, and yet are also the ones that suffer most from flooding and other disasters that are induced by climate as a result of their exposure to climate risk and limited adaptive capacity (Morton, 2007).

Initial efforts at dealing with flood issues focused on mitigation with the aim of reducing greenhouse gas (GHG) concentration in the atmosphere (UNFCCC, 2009). However, granting that reduction or possibly stabilizing the concentration of GHG, global warming would continue to rise over long periods because of the inertia of the earth systems, this will cause weather extremes such as floods to continually occur (Nyong et al., 2008).

In Northern Ghana, floods are among the most regular and destructive natural disaster that affect livelihoods especially farming. Agriculture is mostly rain-fed and predominantly on a subsistence basis with about 90% of farm holdings being less than 2 hectares in size (MoFA, 2007). Thus the occurrence of a flood event directly affects their agricultural output. The region is also noted for its high poverty levels ranging from 69% to 88% in the country as well as underdevelopment (GSS, 2008). The Tolon district is one of the flood prone areas in northern Ghana. Over the years, torrential rainfall and the spillage of water upstream from the Bagre dam in Burkina Faso have resulted in perennial flood situations. Within a ten-year period that is from 2004 to 2014, the district was struck by six flood events in 2004, 2007, 2008, 2009, 2010 and 2012 usually within the months of July to September (NADMO, 2007; Musah et al., 2013). This has resulted in injuries as well as destruction of agricultural produce and key infrastructure. A typical example is the August 2007 floods that affected about 3,000 hectares of farm lands, and destroyed crops including maize, groundnuts, yams cassava and rice (MoFA, 2007; NADMO, 2007; Musah et al, 2013). Again, about 1,300 households were rendered homeless. There was also the outbreak of water-borne diseases such as malaria, cholera and diarrhoea amongst children.

Even though flood events occur at the district and community level, past assessment of flood vulnerability have mostly been at the national level with limited consideration to the local level. Local level assessment is important as it can be used as inputs for macro level assessments (Callaway 2004: Frazer et al, 2011). Again, most farmers at the local level tend to be more vulnerable because of their location and limited adaptive capacity to cope with floods. Hence, there is a need for vulnerability assessment to bring to light local specific conditions and aspects of households and communities' adaptive capacity that require improvement.

This study sought to investigate smallholder farmers' vulnerability to floods in the Tolon Districts in the Northern region. The study also assessed household flood vulnerability in comparable terms and how households draw on available resources to cope with flood impacts.

1.2. Statement of the research problem

Flood hazards are often perceived by rural dwellers as a natural event which cannot be controlled or prevented by man. This is partly true because aside anthropogenic factors that cause floods, the inertia of the earth systems will continue to warm the earth and lead to increase in weather extremes such as floods to occur (Nyong et al., 2008). Therefore, the occurrence of floods may not cease any time soon; however, measures can be taken to strengthen the victims' ability to cope effectively with the impacts. The impact of floods can be minimized if the adaptive capacity of affected people is higher than their exposure and if the sufferers are seen as active agents in managing floods. Unfortunately, policy makers at national and local levels have unfairly perceived the rural poor who are exposed to floods as non-active agents and innocent victims (Anderson & Woodrow, 1991). Such perspective is in line with the all-natural-hazard approach to flood vulnerability and fall short of the socio-economic dynamics that also shape vulnerability (Ford et al, 2010).

In Ghana, efforts to address flood issues over the years have not yielded desired results. This is probably because, efforts in assessing flood situations leave out local perceptions and experiences and portrayed local dwellers as passive agents in flood management, hence, mitigation strategies have basically shrugged off traditional adaptive strategies. Also, government often provide support to affected victims in the form of relief items, rehabilitation and resettlement of flood victims. But these are mostly in a short period and are unable to give long-term solutions to local flood situations or build the adaptive capacity of vulnerable smallholder farmers to floods.

Any attempt at building farmers' resilience to floods will require a detail assessment of household vulnerability in order to highlight where adaptive capacity needs to be strengthened.

Also, there is limited information on local level assessment of flood vulnerability. Assessments are mostly at the national level especially in slum areas and informal settlements in cities (Rain et al., 2011: Danquah, 2013). Micro-level assessment is a vital prerequisite for local-level planning and prioritizing resilience among agricultural dependent communities at risk of climate variability (Fraser et al., 2011). Whiles flood vulnerability assessment is not limited to only national level, studies by Yuga et al., (2010) have asserted that local level assessment of climate induced vulnerability have largely been ignored. In the same light, Deressa et al., (2009) observed that, climate induced vulnerability analysis ranges from local or households level to the global levels. Vincent (2004) and Vincent & Cull, (2010) have also stated that vulnerability analysis of climate hazards is scale dependent; indicators used for assessing national scale adaptive capacity may not be representative at the local level even though local level analysis has the potential of informing policy at the national level.

The study therefore focused on household-level flood vulnerability assessment using four selected communities in the Tolon District as a case study against the background that, the outcome can serve as inputs for national level assessment and also inform policy at the local level.

The research questions addressed in this study are:

- What is the spatial and temporal variation of flood events in the Tolon district?
- What factors trigger the occurrence of floods in the district?
- What are the adaptive capacities of smallholder farmers in the district?
- What is the degree of individual farmers' vulnerability to floods in the district?

1.3. Research objectives

The main purpose of this study was to examine the spatial and temporal pattern of floods vulnerabilities in the Tolon District.

Specific objectives addressed in the study include:

- To assess the spatial-temporal variations of flood events in the Tolon district.
- To identify the factors that trigger flood events in the district.
- To assess smallholder farmers' adaptive capacity to handling flood events in the district.
- To apply the household livelihood vulnerability index to assess farmers' vulnerability to floods in the district.

Propositions

- Households in communities closer to the White Volta River are more likely to be exposed to floods than households inland.
- Households with low adaptive capacity are likely to be more vulnerable to floods.

1.4 Conceptual framework for household vulnerability assessment for the study

The study combined the IPCC's and part of the Department for International Development (DFID) vulnerability frameworks to create the total household vulnerability framework for the assessment.

The total household vulnerability framework for this study conceptualized vulnerability as a product of exposure, sensitivity and adaptive capacity (index components) and adaptive capacity was regarded as access to and possession of assets by households including physical, natural, human, financial and social assets. It assumes smallholder farmers' flood vulnerability to be caused by a wide range of interacting indicators representing the three index components. Indices are also highly interconnected and interact collectively to create a particular vulnerable context.

Individual indices are reflected in the results at varying levels. Adaptive capacity for instance is made up of livelihood assets indicators which include having means to access information, knowledge on climate change, access to credit facilities, disaster aid, number of farms owned, livelihood diversification index, dependency ratio and membership in Farmer Based Organization and Community Based Organizations. The outcome of each index reveals a particular household's strengths and weaknesses in dealing with flood disasters. A household might be least vulnerable in one, two or all the three index categories which may make them least vulnerable in the total household vulnerability. Also, a household might be least vulnerable in one or two category but may be highly vulnerable in the total vulnerability outcome. Hence, the total household vulnerability can be determined from the net effect of the three indices, that is exposure plus sensitivity minus adaptive capacity. Indicators under all three indices are computed based on Hahn et al., (2009) livelihood vulnerability index.

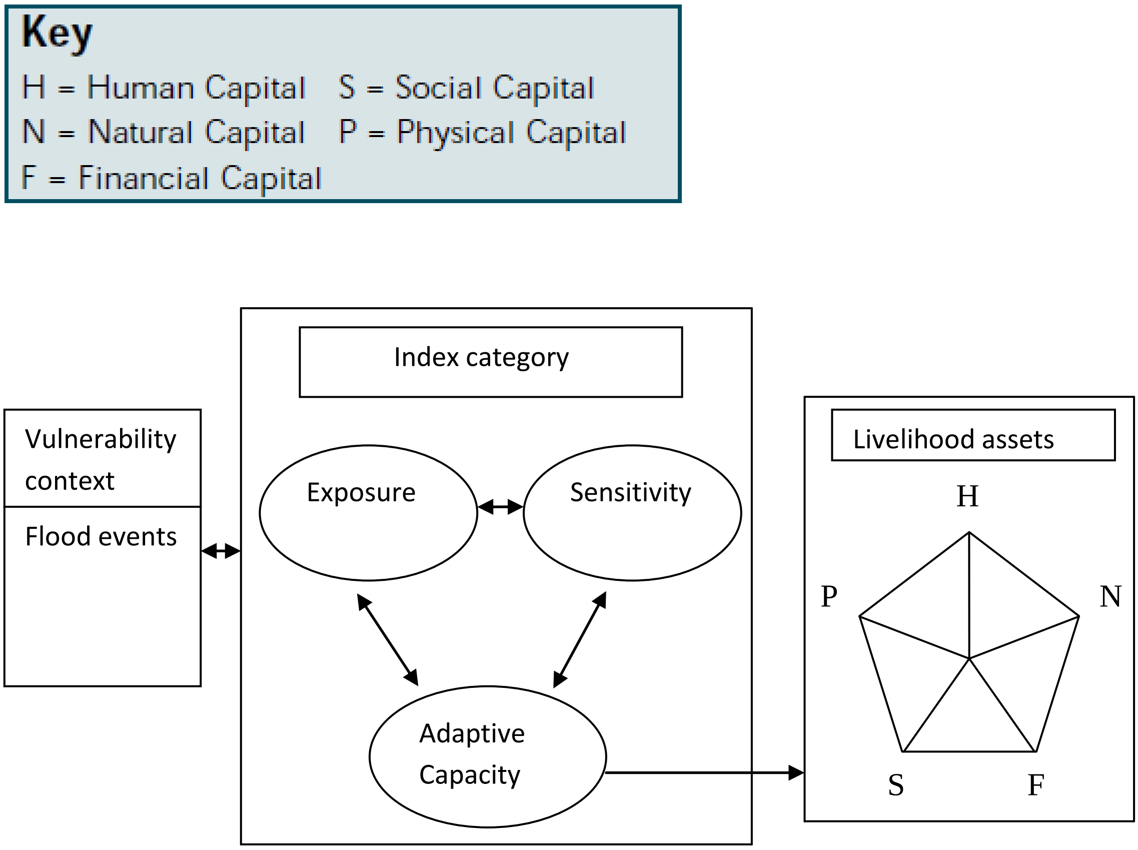

Figure 1.1: Total household vulnerability assessment framework (THVAF)

(Source: field survey, 2015).

The purpose of estimating indicators for exposure, sensitivity and adaptive capacity is to examine their contribution to household vulnerability to floods events. The outcome of the vulnerability index showed patterns in household exposure, elements that are sensitive to flood event and aspect of household adaptive capacity that needs to be maintained or improved. The index is also useful for policy intervention in building the resilience of smallholder farmers to flood disasters.

1.5 Rational of the study

Floods are the most destructive, amongst all natural hazards and this makes it an important environmental problem to study. As established earlier, rural dwellers who have their livelihood grounded in rain-fed agriculture suffer severe impacts of flood. Rural areas are also characterized by high poverty rates and underdevelopments which results in their low adaptive capacity to sustain flood impacts. Strengthening adaptive capacity in flood prone rural areas starts with taking into consideration community needs and priorities.

Though, climate change is experienced worldwide, its impacts are felt differently and varies from locality to locality. Adaptive actions taken to minimize flood impact also vary at different levels even in the remotest areas. Effective policy planning for flood management measures requires a field-base investigation of local vulnerabilities with community priories and needs. Local level assessments can form inputs to inform policy at the macro level. This calls for a comprehensive investigation of vulnerabilities at the local level to provide insights into the underlying issues that shape rural flood vulnerability.

Also, there is limited information on the livelihoods of rural agricultural households and their vulnerability to floods eventualities using integrated approaches of assessment. In line with this, there is the need for detailed exploration of the local level assessment with integrated approaches to provide a holistic understanding of rural agriculture livelihoods and their level of vulnerability to floods.

Academic research in the area includes an M.Phil. Thesis (Awen-Naam, 2011) submitted to the University of Bergen, Norway which investigated the *"Perceptions of Climate change and adaptation; A case study of peasants in the Bulsa district of the Upper East*

Region of Ghana". There are also a number of published works relating to this study in Ghana including Antwi-Agyei et al (2012) who investigated *"Characterising the Nature of Vulnerability to Climate Variability: Empirical Evidence from Two Regions of Ghana",* and Golo and Yaro's (2013) article titled *"Reclaiming stewardship in Ghana: Religion and Climate Change. Nature and Culture".*

The above mentioned studies have examined a wide range of climate related vulnerabilities that are somewhat related to smallholders' vulnerabilities to floods. Nevertheless, none of these studies examined in great details specific issues of integrated flood vulnerability of individual farmers to floods. In view of the above, the study can be justified on the grounds that it provides understanding into varying vulnerabilities of rural farmers to floods.

Again, the Hahn et al., (2009) LVI was developed and applied in two communities in Mozambique at risk of climate related hazards. Their approach proved insightful in capturing differentials in community-level climate vulnerability. Although used in the southern African context of Mozambique, its structured approach provides a realistic measurement of indicators. This study sought to apply the same method in measuring flood indicators in the Tolon district to understand smallholder farmers' livelihood and their flood vulnerabilities.

The study is also significant in contributing to the policy discourse on flood vulnerabilities and the adaptive capacity of rural farmers. It is also relevant for policy formulation and practice, the adaptive capacity of farmers can be relevant for long-term adaptation policies aimed at achieving environmental sustainability and agricultural development to ensure food security and hence contribute towards the achievement of the first United Nations' Millennium Development goal (MDGs) of eradicating extreme poverty and hunger by 2015.

1.6. Scope of the study

The study was carried out in four villages in the Tolon district in the northern region of Ghana. The district lies within the guinea savannah ecological zone and shares borders with the White Volta River. The district has recorded severe perennial floods that affected people and livelihood with the 2007 and 2010 flood being the most destructive in recent times. The region is also characterized by poverty and underdevelopment which generally limits their adaptive capacity to floods.

The study dwelled on the IPCC conceptualization of vulnerability which is a product of exposure, sensitivity and adaptive capacity. Indicators for all vulnerability components were theory-driven and field-driven. The study used a period of 10 years as a recall window and time frame. Data on climate variables such as average monthly minimum, maximum temperature and precipitation were obtained from the Ghana meteorological Agency, northern region and covered a period of 10 years (from 2004 to 2014).

1.7. Outline of thesis chapters

The thesis is structured into six chapters the details of which are outlined below.

Chapter one: Introduction. This is the introduction to the entire thesis and presents the context of the study, giving the background to the study, the statement of the research problem, aims and objectives of the research and rational for undertaking the study.

Chapter two: Literature review

This chapter was devoted to review of literature related to conceptual issues that were addressed in the research. These included data on climate change and floods, smallholder farmers' livelihoods and their degree of vulnerability, theories and frameworks underpinning the assessment of vulnerability, its application and relevance to the study as well as its limitations. Published documents on vulnerability assessments were also reviewed.

Chapter three: the study areas

The chapter provided the context to the study. It started with a broad overview of the community and narrow down to a more specific description that is in line with the objectives of the study. The physical geography of the study area including location, climate, vegetation, and landscape were described. Also, farming and other livelihood activities, resources availability and access were also discussed in this chapter.

Chapter four: Research methodology and methods

The fourth chapter provided methodological approach of data collection methods that were employed in the field, tools and method of analysis. It discussed the choice of methods for the study, date sources, and an account of how the field work was conducted.

Chapter five: analysis and discussion of results

Here, vulnerability maps were produced for all four communities based on the calculated score for each household. Access to livelihood resources and how that determines their adaptive capacity was discussed as well as issues of their perceptions on the effectiveness of their adaptive strategies.

Chapter six: Summary, conclusion and recommendations

The final chapter summarized major findings of the research in line with the aims and objectives, provided recommendations and proposed areas for further studies.

CHAPTER TWO: REVIEW OF RELATED LITERATURE

2. 1 Introduction

Smallholder farmers' vulnerability to floods induced by climate change is not solely about the occurrence of flood events but a combination of the events and the internal factors (biophysical and socio-economic) which interact to shape farmers' vulnerability. This chapter presents a review of literature on evidence of climate change in Ghana, smallholder farmers' and their access to resource and a conceptual framework that underpins the concept of climate change vulnerability for the study.

2. 2 Climate change

Climate change is one of the challenges facing humanity in recent times. Warmer temperatures, changes in precipitation patterns, increased climate variability and more extreme weather events such as floods, droughts and cyclones are expected to pose insecure conditions (IPCC, 2007).

The IPCC defines climate change as "a change in the state of the climate that can be identified (e.g., by using statistical tests) by changes in the mean and/or the variability of its properties, and that persists for an extended period, typically decades or longer". Climate change may be attributable to natural internal processes or external forces such as the inertial of the earth systems, modulations of the solar cycles, volcanic eruptions, and man's continual emission of GHG into the atmosphere which alters it (IPCC, 2007). Simulation models have been used in climate change assessment to estimate the relative contribution of natural factors including changes in radiation from the sun, dust from volcanic eruptions, and anthropogenic factors such as GHG emissions.

Significant rise in temperature have been observed during the 20th and 21st centuries. Initial efforts employed to manage climate change issues focused on mitigation with the aim of reducing GHG concentration in the atmosphere (UNFCC), 2009). However, granting that reduction or possibly stabilizing the concentration of GHG, global warming would continue to rise over long periods because of the inertia of the earth systems causing weather extremes such as floods and droughts to continually occur (Nyong et al., 2008).

Floods disasters have been seen to be the most common and destructive type of natural disasters that strikes humans and their livelihoods around the world (Dhar &Nandargi, 2002). Flood is defined as water overflowing onto land that usually is dry and often caused by heavy rainfall. Flood events lead to damages through the power of flowing water and through the deposition of dirt and debris when flood water recede (Doswell, 2003). Over the years, there has been catastrophic flooding experienced worldwide in China, India, Bangladesh, Germany, Poland, Mozambique, South Africa, Zimbabwe, Malawi, Botswana, Namibia, Ghana and many places but a high proportion of people that suffer the toll live in rural areas in less developed countries (Dhar &Nandargi, 2002). In Mozambique for instance, the 2000 flood disaster displaced about 4000 people in just Maputo alone and destroyed key infrastructure including transport networks (Christie and Hanlon, 2001). The causes of the floods were extreme downpour over several days. Also, heavy down pours in East Africa in 2002 resulted in flood situations which rendered thousands of people homeless in Rwanda, Kenya, Burundi, Tanzania and Uganda (Klein et al., 2007).

While climate change is global in nature, potential changes are not expected to be globally uniform; rather, there may be dramatic regional differences. Climate change is a major threat to sustainable growth and development in Africa, and the achievement of the Millennium Development Goals. Although Africa is the continent least responsible for climate change, it is particularly vulnerable to the effects, including reduced agricultural production, worsening food security, the increased incidence of both flooding and drought, spreading disease and an increased risk of conflict over scarce land and water resources (Dhar & Nandargi, 2002).

Africa is highly vulnerable to climate change with more challenging hurdles in reaching the Millennium Development Goals (MDGs). Climate change and variability will have wide-ranging effects on the environment, and on socio-economic sectors, including water resources, agriculture and food security, human health, terrestrial ecosystems and biodiversity. Changes in rainfall pattern are likely to lead to severe water shortages and/or flooding.

2.2.1 Evidence of climate change and variability in Ghana

Climate change is increasingly recognized as a major human security issue that poses serious threat to the world of which Ghana is not an exception. The climate is dominated by two major air masses: the dry and warm North-East Trade Winds and the moist South-Westerlies or the monsoons. The moist maritime monsoons are associated with rainfall while the dry Trade Winds bring dry conditions. Thus the country has distinct dry and wet seasons depending on the dominant wind in the area.

Generally, rainfall in Ghana has decreased from south to north. The wettest area is the extreme southwest where annual rainfall is about 2000mm. In the extreme north, the annual rainfall is less than 1100mm (Environmental Protection Agency (EPA) of the Government of the Republic of Ghana, 2000: EPA, 2010). The driest area is the wedge-like strip from east of Sekondi-Takoradi, extending eastward up to 40km where the annual rainfall is about 750mm. The dry conditions in the south eastern coastal strip are anomalous and are the cause of important differences in ecology and land use from the rest of the country. Temperatures throughout the country are typically high. The mean annual temperature is generally above 24ºC, a consequence of the low latitude position of Ghana and the absence of high altitude areas (EPA, 2010).

Climate change and variability is already affecting Ghana’s water resources, and often attributed to global warming caused by increased greenhouse gas emissions for several decades. Whilst there is no concrete evidence of climate change occurring in Ghana (some climate variability through changing regimes of climatic factors are evident), the country is experiencing the impacts and outcomes of climate change through global warming effects. These climate changes considerably impact on water resources, with a reduction in river flows, reduced groundwater availability and floods; they also negatively affect agricultural yields, particularly in the centre and north of the country.

Ghana is also vulnerable to floods that damage property and lives. Flooding events in northern Ghana alone, in recent times (especially 2007 and 2009) and the most recent ones in Accra (in 2011), have had serious consequences and sent a strong signal of the need for better flood control infrastructure in this part of the country (GSS, 2008).

Climate change may also manifest itself in changes in the rainfall pattern. Extreme rainfall intensities may result in serious soil erosion and overall land degradation. The majority of people in northern Ghana are dependent on rain-fed farming for their livelihoods, and alternative income generating strategies are limited (Etwire et al, 2013). Food and livelihood security are challenged by decreasing soil fertility, desertification, deforestation and inequitable access to and control over resources such as land. They are already experiencing the impacts of climate change in the form of shifting rainfall patterns and more frequent and extreme droughts and floods (Musah et al., 2014); this further put strains on food security and livelihoods, leading to dire consequences for already vulnerable people. Not surprisingly, climate-related hazards such as droughts, floods and erratic rainfall were highlighted as having the most significant implications for food and livelihood security in northern Ghana (Armah et al 2010: Etwire et al, 2013).

The IPCC model ensemble indicates a possible decrease in mean monthly precipitation of 80 mm in the northern and an increase of 80mm in southern parts of Ghana over the summer months of June, July and August. Furthermore, inter-annual variability in rainfall is expected to increase, with a rise in the intensity of high rainfall events but an overall decrease in the number of rain days. Annual rainfall in Ghana is highly variable on inter-annual and inter-decadal time scales. This means that long-term trends are difficult to identify. Rainfall was particularly high in the 1960s, and decreased to particularly low levels in the late 1970s and early 1980s, leading to an overall decreasing trend in the period 1960 to 2006, with an average of 2.3 mm per annum. (EPA 2009).

2.3 Smallholder farmers' agriculture and flood adaptive strategies

Smallholder agriculture is often used to represent rural producers predominantly in developing countries where farming is done on small parcels of land of three ha or less per farmer (IFAD, 2012). This type of farming is usually done with family labour for consumption purposes and also serves as a main income source for farmers which they use to meet their basic needs (Cornish, 1998). This system is generally characterized by low level of technology with small farm holdings often practiced under traditional land tenure. Much of farmlands owned by smallholder farmers are on marginal or climate risk-prone environment (Scoones et al., 1996). Apart from crop farming, smallholders are also engaged in livestock rearing and practice hunting and gathering of wild resources. They are also mostly involved in non-farm economic activities and income generated is used to supplement farm income for their livelihood activities (Cornish, 1998).

Worldwide, smallholder farmers' population is estimated to be about 450 to 500 million farmers which accounts for 85% of world's farms (Harvey et al., 2014). Farmers with small farm holdings also represent about half of the hungry in the world and close to three-quarters of the hungry in African. According to IFAD (2012), about 50% of less developed countries (LDC) rural population are smallholders (cultivating on a crop land of 3 ha or less per farmer). The proportion of smallholder farmers in sub-Saharan Africa is higher at 73%. Rural smallholder farmers produce 80% of food locally consumed in Asia and Sub-Sahara Africa with women farmers constituting a significant percentage (Adejuwon, 2006). Ironically, smallholder farmers have been discovered undoubtedly to have an important role in producing adequate food for present and future generations, and yet are also the ones that suffer most from flooding and other climate change induced disasters as a result of their exposure to climate risk and limited adaptive capacity (Morton, 2007).

Extreme weather events are expected to disproportionately affect smallholder farmers especially in the tropical regions (Hertel &Rosch, 2010). This is because; households in the same community can experience the same type of hazards and yet have varying vulnerabilities due to the differences in exposure, sensitivity and adaptive capacity. Exposure to floods for instance may differ depending on the location of households in relation to floodplains, steep slopes, low-lying areas or ravines. In most cases poorer households are those that inhibit these locations (Harvey et al., 2014).

Smallholder farmers who rely directly on agriculture for their livelihoods are highly sensitive to climate induced disasters like flooding especially if the household does not have diversified resources (Nyong et al., 2008). Flood sensitivity extends to include a large portion of household income from farming used to purchase food and other necessities. It also includes crop damage and land degradation caused by flood events. Climate change studies using simulation models have showed that even moderate rise in temperature will affect rice, wheat and maize production negatively (Morton, 2007). Increase in the frequency and severity of floods are expected to cause poor yields, crop failure, and livestock mortality which is likely to affect smallholder farmers' livelihood gravely. Low agricultural yields can consequently impact on food security, nutrition, income and wellbeing of smallholder farmers (McDowell & Hess, 2012: Morton 2007). Ribot et al. (1996) illustrated that having a strong adaptive capacity to climate change disasters reduces their impact. But underdevelopment and poverty fundamentally constrains adaptive capacity, especially because of a lack of resources to adjust to extreme but expected events. They expounded that, "It is not that the risk is unknown, not that the methods for coping do not exist… rather inability to cope is due to lack of or systematic alienation from resources needed to guard against these events" (Ribot et al., 1996). Adaptive capacity is therefore defined as the ability of social systems to sustain impacts from flood disasters and minimize potential damage using available resources and techniques (IPCC, 2007)**.** Broadly speaking, adaptive capacity can be explained as a net product of a social system's stability to climate stresses, and access to key resources. According to Scoones, (1998) and Ellis, (2000), farmers' capacities to absorb climate change impacts depend on ownership or access to a wide range of resources such as credit and insurance, education and age, technical assistance and access to information, social networking, and government and external support programs. Hence, when there is limited access to these resources, the probability of farmers becoming defenceless is very high or farmer become incapacity of avoiding risks they are exposed to (Piya et al.,2012).

Households with diversified resources have the ability to cope with or adapt to increased level of risks. These households will have more options to engage in other alternative livelihood activities during the times of climate disaster, hence having more adaptive capacity. For example, smallholder farmers' household with a lot of savings (financial assets), or memberships in saving and credit institutions (social assets) and have access to loans from rural financial institutions have greater capability to minimize livelihood risks brought about by crop failure due to climate induced disasters. In a similar way, households involved in some off-farm livelihood activities generate additional income to supplement income from farming. This enhances the adaptive capacity of the households through risk sharing across different livelihood sources (Eakin et al., 2006).

2.4 Conceptualizing climate change vulnerability

Vulnerability as a concept emerged from the social sciences specifically geography and natural hazard studies as a reaction to an entirely hazard-oriented understanding of disaster risk in the 1970's (Schneiderbauer and Ehrlich, 2004). The term has become a focal concept in many research areas including poverty and development, livelihood and food insecurity, disaster management, sustainable development and many others. In recent times, it is extensively used in climate change studies to mean having the potentials to be harmed or the degree of harm a locality is expected to be affected by climate stresses like floods. In the context of climate change, there are a wide range of studies on vulnerability and its definitions which depends on the perception of the researcher. Adger (1999) for example defines vulnerability as the extent to which a natural or social system is susceptible to absorbing harm from climate change. It is generally denoted to be a function of two components; that is an impact that weather extremities may have on humans, referred to as capacity or social vulnerability and the risk that such an extreme may occur, usually referred to as exposure. Chamber and Conway (1992) expounded that vulnerability has two sides. One is an external side of risks, shocks to which a households or community is subject to climate change impacts and an internal side which is the ability to cope with climate change stresses. Blaikie et al., (1994) defined vulnerability as the characteristics of a person or group in terms of their capacity to anticipate, cope with, resist and recover from the impacts of natural hazards and states that vulnerability can be assessed along a continuum from resilience to susceptibility. Hazard here is used to denote the physical occurrence of climate variability and change such as floods and usually observed based on definite values from mean weather elements such as rainfall and temperature (Ibid).

The International Strategy for Disaster Reduction (UN/ISDR) is one of the best-known definitions which view vulnerability as: “The conditions determined by physical, social, economic and environmental factors or processes, which increase the susceptibility of a community to the impact of hazards.” (UN/ISDR, 2004). A recent definition of vulnerability by United Nation University- institute for Environment and Human Security (UNU-EHS) holds that: “Vulnerability is the intrinsic and dynamic feature of an element at risk (community, region, state, infrastructure, environment etc.) that determines the expected damage/harm resulting from a given hazardous event and is often even affected by the harmful event itself. Vulnerability changes continuously over time and is driven by physical, social, economic and environmental factors”.

The IPCC explains vulnerability as the degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and extremes (IPCC 2007). Vulnerability in the above definition typically denotes the state of three inter-related indicators: exposure, sensitivity, and capacity to adapt to impacts.

2.4.1 Approaches to vulnerability assessment

There are generally two schools of thought regarding the definition of vulnerability in climate change studies. One is the natural-hazard school of thought which emerged in the initial studies of disaster risk. This school explained vulnerability in terms of exposure and level of (potential) damage of a system, individual or community caused by a particular hazard event such as floods (Adger and Kelly, 1999). It is based on the assessment of hazards and their negative impact on society but neglected the role social systems play in impacting on disastrous events. Natural-hazards vulnerability fundamentally focuses on exposure leaves out the ability of people to cope with calamities arising from climate change (Adger et al., 2004). The works of Nicholls et al., (1999) for example in natural-hazard vulnerability assessment, investigated factors such as increase in the number of people at risk of flooding based on future projections of rise in sea levels. Some scholars have referred natural-hazard vulnerability as biophysical vulnerabilities and used indicators such as human mortality and ecosystem damage to measure vulnerability (Jones and Boer, 2003).

The second school regarded vulnerability as a condition that exists within a system before it is hit by a hazard. And the conditions are those that make human systems susceptible to losses prior to a hazard event (Allen, 2003). In this regard, vulnerability is embedded in the internal structure of social systems independent of physical occurrence of a hazard and has generally been known as social vulnerability. According to Adger et al., (2004), vulnerability is in two parts: (i) ‘internal’ and (ii) ‘external’. The internal side consist of the capacity of a system to cope when hazard events struck. The external side entails the risks and disruptions an individual or society is subjected to. In this tradition, elements such as coping strategies, resilience, resistance, sensitivity are common issues and indicators such as access to resources and assets, poverty, inequality, food entitlements and so forth are identified and assessed or measured (Blaikie et al., 1994; Adger and Kelly, 1999). Vulnerability in the context is also viewed as a 'starting point' where social units are conceived as changing over time resulting from economic, social and political processes and structures (O'Brien et al., 2007). Ford et al (2010) have also contended that, vulnerability is "place-based" as it differs across geographic space and time. However, concentration on only socio-economic factors in the social vulnerability downplay impacts by hazards and physical damage limiting research in this tradition to holistically investigate vulnerable social units' exposure to a hazard (Cardona, 2004).

The limitation of these two approaches coupled with the changes in scientific knowledge of complex social systems led to the emergence of the integrated approaches in climate change vulnerability studies. Gallopin et al (2001) has expounded that society has become more complex as a result of "interconnectedness" relating to economic, social and political interactions such as increase in cost of inputs and items, more participatory decision-making processes; wider acceptance of environmental issues, human rights). This has led to new ways of thinking and defining concepts to capture vulnerability issues in a wider context with reference to a particular hazard and group of individuals (Ibid). In line with the above, Brooks and Adger (2003) expounded that, both natural-hazards and social vulnerability assessment should be integrated to produce a holistic understanding of specific vulnerable group but with the use of appropriate indicators that are transparent.

2.4.2 Integrated approaches to vulnerability

Integrated approach is rooted in geography as "human ecology". The key feature of the integrated approach is the amalgamation of the natural-hazard and social vulnerability considerations (Fussel & Klein, 2006). It entails conceptualizing and analysing elements from the biophysical and social vulnerability perspectives in a single study with the aim of using both to complement each other and to improve the information provided (Mastrandrea et al., 2010).

The World Food Programme (2004) defines integrated vulnerability in the context of food insecurity as "… being composed of two principal components, namely: (i) risk of exposure to different type of shocks or disaster event… (ii) Ability of population to cope with different type of shocks or disaster event. These definitions are generally used in the area of environmental and climate change studies in a particular region or community. Another key feature of the integrated approaches is the multidisciplinary approach in selecting vulnerable societies for Vulnerability Assessment and mapping. Fussel and Klein (2006) have argued that the biophysical and social perspective of vulnerability should not be mutually exclusive and that their concepts should be merged so as to holistically explain the vulnerability of a group.

2.5 Indicator selection for vulnerability assessment.

As stated earlier, there have been a wide range of contested definitions, concepts and methods to systematize vulnerability in literature and this has made the term ambiguous and difficult to understand. Birkmann (2006) contends that 'we are still dealing with a paradox: we aim to measure vulnerability, yet we cannot provide an exact definition'. Adger et al., (2004) noted that difference in concepts and methods in vulnerability research is functional and subject-oriented. Hence, the precise methods for vulnerability

Assessment (VA) are specific to a particular study but have to be contextually transparent. VAs are conducted on different purposes to bring to light specific vulnerabilities that can recommend and inform policy option for minimizing vulnerabilities related to multiple stresses.

Birkmann, (2006) argued that, vulnerability studies require a paradigm shift away from natural hazard assessment and their quantification towards the identification, assessment and ranking of various vulnerabilities in a particular society. He also expounded that, it is very pertinent to develop apposite indicators and assessment tools to analyse place-based vulnerability. In line with that, the Hyogo Framework emphasized the importance of developing indicators as a "key activity". Developing indicators in VA at all levels will enable decision makers to understand the social, economic, and physical variables that shape vulnerability. Vulnerability indicator selection is based on a large number of variables centred around the fundamental theoretical understanding of vulnerability (Moss et al., 2001). Brooks and Adger (2003) has also added that, there is the need to operationalized concepts and empirically test variables to highlight the reality on the ground for a specific vulnerable society. For instance, flood-related indicator may include the proportion of people that are highly dependent on rain-fed agriculture and those that do not have access to clean water in rural area especially (Adger et al., 2004).

2.6 Measuring vulnerability to climate change

Several scholars have attempted to measure vulnerability with different frameworks and methodology they deemed appropriate. Hahn et al. (2009) developed Sustainable Livelihood Vulnerability Index (SLVI), a methodology drawn from the livelihood framework analysis of Chambers and Conway (1992) in Development studies. The SLVI was modified from the Sustainable Livelihood Approach into new indicators, which includes a specific climate extreme element. It is also designed in a manner that can be changed to suit the use of household survey data. Hahn et al. (2009), developed LVI indicators into the three IPCC contributing factors to vulnerability, that is; exposure and sensitivity (biophysical indicators) and adaptive capacity (socio-economic indicators). They applied the methodology in two communities in Mozambique with different socio-economic and environmental conditions. Their results showed that one community was more pressurized by physical limitation of water resources while the other experienced grave socio-demographic vulnerabilities.

Another integrated approach similar to Hahn et al. (2009) was followed up by Piya et al., (2012) who studied the vulnerability of rural households to climate change and extremes in Chepang in the Mid-Hills of Nepal. They developed components under exposure, sensitivity and adaptive capacity indicators and assigned scores using principal component analysis. They concluded that exposure of communities to natural disaster was the prime component to determine total vulnerability of communities.

Deressa, et al. (2009), conducted a crossed-sectional survey research and conceptualized vulnerability as expected poverty (given by the Word Bank) which was used to assess farmers' household vulnerability to climate change in the Nile basin of Ethiopia. They used a range of socio-economic data and the frequency of climate change extremities and estimated the probability of farmers being vulnerable. They found out that, farmers living in different agro-ecological settings have different levels of vulnerability under four poverty line scenarios (using minimum income levels of 0.3, 1, 1.5 and 2 USD per day). Whereas this approach is important for determining income poverty and measuring future vulnerability, it does not measure current vulnerability.

In northern Ghana, Etwire, et al., (2013), applied the livelihood vulnerability index to assess regional climate vulnerability in northern Ghana. Indices such as educational attainment, social networks, health status and access to health care centres were used. It was reported that, farmers do not receive prior notices or warning about pending disasters such as floods and drought as well as the annual spillage of the Bagre dam in Burkina Faso. It was also found out that, Upper West Region was more vulnerable to food inaccessibility and the northern region was more vulnerable to disasters resulting from climate change.

From empirical evidence, Armah et al., (2010) researched on the impact of floods on livelihood and vulnerability of natural resource dependent communities in northern Ghana. Their study used qualitative modelling to explore factors that cause flood vulnerability. Some of the factors addressed included decline in environmental quality, destruction of seeds, rural exodus, agricultural labour availability and food production. They used these factors to design what they called ‘a simplified causal loop diagram’ and conceptualized flood-induced coping strategies which showed how factors that are interrelated affect one another. Their results showed that, some characteristics of the socio-cultural environment appear to reduce flood risk and vulnerability. In that regard, social networks were very crucial in strengthening livelihood security. Their study also found that, farmers with diversified livelihoods, both occupationally and geographically were less sensitive than those who relied squarely on crop cultivation.
Whereas their study explored flood coping strategies, it did not cover biophysical aspects of flood vulnerability.

Similarly, Musah et al., 2013 investigated the effects of flood coping mechanisms in the Tolon District in the northern region. Coping strategies identified included livelihood diversification, exchange of labour for food and acquiring loans from social contacts. Indicators addressed included loss of food stuffs, loss of human live and properties, destruction of farmlands and pollution of water bodies. Their results showed that floods occur on yearly basis and destroyed farmlands, causes soil erosion and pollutes water bodies in a short-term. In the medium term, floods affect food reserves which decrease food availability for two to six months. The long-term effect is food insecurity. They concluded that, though farmers employed some coping strategies to minimize floods, they were weak and this made them depend heavily on support from donors and NADMO.

Another flood vulnerability study was followed up by Musah et al., (2014). They examined flood impacts on food security in the Tolon district. Results from the study showed that, flood events affected crops and also washed away soil nutrients which led to crop failure and consequently food unavailability. A chi square test showed a significant level of relationship of 0.001 of variables of yields before and after flood events. Yields were lower in the aftermath of floods and were comparatively higher when there are no floods. Impacts of floods on crops led to food insecurity in the district. Their study highlighted more on food insecurity as a result of flood events but did not explore into details other indicators of flood vulnerability including exposure, access to available assets among others.

2.6.1 The Intergovernmental Panel on Climate Change (IPCC) concept of vulnerability

The IPCC vulnerability concept expresses it as a function of exposure, sensitivity and adaptive capacity. Exposure and sensitivity are considered as the biophysical aspects of vulnerability and adaptive capacity as socio-economic (IPCC, 2007; IPCC, 2013).

They defined exposure as the extent to which a system is placed unprotected to extreme weather events. The presence of people, livelihoods, species or ecosystems, environmental functions, services, and resources, infrastructure, or economic, social, or cultural assets in places and settings that could be adversely affected.

Sensitivity is denoted as the extent to which a system is affected negatively from the occurrence of weather extremes. The sensitivity to climate induced hazards in agriculture is mostly assessed in terms of the degree of decline in crop yields, losses in agricultural profits, increased costs of production or losses in production quality (Easterling, 1996).

The IPCC also stated that, the ability to adapt to climate stresses depends on the level of development and the adaptive capacity of social systems. Adaptive capacity depends on a wide range of social and economic factors such as access to resources, level of poverty, improved infrastructure, level of education and training, access to financial resources, adequate skills and technology, insurance mechanism, strong institutions and effective organisations, existing early warning and protection from natural hazards.

Even though the IPCC provides a framework in assessing vulnerability, they did not provide how these indicators can be measured.

2.6.2 The sustainable livelihood framework (SLF).

The Department for International Development (DFID) sustainable livelihood framework (SLF) is one of the most widely used livelihoods vulnerability frameworks in development practice. The framework was inspired by the works of Chambers and Conway (1992) that developed the livelihood framework to understand poor people’s livelihood in development studies. The DFID’s SLF was integrated in its program for development cooperation in 1997. The Framework can be understood as a tool to understand factors that affect livelihoods and the way in which these factors interact to create a livelihood pattern. The framework places people at the centre of development, people rather than the resources they use are given priority in this approach but emphasis is on their ability to access and use resources available. The approach does not operate in a linear manner; it is flexible and can be modified to suit a particular study and context making its adoption in this study appropriate.

The framework assumes that, a community or a household’s vulnerability is shaped by multiple forces and factors which changes constantly. People operate within a vulnerability context that is shaped by different factors – economic and disaster shocks and trends (resource, technological and governance). It describes social systems in terms of their natural capital, social capital, financial capital, physical capital, and human capital. It is applied by investigating capitals or assets available and how people get access and use them. These assets consist of indicators which include access to information, traditional knowledge, skills and capacity, availability of credit and social networks, natural resources, access to education and health, availability of markets and participation in decision making.

How they draw on different types of livelihood assets or capitals in different combinations is influenced by: the vulnerability context, a range of social, institutional and political processes. Impacts from shocks such as climate stresses are influenced by these assets which shape specific pattern of vulnerability. Their asset base is used to develop multiple livelihoods strategies to achieve desired livelihood outcomes (De Stagé et al., 2002). However, themes such as exposure, sensitivity of flood vulnerability are specifically not captured in the approach which makes it limited to this particular study. The approach is useful because it is flexible and can be modified to suit a particular study. In that regard, its asset indicators were adopted to assess adaptive capacity in the study.

2.6.3 Hahn et al., (2009) Livelihood Vulnerability Index (LVI).

The Hahn et al., (2009) livelihood vulnerability index was developed and applied in Moba and Mabote districts in Mozambique with different socio-economic and environmental conditions. They developed their indicators into the three IPCC contributing factors to vulnerability, that is exposure and sensitivity (biophysical indicators) and adaptive capacity (socio-economic indicators). They concluded that, Moba district were less vulnerable compared to Mabote district. This was because, the adaptive capacity in Moba including food storage, crop diversification and seed preservation were stronger than in Mabote.

This approach is however useful in measuring vulnerability because it uses primary data from household survey to construct the indices which eliminate weaknesses associated with using secondary data for vulnerability assessments. Another merit about this method is that, it reduces the reliance of climate change hazard models with large scale assessments that does not give accurate projections and picture of what really exist at the household level. Household level assessment provides insights into flood vulnerability needed for community development and planning (IPCC, 2007). The LVI also focuses on exploring and quantifying current vulnerability rather than assessments based on future climate projections. Again, it uses the equal weighting approach (Sullivan et al., 2002) where the main indices contribute in the same way to vulnerability which makes it simple to compute. Finally, the approach provides development organizations and policy makers with a practical tool to understand exposure of households and elements at risk as well as the socio-economic factors that shapes adaptive capacity. Apart from the overall indices, individual indicator scores can be separated to identify areas for intervention.

There are some limitations of the LVI approach nonetheless. First of all, place-specific indicators used based on review of available data is highly subjective and may not be applicable to other areas. It is mainly for some particular assessment. Another limitation is that, indicators and indices obtained are used to oversimplify a complex reality and inherently, there is no direct way to validate indices which consist of very different indicators. Considering the limitations of the Hahn et al., (2009) index, the strengths far outweighs the limitation hence its use is credible.

2.7 Conclusion

Research on vulnerability studies has been on the increase and adding knowledge about vulnerability to climate induced hazards. Major issues from the above reviewed literature is that vulnerability is not solely about exposure and the physical occurrence of a hazard but is a function of environmental and human processes that shape household vulnerability. The dynamics and state of processes differ from household to household in character and in degree and as such, people who suffer the same climate hazard are not impacted in the same fashion. These processes often include issues of location, frequents occurrence of flood extremes and access to resources. Assessment of vulnerability is also context specific: for example, national level assessment cannot be applied in the local context even at the household level, there are still variations. Specific local assessment is necessary therefore to highlight trends in VA and areas in adaptive capacity that requires strengthening. Case study assessments also help to draw comparison and synthesize results across households in different communities on the degree and causes of their vulnerability. Again, VA comes with identification of indicators that reflect peoples' vulnerability. Indicators are usually obtained in theory and conceptual works in vulnerability literature. However, they require verification on the field by local stakeholders based on their experiences and opinions as to what makes them vulnerable.

CHAPTER THREE: PROFILE OF THE STUDY AREA

3.1 Introduction

This chapter presents information about the Tolon district in general. It describes its physical features, socio-economic characteristics and flood events experienced within which the research problem is embedded.

3.2. Physical geography of the study area

The physical geography refers to the natural characteristics of a region including its climate, rainfall pattern, soil and terrain features. The physical landscape features together with social systems define flood events in a region. In this regard, physical attributes of the study district include its location, rainfall, hydrology, vegetation cover, soil types and topography.

3.2.1 Location of the study area.

Figure 3.1 shows the study areas in the district context. Communities were categorized into those that were closer to the White Volta River and those that were further away from it to assess household variations of flood vulnerabilities. Simple random sampling technique was used to select two communities each from these two categories. Thus, Tampia and Kpalisogu-Kura were the selected communities under communities closer to the White Volta River. Yoggu and Kpalgun were also selected under communities further away from the river (Field survey, 2015).

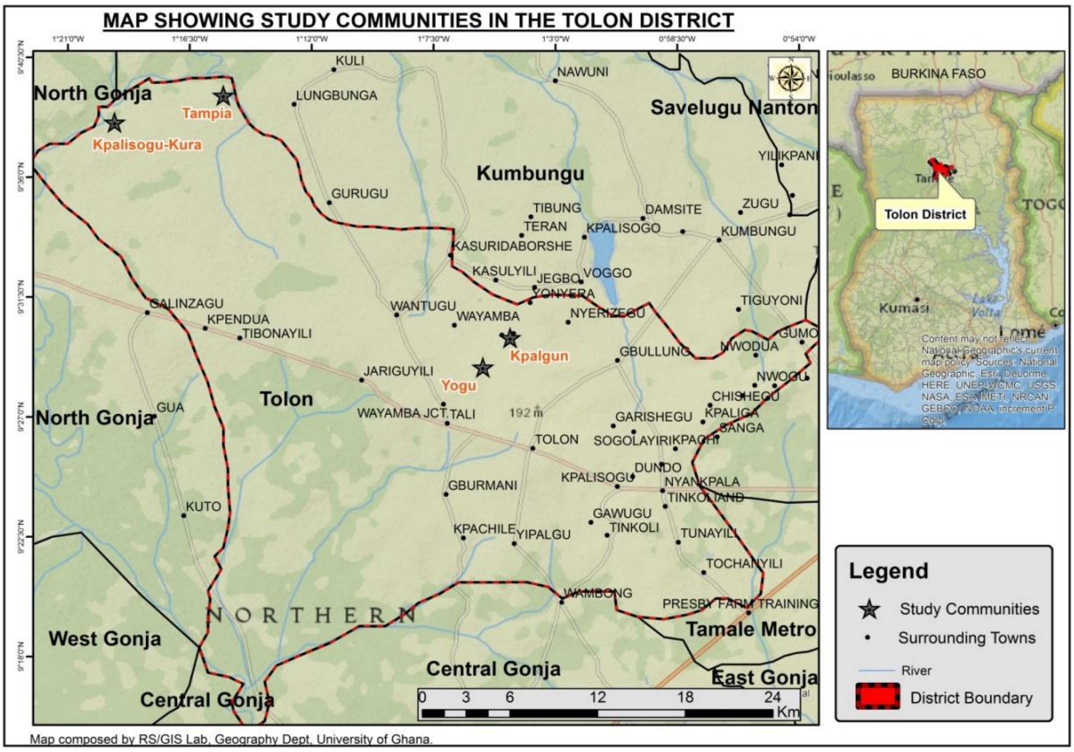

Figure 3. 1: Tolon district map

(Source: Author’s construct).

The Tolon District is one of the 26 districts in the Northern region with Tolon as its administrative capital. The district was formerly Tolon/Kumbungu district but it was divided and separated from Kumbungu in 2012 by an Executive Instrument (E.I). The district shares borders with North Gonja to the West, Kumbungu District to the North, Central Gonja to the south and to the East with Tamale Metropolitan. The District covers an area of about 2,741 square kilometres and forms about 3.9% of the regions total landmass. The District lies between latitude 10-20 north and Longitude 10 to 50 west.

The White Volta River passes through the district as shown in figure 3.1, which means that torrential rainfall combined with excess release of water from the Bagre dam in Burkina Faso creates floods conditions during the short rainy season.

3.2.2 Rainfall distribution

Rainfall is a prime climatic feature that has the potential of triggering the processes of flood disaster worldwide. The Tolon district lies in the Guinea Savannah agro ecological zone of Ghana. It experiences two marked seasons that is the rainy and dry season. The rainy season generally begins in May and ends in September and the dry season also begins in October and ends in April. During the dry season, temperature ranges from a low of 15° C at night and to a high of 40° C in the day. Annual rainfall ranges from 800mm to 1100mm. The climate is dominated by two major air masses: the dry and warm North-East Trade Winds and the moist South-Westerlies or the monsoons. The moist maritime monsoons are associated with rainfall while the dry Trade Winds bring dry conditions which determines the two distinct seasons all year round. The mean annual rainfall figures vary between 840mm and 1400mm (Tolon District Report, 2014).

A very important feature of rainfall in the district is that it is erratic in nature and generally departs from normal expectation and poorly distributed. The raining season is also characterized by torrential rainfall which usually occurs in August and September. Heavy continuous rainfall is mostly the cause of flooding followed by excess release of water from the *Bagre* dam at the upper course of the White Volta River (Field survey, 2015).

3.2.3 Soils

The soil moisture is adequate for the cultivation of crops such as maize, yam, groundnuts, soya beans and cowpea. The unreliable nature of rainfall in the district affects plant growth negatively resulting in poor harvest from year to year. Temperatures are high in most part of the year, ranging between 22.5ºC to 45ºC, low between

December and January, and high between March and April. Average monthly maximum temperature is 33ºC whereas the daily highest is 35ºC.

Soil types found in the district alluvial laterite and savannah ochrosols (Tolon District Report, 2014). Alluvial soils are very fertile and mostly found along the Volta River, their tributaries and floodplains. As a result, most farmers farm along river banks and when the river overflow, crops get destroyed (Field survey, 2015)

3.2.4 Vegetation

The vegetation of the district is of the Guinea Savannah grassland. The predominant trees in the district are Shea (Vitellaria paradoxa), dawadawa (Parkia biglobosa), Kapok (Ceiba pentandra), Baobab (Adansonia dipitata), mahogany (Khaya snegalensis), cashew (Anacardium occidentale), mangoes (Mangifera indica), Akee apple (Blighia sapida), Guava (Psidium guajava), Teak (Tectona grandis), Neem (Azadirachta indica). The last two, namely cashew and mango are exotic species, which also thrive well in the district. Shrubs and climbers are also common plant types found in the area. Household draw on different tree species for their livelihood including fire wood, charcoal production, construction of houses, craft works, fencing of gardens and fence for animals. The presence of short shrubs and grasses provides feed for livestock. (Tolon District Report, 2014).

The main plant species which contribute to household sustenance are sheanut and dawadawa trees. These are of economic importance when processed and serve as a way of diversifying their livelihood which reduces over dependence on agriculture.

There is also gallery of forests along the White Volta River and its tributaries.

However, tracts of the natural vegetation are disappearing, largely due to anthropogenic factors including cultivation of new farms, overgrazing, bushfires and felling of tress. (Field survey, 2015)

3.2.5 Topography and drainage

In term of topography and drainage, the district lies in the Savannah high plains, which is generally undulating with an average height of between 180m and 300m above sea level. A distinct uni-modal rainfall pattern is experienced in the district. The landscape is also good for agriculture and other physical developments. The White Volta River and its tributaries are the main drainage systems in the district with farming taking place in the floodplains.

3.3 Social and Economic characteristics

The patrilineal system in the study area has given rise to the dominance of male household heads resulting in an uneven gender balance. Majority of the respondent had no formal education representing 66% of the respondents and the remaining 36% had their education at the basic level (Field survey,2015).

Dagombas are the predominant tribe in the Tolon District and constitute over 80% of the total population. Other tribes around the area include Gonjas, Mamprusis and Ewes. The Ewes are mostly at communities close to the White Volta River where they engage in fishing. The other tribes were mainly farmers of which a few engage in other non-farm economic activity including thatch and smock weaving.

The dominant economic activity in the district is agriculture which is basically rural in nature involving over 90% of the population who have small farm holdings. The farming system in the district is dictated by the agro-ecological conditions; largely by the rainfall pattern which is uni-modal. Farmers generally engage in two different farm types are in the district, these are compound and bush farm. Farming in the district involves the cultivation of crops including groundnut, rice, maize, sorghum and vegetables and raising of livestock such as cattle, sheep, goats and poultry. Farmers are predominantly smallholders and farm on small parcels of land for household consumption and sometimes sell surplus at markets (Field survey, 2015).

Fishing also practiced as an economic activity in the district mostly by the males in communities with close proximity to the White Volta River. Agriculture in this area is more vulnerable as it depends on climate and mostly rain-fed. Any change in weather condition, or increase in climate-induced disasters such as floods can have very negative impact on their livelihood (Harvey et al., 2014).

About 58% of farmers do not engage in off-farm economic activities against 42% of those who engaged in that. Majority of the female population are into shea-butter processing, dawadawa processing, charcoal burning, fire wood gathering and petty trading. Whilst the males mostly weave smocks, mats and engage in artisan work including carpentry and masonry (Field survey, 2015).

Though, agriculture contributes significantly to the livelihoods of majority of population in the district, perennial occurrence of floods are bottlenecks for agriculture productivity. Strategies put in place by rural folks to minimize floods impacts were weak. As a result, affected flood victims usually depend on support from NADMO, NGO's and individual donors.

3.4 Flood events

Even though, the district experiences drought, floods have become a great concern for farmers especially farmers in the communities that are bounded by the White Volta River. During the raining season, excess rainfall usually causes the river that drains the rainwater runoff to overflow resulting in flood situations. The in-land communities are far from the river, but also experience flood events because most farms are located on low lying areas. The floods occur when there is excessive rainfall and high volume of runoff water as well as spillage of water from the *Bagre* Dam at the upper stream of the White Volta River. However, additional factors that trigger flooding in the district include the nature of soil, soil saturation, control structures and management (Musah et al. 2013).

As one of the flood prone districts in the northern region, the district grapples with a perennial record of flood events which leads to almost yearly loss of crops and farmlands, property and lives in extreme cases. Floods of 2007 and 2010 in the region have been the most devastating. Farmers in the district have incurred a high cost in flooding owing to the loss in crops, livestock, property damage (MoFA, 2007, NADMO, 2011). Smallholder farmers in the area have less coping capacity including less financial solvency to manage losses and this increases their flood vulnerability (Field survey, 2015).

3.5 Conclusion

The understanding the unique characteristics of the study area enables the researcher to have fertile grounding and to know in detail key issues such as climate variables and socio-economic activities that may be responsible for putting small-scale farmers in a vulnerable state. Knowledge about the study area can also influence recommendations and suggestion arising from the study, which would enhance the adaptive capacity of farmers to effectively respond to flood disasters.

CHAPTER FOUR: RESEARCH METHODOLOGY

4. 1 Introduction

This chapter presents the research design and specific techniques that were adopted to address the objectives of the study. The review of literature in chapter two revealed a paradigm shift of vulnerability analysis from the hazard tradition to an integrated one which entails investigating a specific hazard event as well as an inherent condition of a social system and their ability to obtain resources to recover from a flood disaster. As reviewed in literature, vulnerability is context specific and as such, indicators need to be identified by local folks based on their experiences.

In view of the above, it is necessary to employ indicators and appropriate research methods that will adequately explore the subject matter of smallholder farmers' vulnerability. The chapter presents the research design and the methods used in the selection of the research participants, data collection, and analyses and how the study applied the Hahn et al., (2009) livelihood vulnerability index in the assessment.

4. 2 Research Design.

As stated in the first chapter, the purpose of this study is to assess smallholder farmers' vulnerability to floods in the Tolon district in the northern region of Ghana with the aim of understanding the nature of vulnerabilities and the condition that put people in a vulnerable state. The data required for this study varies in nature and would have to be obtained from different sources making the adoption of mixed methods appropriate. In connection with this, both qualitative and quantitative research methods and tools were employed to collect data and in data analysis. These included interviews, questionnaires, field observation and documentary analysis.

4.3 Selection of the study site.

The Tolon district which is one of the flood-prone districts in the northern region formed the study site for the research. A detailed description of the district is provided in chapter three: profile of the study area. The District was purposefully selected for a case study analysis of flood vulnerabilities of smallholder farmers.

4.4 Sampling techniques

4.4.1 Multi-stage sampling procedures

This technique was used in the study. The stages involved are showed in figure 4.1. At the first stage, the district was classified into two clusters for the research. The district is located at the Guinea savannah agro-ecological zone in Ghana and borders the White Volta River to the West. The district was structured into two clusters based on the district's reports: thus inland communities and communities closer to a river source in order to assess flood vulnerability across the two distinct geographical locations in the district. Stage two was done by randomly selecting two communities each from the two clusters; Tampia and Kpalisogu-Kura in cluster one, Yoggu and Kpalgun in cluster two as showed in figure 4.1. The third stage was carried out by enumerating all households to obtain the sampling frame. And finally, simple random sampling was also used to select households for the questionnaire survey. In cases where there are more than one household in a house compound, one household out of the lot was selected.

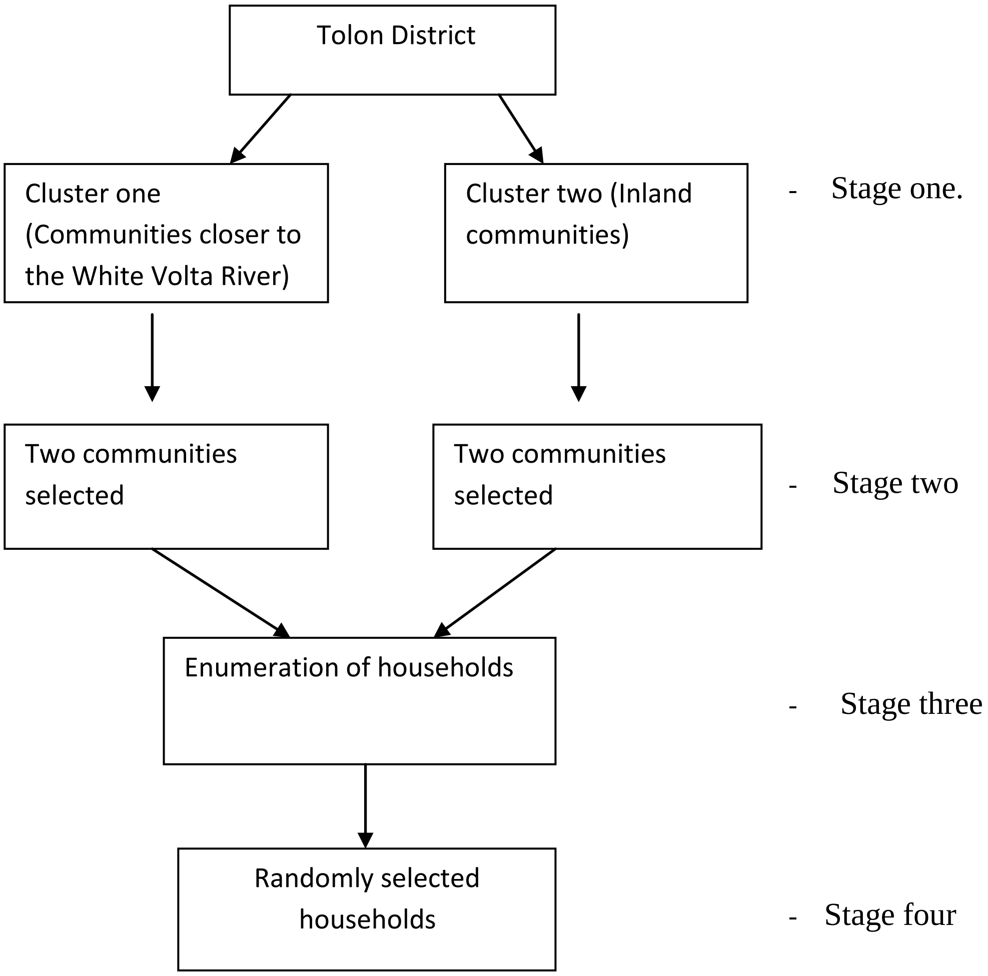

Figure 4. 1 Stages for multistage sampling.

(Source: Field survey, 2015).

A household is however defined as a group of people who usually live and eat together in the same dwelling, share the same kitchen and consider themselves as a unit in making plans and decisions about daily life.

4.4.2 Sampling frame and size

The sampling frame for the study consisted of 387 households. This was arrived at after enumerating all households in the four study communities. Kpalgun had a total number of 111 households; Yoggu had 119 households; Tampia had 47 and Kpalisogu-Kura had 110 households.

Probability proportional sampling was used to determine the general sample size and the sample size per community. A total of 159 households was selected as the sample size for the study after sampling 40% of households randomly across all study communities.

Thus Kpalgun had a proportional sample of 45, Yoggu 67, Tampia 12 and 32 for Kpalisogu-Kura. The sample of each community was based on the total number of households it contained. This method was selected because it reduces inaccuracies as a result of community growth or diminution and it is more appropriate for comparative analysis (Yansaneh, 2005). Table 4.1 shows a summary of the sample frame and size.

Table 4. 1: Household sampling frame and size in the study areas

Number	**Community**	**Number of household per community**	**Sample size per community**
1.	Kpalgun	111	45
2.	Yoggu	119	67
3.	Tampia	47	12
4.	Kpalisogu-Kura	216	32
Total		387	156

(Source: Field survey, 2015)

Proportional sampling was also used with the aim of achieving equity in representation (Sarantakos, 1997). Simple random sampling was used to select households for the study. This allowed every eligible farm household an equal chance of being selected for the household questionnaire survey. Households represented the basic unit for the field survey where the household heads were the respondents.

Even though the sample size for all the study communities was 159, the research team could only cover a total of 149 households due to resource constraints including financial and time.

4.5 Method of data collection

Based on the research questions and the type of data required for analysis, the appropriate way to collect data for the study was a combination of both qualitative and quantitative methods of inquiry. These methods were used because some qualitative data was required and was obtained through interviews and transect walk whilst other data types needed were quantitative in nature and was collected by the use of questionnaires. There are a range of relevant journals articles, annual reports, newspapers and books that provided useful data for the study. Data taken from secondary sources included issues on climate change and floods, vulnerability assessment frameworks and indicators and research methodology.

The study therefore used semi- structured questionnaires, interviews, transect-walk and documentary analysis/secondary sources of data to improve the quality of data elicited.

4.5.1 Questionnaire survey

Questionnaires were one of the commonly used tools for obtaining data in survey research. This instrument allows a researcher to collect standardized data with the same variables for all the sampled population (Bryman, 2004). MacMillan and Schumacher (2001) added that questionnaires were used to elicit respondents' perceptions, attitude, values and perspectives on a range of research issues. This made the questionnaire an appropriate instrument for gathering data about peoples' opinions.

The questionnaires administered contained both open and close-ended questions to allow flexibility in the responses and also help to solicit for particular lines of answers. Household questionnaire survey was developed to cover the research objectives which include information on household sociodemographic features, causes of flooding, household adaptive capacity in relation to assets availability and use (physical, social, financial, natural and human assets).

The questionnaires were then administered to 20 sampled households as pre-test. After which questions were modified for the main survey. The main survey was conducted with four other field assistants. Once the field team arrived in the communities, community leaders were consulted to explain the purpose of the research and to seek for permission to visit households. Verbal consent of household heads was sought for before engaging them with questions. Each member of the research team guided respondents to answer questions in the form of an interview in different households. In this case, discussions were done in the local dialect (Dagbani or Gonja) of respondents and recorded in English. Ground control points (GCP) was collected in each household compound with the help of a GPS receiver.

4.5.2 Key informant Interviews

Interviewing serves a good purpose for taking qualitative data in a research as it allows respondents to express themselves and interact with the researcher to address research concerns (Freebody, 2003). Eight (8) key informant interviews were conducted in the study: two key informant interviews each in all four study site. The respondents were community chairmen/chiefs and assemble men. This method was carry out to elicit information on the support they render to the farmers in the districts to help them manage flood disasters. This was done with the help of interview guides which was designed for each key stakeholder to address issues specific to their respective roles in flood management. Field note-book was used to record responses from each participant during the interview.

4.5.3 Focus group discussion (FGD)

This primary source of data was employed at each study site to obtain information on collective experiences and opinions in line with the research concerns. According to Morgan (1997), FGD is a useful way to gather people from the same background or experiences to discuss issues relating to a specific problem. Denzin and Lincoln (1994) added that "focus group" is a situation in which the moderator(s) seek answers from group members on very specific questions about a topic after considerable research has already been completed.

The choice of FGD is essential as it complements the use of household survey to enhance clarity on the general issues of flood vulnerability, including identifying and reviewing indicators for vulnerability assessment. One FGD was carried out in each community with representatives consisting of five knowledgeable and experienced men farmers and four for women farmers. The discussion was carried out with a facilitator (who maintain a neutral attitude and appearance) to ensure even participation of members and fairly reflect opinions of participants. A range of participatory and extractive data collection activities was employed including marking of flood years within a 10-year period (from 2004 to 2014), identification and verification of indicators and discussion of the various asset types and their availability and access in communities.

4.5.4 Transect walk

This is a participatory process of data collection that involves key informants in each study site with adequate knowledge about the communities. The method was used to visit farmlands and to observe ecological features in each study area. This participatory process involved a walk along major and specific routes of localities by the research team and assigned knowledgeable key informant with the aid of a community resource map/diagram.

The transect walk was done slowly and the research team engaged the key informant in informal discussions to understand observations made and ask questions related to social issues, common assets and how they were used. Results from the transect walk was presented to selected community members for discussion and verification of findings.

Data gathered from the transect walk was used for further analysis and triangulate available data collected by other methods.

4.6 Method of data analyses and presentation

The research used a variety of analytical methods to assess smallholders' vulnerability to floods. Some of the analysis was done as data collection was still going on; this offered an opportunity for simultaneous synthesis. In addition to the daily and weekly analyses of data during the main field survey, a detailed periodic analysis involving examining data, categorizing took place from time to time.

4.6.1 Qualitative analysis

For qualitative analysis, descriptive statements comprising summaries and brief descriptions were examined and discussed. A comparative and logical qualitative method was employed in the study. The comparative analysis involves taking one piece of data (one interview, one statement,) and relating it to all others that may be similar or different in order to draw possible relations between various pieces of data (Thorne, 1997). Logical Analysis was applied to data gathered which involved synthesis, that is filtration of preconceptions, expectations, personal opinions and separating biases and stereotypes, cross-checking, triangulating data sources and validating/in-validating was done. This was done to categorize responses and to draw patterns of relation and similarities and show logical flows. Interpretation of data was done by combining statements, statistical facts and observations with secondary data. Consistencies and inconsistencies were analysed with the view of providing understanding. Data was presented on tables and photographs, and written descriptions are used to present data for meaningful interpretation.

4.6.2 Quantitative analysis

Data from the household questionnaire survey was cleaned up and errors that were detected in the filling of the questionnaire were corrected. Data was then coded and fed into Statistical Package for Service Solution (SPSS) 14.0 for windows. Analysis was done to generate percentages of responses in order to acquire a descriptive picture of data gathered on themes such as the spatial and temporal pattern of flood events, perception on causes of floods and household vulnerability profile. After which household exposure, sensitivity and adaptive capacity were manually calculated. Total vulnerability was also manually computed using Hahn et al (2009) LVI as showed below

4.6.2.1 Calculation of vulnerability index

The vulnerability index calculated in the study was based on the IPCC definition which views vulnerability as the net effect of exposure, sensitivity (biophysical) and adaptive capacity (socio-economic).

Indices of exposure, sensitivity and adaptive capacity were calculated using Hahn et al. (2009) livelihood vulnerability index. Indicators were selected based on indigenous knowledge of local farmers. A total of 21 indicators were selected and were all assumed to have an equal contribution to overall household flood vulnerability (Sullivan et al., 2002). Step one involves standardizing each indicator as an index to bring them to comparable terms since indicators were measured on different scales. This was done using equation 1.

$$\textbf{Index} = \frac{Sr - S\,min}{S\,max - S\,min} \qquad \textbf{Equation (1)}$$

Where sr is the observed sub-component indicator for region *r*, and *s min* and *s max* are the minimum and maximum values, respectively. After values for each of the 21 indicators for a region are standardized, they are averaged using Equation (2) to obtain indices of exposure, sensitivity and adaptive capacity for a particular household:

$$\textbf{CFd} = \frac{\sum_{i=1}^{n} W\,mi\;Mdi}{\sum_{i=1}^{n} Wmi} \qquad \textbf{Equation (2)}$$

Where CFd is an IPCC-defined contributing factor (exposure, sensitivity or adaptive capacity) for household *d, Mdi* is the weight of each major component, and n is the number of sub- components in each contributing factor.

For adaptive capacity however, dependency ratio was subtracted from the index since it contributes negatively to adaptive capacity. The weights of each component are determined by the number of indicators it is composed of to ensure that, all main components (exposure, sensitivity and adaptive capacity) contribute equally to household flood vulnerability. Under the three main components, the index ranged from 0.67 to 1 (highly vulnerable), 0.34 to 0.66 (vulnerable) and 0 to 0.33 (Least vulnerable).

Finally, total household flood vulnerability is worked out using the following equation:

$$\textbf{IPCC-Vd} = \textbf{Ed} + \textbf{Sd} - \textbf{Ad} \qquad \textbf{Equation (3)}$$

Where IPCC-Vd represents household vulnerability index for community d, E is the calculated score for household d (which includes these indicators: standard deviation for monthly precipitation, minimum and maximum temperature, number of flood occurrence from 2004 to2014, number of farms at low-lying areas and floodplains). Sd is the calculated sensitivity score for household d (indicators: weighted average of number of injuries incurred by household members, acre of farmlands degraded by floods, quantity of crop damage and number of livestock lost due to floods) and Ad for adaptive capacity score for household d (physical, financial, human and social assets). The categories ranged from highly vulnerable (that is from 0.50 to 1), vulnerable (from 0.49 to 0) and least vulnerable (from -0.6 to -0.1). When exposure and sensitivity of households exceeds adaptive capacity, households become more vulnerable and vice versa.

4.6.2.2 GIS methodology for developing vulnerability maps

GIS was employed to give a geographical representation of components of vulnerability in the four study sites. First of all, GPS coordinates were picked for all sampled households in the study communities as ground truths, because there was already a town secondary data.

After the points were picked it was plotted to show the four study areas. A district map was composed showing study areas as showed in figure 3.1 in chapter three. Vulnerability maps were developed using graduated symbol renderer. The graduated symbol renderer is one of the common renderer types used to represent quantitative information. Using a graduated symbols renderer, the quantitative values for a field are grouped into ordered classes. Within a class, all features are drawn with the same symbol. Each class is assigned a graduated symbol from smallest to largest.

4.7 Vulnerability indicators

As stated earlier, the study dwelled on the IPCC concept of vulnerability which is a product of exposure, sensitivity and adaptive capacity. Indicators were identified under each vulnerability index through FGDs during data collection. Below are the indicators that were selected.

4.7.1 Exposure indicators

Indicators that represent exposure include climate variables (monthly average precipitation, monthly average minimum and maximum temperature), frequency of flood events and farms located at floodplain and low-lying areas. Historical records of monthly precipitation from May to October were obtained at the meteorological station at the regional level for a period of 10 years (from 2004 to 2014) for the purpose of this study. The reason for choosing these indicators was because it came from a reputable source. The inclusion of general regional records of climate elements is problematic for precise community level analysis of exposure in vulnerability assessment. However, due to the unavailability of data at the community level, it is satisfactory to assume an even distribution of monthly climate variables across the region. Also, the regularity of flood events also exposes households to continuous flood impacts. Data on flood regularity was obtained at the household level over the last 10 years during the field survey. Here, it is assumed that if there is increase in climate variables and frequency of flood occurrence are high; households will be highly exposed to flood events.

Table 4. 2: Exposure indicators

Indicator	Indicator description	Unit
Climate variables	• Standard deviation of change in average monthly minimum temperature (From2004 to 2014).	• °C
	• Standard deviation of change in average monthly maximum temperature From2004 to 2014).	• °C
	• Standard deviation of change in monthly precipitation From2004 to 2014).	• mm
Flood events	Flood occurrence in the last 10 years (2004 to 2014).	Number of events recorded
Location of farms	Farms located at low-lying areas and floodplains	Number of household farms

(Source: field survey, 2015)

4.7.2 Sensitivity indicators

Damage to properties such as land, livestock and crops as a result of flood events in the past 10 years formed the sensitivity indicators for the study. Farm lands degraded by flood events will increase sensitivity as lands will no longer be suitable for cultivation and hence increases vulnerability. Also, significant crop damage and livestock loss due to floods can lead to decrease in yield levels and domestic animal assets possession and hence can make farmers highly sensitive.

Table 4. 3: Sensitivity indicators

Indicator	Indicator description	Unit
Fatalities	• Injuries incurred by household members as a result of floods	Number of household members with injuries
Damage to properties	• Farm land degraded by flood events in the past ten years	No. of household farms
	• crops damaged due to floods	Quantity of crops
	• Livestock lost	Number of livestock lost

(Source: Field survey, 2015).

4.7.3 Adaptive capacity indicators

The adaptive capacity of households is given as a product of five types of assets that are interconnected in social systems, hence physical, natural, human, financial and social assets. These assets interact with each other and influence the capacity of households to respond to flood events. Indicators here influence vulnerability in a positive way except the dependency ratio of households. The use of improved crop variety that is flood tolerant, irrigation of land and having device to access information for instance play an important role in reducing flood impacts. All the other indicators cushion households to absorb flood impacts through risk distribution.

Table 4. 4: Adaptive capacity

Index component	Indicator	Indicator description	Unit of measure
Physical/technological assets	Improve crop variety (use of flood tolerant varieties)	Use of improved crop varieties including flood tolerant varieties and early maturing varieties.	Number of crop varieties used
	Dry season farming through irrigation	Households engaged in dry season farming to make up for crop loss as a result of floods.	Estimated land in acres used for dry season farming.
	Have device to access information (radio, mobile phone)	Have device to receive information on farming and flood related issues to enable households take proactive measures and plan for coping with flood risks and impacts.	Number of devices owned
Natural assets	Multiple farms lands at different location	Having multiple farms at different locations reduces the probability of losses from flood events	Number of farms
Human asset	Level of formal education	Farmers who have formal education are likely to adopt new methods of farming to reduce flood impacts.	Number of household members with formal education
	Dependency ratio	Household members who are below 16 years and 65 years and above are dependent have a lower capacity to sustain flood shocks.	Ratio of households < 15 and > 65 years to the number household members between age 18 and 65.
	Training received to take flood risk measures/vocational training	Training on farm related activities and flood risk reduction measures/vocation training.	Number of training received
Financial asset	Access to credit facilities (formal and informal)	Access to loans for productive investments including vegetable farming, livestock rearing.	1 for access, 0 for no access
	Livelihood diversification index	households engaged in non-farm activities including artisanal skills, trading, rent/hire, corn mill operators to earn more income	Number of non-farm activities.
Social assets	Membership in CBO's and FBO's	Membership of CBO and FBO improves social networks and access to information during contact with outside stakeholders, share ideas on flood risk measures and collective management of communal resources like forests	Number of CBO's and FBO's households are involved in.
	Disaster aid	Provision of emergency relief services to households affected by floods by the district, NGO's family and friends.	Number of times households received disaster aid
	Migration	Household members migrate to look for support for the family in the form of remittances during floods.	Number of household members who migrated

(Source: Field survey, 2015)

4. 8 Steps involved in calculating indicators, indices and total vulnerability.

Below are examples of how indicators, indices and total vulnerability were calculated for each household.

Table 4.5: Values for indicators under exposure for household one in Tampia community

Index	**indicator**	**Unit of measurement**	**Actual Value**	**Standardized value**	**Max. value of indicator in Tampia**	**Min. value of indicator in Tampia**
Exposure	SD of monthly min tem.	° C	-	0.42	-	-
	SD of monthly max tem.	° C	-	0.74	-	-
	SD of monthly average precipitation	mm	-	0.31	-	-
	Flood events recorded	No.	5	0.75	6	2
	Farms at low-lying areas	No.	1	0	3	1

(Source: Field survey, 2015)

Step (1) for standardizing indicators (flood events) = $\frac{\text{Actual value} - \text{minimum value}}{\text{Maximum value} - \text{minimum value}}$

$$= \frac{5 - 2}{6 - 2} = \frac{3}{4} = 0.75$$

(Repeat for all indicators under exposure)

Step (2) for exposure index for household 1 (CFd) = $\frac{\sum_{i=1}^{n} W\ mi\ \ Mdi}{\sum_{i=1}^{n} Wmi}$

$$= \frac{0.4 + 0.7 + 0.3 + 0.75 + 0}{5} = 0.4$$

Table 4.6: Values for indicators under sensitivity for household one in Tampia community

Index	indicators	Unit of measurement	Actual Value	Standardized value	Max. value of indicator in Tampia	Min. value of indicator in Tampia
sensitivity	• Injuries incurred by household members as a result of floods	No. of members with injuries	3	0.5	5	1
	• Farm land degraded by flood events in the past ten years	No. of farms acres	2	0.2	6	1
	• crops damaged due to floods	Quantity of crops in local bags	30	0.6	52	3
	• Livestock lost	Number of livestock lost	7	0.6	10	2

Step (1) for standardizing indicators for sensitivity (Injuries incurred):

$$= \frac{\text{Actual value} - \text{minimum value}}{\text{Maximum value} - \text{minimum value}}$$

$$= \frac{3 - 1}{5 - 1} = \frac{2}{4} = 0.5$$

(Repeat for all indicators under sensitivity)

Step (2) for sensitivity index for household 1 (CFd) = $\frac{\sum_{i=1}^{n} W\ mi\ \ Mdi}{\sum_{i=1}^{n} Wmi}$

$$= \frac{0.5 + 0.2 + 0.6 + 0.6}{4} = 0.5$$

(Repeat for sensitivity index for the rest of the households).

Table 4.7 Values for indicators under adaptive capacity for household one in Tampia

Index (For household 1)	Indicators	Unit of measurement	Actual Value	Standardized value	Max. value of indicator in Tampia	Min. value of indicator in Tampia
Physical /technological assets	Improve crop variety (use of flood tolerant varieties)	No.	2	1	2	1
	Dry season farming through irrigation	Estimated area of land in acres	2	0.3	5	1
	Have device to access information (radio, mobile phone)	No.	1	0.0	2	1
Natural assets	Multiple farms lands at different location	No.	3	0.5	5	2
Human asset	Level of formal education	No. of household members with formal education	2	0.5	3	1
	Dependency ratio (-)	Ratio of households < 15 and > 65 years to the number of household members between age 18 and 65.	-	0.7	-	-

	Training received to take flood risk measures/ vocational training	Number of training received	0	- 0.5	3	1
Financial asset	Access to credit facilities (formal and informal)	1 for access, 0 for no access	-	0	-	-
	Livelihood diversification index	Number of non-farm activities.	2	0.5	3	1
Social assets	Membership in CBO's and FBO's	No.	2	1	2	1
	Disaster aid	Number of times households received disaster aid	4	1	4	1
	Migration	Number of household members who migrated	2	0.5	3	1

Step (1) for standardizing indicators for adaptive capacity (use of flood tolerant varieties):

$$= \frac{\text{Actual value} - \text{minimum value}}{\text{Maximum value} - \text{minimum value}}$$

$$= \frac{2 - 1}{2 - 1} = \frac{1}{1} = 1$$

Step (2) for adaptive capacity index (CFd) $= \dfrac{\sum_{i=1}^{n} W\,mi\;\;Mdi}{\sum_{i=1}^{n} Wmi}$

$$= \frac{1+0.3+0+0.5+0.5+0.7\ (-0.5)\ +0+0.5\ +1+1+\ 0.5}{12} = \frac{55}{12} = 0.5$$

(Repeat adaptive capacity for the rest of the households)

Step (3) total vulnerability (IPCC-Vd) = Ed + Sd - Ad

= 0.4 + 0.5 – 0.5 = 0.4

(Total vulnerability for the rest of the households was worked out likewise the results shown in Table 4.5, 4.6 and 4.7).

CHAPTER FIVE: SMALLHOLDER FARMERS' VULNERABILITY

5. 1 Introduction

Description of the study area in the preceding chapter shows evidence that, torrential rainfall is a major cause of flood events in the district which comes with huge economic cost as a result of the destructions it causes. However, the high poverty levels of smallholder farmers limit their adaptive capacity to effectively respond the flood shocks thereby, making them vulnerable to flood disasters. In view of the above, this chapter covers an in-depth analysis of socio-demographic profile of respondents, respondents' perception on factors that cause flooding and the flood vulnerability levels of households.

From the data gathered, though households in all the four study communities are generally vulnerable to floods, there are variations which put each household on a scale of being highly vulnerable, vulnerable and least vulnerable in comparable terms.

5.2 Socio-demographic profile of households

There was no variation in the household demographic profile in the four study communities. From table 5.1, an overwhelming average of 87% constituted males, with only 13% being females, resulting in an uneven gender balance. The variations in gender characteristics of respondents may be due to the patrilineal system in the study area that gave rise to the dominance of male headed households. Majority of the respondents, representing 66%, had no formal education and an average of 23% and 11% had basic education and 'A' level/SHS education respectively. The average household size stood at 6 persons and majority of population (81%) were within the active population that is, from 21-40 years and 41- 60 years. About 64% (n= 96) of households had their total annual income from farm and non-farm below 1,500 Gh cedis as shown in table 5.1. This places households below the national average of poverty line and implies households have insufficient means of living to meet their basic requirement.

In all four communities, living conditions of small holder farmers were poor. Farmers dwelled in houses made of local materials including mud and thatch. Households in Kpalisogu-Kura and Tampia get water from the river, which is their only source of water and 66% and 34% of respondents obtain water from dams and boreholes in Yoggu and Kpalgun communities. About 78% of respondents were born and breed in the study communities and the rest were migrants who moved to the communities for farming purposes and because of marriage.

In terms of asset possession, only 20 % of respondents owned a mobile phone and the remainder did not own any. Also, 18% had bicycles, 5% own motor bikes and 7% had tricycles popularly known as *motor king*. This implies that, majority of respondents did not have any means of transportation and either have to walk or pay for a tricycle public transport to nearby markets to sell farm produce. More than 90% of respondents did not have savings, with just 6% having personal savings with *Susu groups* in the study communities.

Table 5. 1. Household socio demographic profile

Household socio-demographic characteristics	Kpalisogu-Kura (n=32)	Tampia (n = 12)	Yoggu (n= 60)	Kpalgun (n = 45)	Percentage of respondents in all four communities (n = 149)
Gender					
Male	81%	75%	93%	84%	87%
Female	19%	25%	7%	16%	13%
Educational level					
No education	76%	75%	63%	64%	66%
Basic school	19%	17%	27%	25%	23%
'A' Levels/SHS	9%	8%	10%	11%	11%
Household size					
1-3	13%	8%	12%	11%	11%
4-6	56%	50%	37%	60%	49%
7-9	22%	25%	33%	20%	26%
More than 10	9%	17%	18%	9%	13%
Age					
Below 20	6%	8%	13%	9%	10%
21-40	34%	42%	52%	53%	48%
41-60	47%	33%	29%	29%	34%
61 above	6%	17%	6%	9%	8%
Alternative source of livelihood					
Have	19%	17%	48%	42%	39%
Do not have	81%	83%	52%	58%	61%
Annual household income (GHS)					
Below GHS 1500	78%	75%	58%	62%	64%
Between GHS 1,600 &2,500	16%	17%	23%	20%	20%
Between GHS 2,600 & 3,500	6%	8%	13%	11%	10%
More than GHS 3,500.	0%	0%	6%	7%	6%

(Source: Field survey, 2015)

In terms of alternative sources of livelihood, the percentage of those engaged in that is higher for Yoggu and Kpalgun than in Tampia and Kpalisogu-Kura. Some of the alternative livelihood options included masonry, carpentry, petty trading, sheabutter processing and dawadawa processing, smoke and thatch weaving.

5.3 Spatial and temporal variations of floods in the study communities

In assessing the spatial and temporal variations of flood events, two parametres were used. That is; the regularity and period of flood events and where they occurred. These were assessed within a ten-year period that is, from 2004 and 2014.

A ten-year period was chosen as the recall window for flood occurrences indicator because respondents are likely to inaccurately report disasters earlier than 2004. Another reason is that, a serious flood disaster occurred in 2004 in communities sharing borders with the White Volta River due to the Bagre dam spillage (NADMO, 2007) and respondents in a FGD could still recall that incident. However, this is highly subjective and could lead to bias in recalling the events. Data from District Assembly at the community level would have been more accurate in indicating the frequency of flood events. However, there was no data available on the number of floods recorded so the study dwelled on community stakeholders' perception.

From the FGDs, it was revealed that flood occurrence varied in the study communities depending on their proximity to the river. Tampia recorded the highest with 6 floods events from 2004 to 2014 followed by Kpalisogu-Kura with 5 flood events experienced. Yoggu and Kpalgun recorded 2 events each as shown in table 5.2

Table 5. 2: Frequency of flood occurrence from 2004 to 2014

Name of community	Years of flood occurrence											Total no. of floods
	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	
Tampia	x	-	-	x	x	x	x	-	x	-	-	6
Kpalisogu-Kura	x	-	-	x	x	-	x	-	x	-	-	5
Yoggu	-	-	-	x	-	-	x	-	-	-	-	2
Kpalgun	-	-	-	x	-	-	x	-	-	-	-	2

(Source: Field survey, 2015)

Note: x = flood occurrence

– = no flood occurrence

The variation in the occurrences of floods events was because Tampia and Kpalisogu-Kura communities were closer to the White Volta River and suffered floods from the spillage of water from the Bagre dam which is at the upper course of the White Volta River in Burkina Faso. In addition, torrential rainfall usually leads to flood situations in these communities. A combination of floods from torrential rainfall and the spillage of the dam explains why flooding is higher in communities with close proximity to the river. In Yoggu and Kpalgun however, only torrential rainfall caused flooding in low-lying areas and in areas with poor drainage. These communities are further away from the White Volta River and they did not suffer river floods from dam spillages. This explains why they comparatively experienced few flood events for the ten-year period.

Findings from the study also revealed that, floods usually occurred in August and September when rainfall is heavy and continuous. About 87% of households responded to that effect as seen in table 5.3 below. Again 9% of households indicated that floods occurred in July and August when there are torrential rainfall and the remaining 26% stated that they usually occurred in September and October when excess water is released from the Bagre dam at the upper stream of the Volta River. The 26% were specifically responses from households in communities that were closer to the river (that is Tampia and Kpalisogu-Kura) and the rest of the responses were from all four communities.

Table 5.3: Month of flood occurrences

	month	**Frequency of response**	**Percentage of response**
Torrential rainfall	July/August	14	9%
	August/September	137	87%
Dam spillage	September/October	41	26%

(Source: Field survey, 2015)

Whilst communities located away from the White Volta River experienced floods in July, August and September owing to torrential rainfall, communities closer to the river experienced floods from July to October from both torrential rainfall and spillage of water from the dam.

With respect to the spatial pattern of flood occurrence, households in Tampia and Kpalisogu-Kura reported that flooding usually occurred at floodplains where farming takes place and at low-lying areas further away from the floodplains. Households in Yoggu and Kpalgun also indicated that floods occurred at areas that were low and had poor drainage. Such areas were used for rice cultivation which thrived well in the absence of floods.

5.4 Factors that trigger floods in the Study Communities.

Analyses of the causes of floods were looked at from the communities closer to the White Volta River and those that were further away. Respondents identified the triggers of floods in all the study communities and analysis was done based on farmers' perceptions.

5.4.1 Factors that trigger flooding in communities closer to the White Volta River

For communities closer to the river, that is Tampia and Kpalisogu-Kura, a total of four factors were mentioned. These included continuous intensive rainfall, spillage of water from the Bagre Dam, siltation, houses and farms located at floodplains. Respondents were asked to rank these triggers in order of importance that is from the most serious trigger to the least. Out of the four triggers mentioned, continuous rainfall came first. According to the respondents, continuous rainfall over many days usually around August and September increases the river volume which makes it to overflow causing floods. They explained that there were days in the raining season they could have continuous rainfall for a whole week which traps them indoors. This continuous intensive rainfall coupled with the fact that their farms and houses located in low-lying areas exposes them to floods. This resonates with that of the works of Christie and Hanlon (2001) in Mozambique. They stated that heavy rainfall over several days was the cause of the 2000 flood disaster which displaced about 4000 people in just Maputo alone and destroyed key infrastructure including transport networks. However, the results also contradict that of Guiteras et al., (2015) in their study in Bangladesh on exposure to floods. Using correlation for monthly rainfall and monthly flood extent, they concluded that rainfall is a weak proxy for flood occurrence.

The trigger of floods that was ranked second by respondents was the spillage of water from the Bagre dam. The respondents explained that, the Bagre that was constructed at the upper course of the Volta River in Burkina Faso is spilled occasionally anytime that dam was full to capacity. This caused floods downstream and affects farm and houses located close to the river. Respondents also stated that, they did not receive prior notice when water from the dam was to be spilled, even though they were assured by the district assembly that they were to notify them after the devastating 2007 floods but they never did.

The third trigger according to respondents was the gradual siltation of the river bed. Farmers locate their farms very close to the river in search of fertile soils. And as a result of this practice, anytime there were heavy rains, the run-off water easily carries loose soil into the river silting it. Once the river bed is silted, it reduces the water volume capacity the river used to contain. Therefore, the river overflows and results in floods.

The final trigger of floods respondents cited was the location of farms and houses close to the White Volta. Respondents cited two reasons that attracted them to build their house in floodplains. The first reason was that, it was relatively cheaper and easier building within floodplains. They explained that, lands at the floodplains were flat and they did not have to level the ground before building as compared to uplands that are hilly and stony. The second was that, the main building material which is mud is readily available around the river and cost them less to transport. With respect to locating farmlands close to the river, respondents explained that soils within the floodplains are rich for their farming activities. This therefore attracted farmers to locate their farms in floodplains rather than uplands. As a result of locating farmlands and houses in floodplains, anytime the river overflows, floods occurred.

Table 5. 4: Multiple Response Ranking of household perception on factors that trigger floods.

Factors that trigger floods	Kpalisogu-Kura and Tampia (communities closer to the White Volta River)	
	Number of responses	Rank *
• Continuous heavy rainfall	41	1st
• Spillage of water from the Bagre Dam	37	2nd
• River siltation	26	3rd
• Houses and farms close to the river	18	4th

(Source: Field survey, 2015)

In responding to the effects of floods, majority of the respondents were of the view that apart from few instances where floods were beneficial for agriculture and fishery in the floodplains, floods generally in these communities were very destructive. Respondents mentioned the floods of 2007 and that of 2010 as the most damaging of all floods they have ever experienced in recent times.

5.4.2 Factors that trigger flooding in inland communities away from the White Volta River

In the case of inland communities, respondents mentioned two factors responsible for triggering floods. This is understandable because the inland communities (Yoggu and Kpalgun), are not drained by the White Volta and therefore do not have a direct effect of the river floods. They identified the triggers of floods to include continuous heavy rainfall, and location of houses and farms at low-lying areas. Continuous rainfall was ranked first followed by location of houses and farmlands at low-lying areas. With regards to continuous rainfall, respondents indicated that any time it rained water does not easily drain either through runoff or seepage. Rain water therefore increase in volume gradually over time causing floods. The second trigger respondent cited was location of houses and farms at low-lying areas. The explanation given was that low-lying areas had fertile soil suitable for rice cultivation. As a result of locating farmlands and houses in low-lying areas, anytime it rained continuously and heavily coupled with the fact that the area generally is poorly drained, floods occur.

Table 5. 5: Multiple response ranking of factors that trigger flooding in communities away from the White Volta River.

Factors that trigger floods	Yoggu and Kpalgun (Inland Communities away from the White Volta River. N = 112)	
	Number of responses	**Rank**
• Continuous heavy rainfall	107	1st
• Relief (Low-lying lands)	71	2nd

(Source: Field survey, 2015).

Findings from the study therefore indicated that, flood is not only associated to close proximity to river courses because there were households farther away from the river that also experienced floods. However, communities closer to the river are more exposed.

5.4 Households' Vulnerability Profile

Indicators for exposure, sensitivity and adaptive capacity were generated in order to obtain standardized values. Values obtained were used to work out for indices of exposure, sensitivity, adaptive capacity as well as total vulnerability for each household in the four study communities based on Hahn et al., (2009) LVI. Results from the calculation showed some significant variations in all the four communities. The weights of each component are determined by the number of indicators it consists of. This was to ensure that, all main components (exposure, sensitivity and adaptive capacity) contributed equally to household flood vulnerability. Under the three main components, the index ranged from 0.67 to 1 (highly vulnerable), 0.34 to 0.66 (vulnerable) and 0 to 0.33 (Least vulnerable).

Total vulnerability was assigned a different range; this was as a result of the variations in the general scores obtained for the three indices (exposure, sensitivity and adaptive capacity). For instance, the least score in the three indices was 0.08 and the highest being 1. For total vulnerability however, both negative and positive scores were obtained with the lowest being - 0.5 and the highest being 1 (See appendix 1, II, III, and IV).

However, the index obtained does not represent an absolute vulnerability value. It is rather a measure that compares household vulnerability in relation to other households based on their perception on flood disaster and their capacity to adjust to it.

5.4.1 Household exposure to vulnerability estimated from LVI.

With regards to exposure to vulnerability, results were based on the five indicators that is; average monthly minimum and maximum temperature, precipitation, frequency of flood events over the period of 10 years and farmlands located at low-lying areas. Secondary data on average monthly precipitation, minimum and maximum temperatures were obtained at the Meteorological Survey Department in Tamale (Northern regional capital). Regional data was used for all the four study communities as a result of absence of community level data on climate elements. The standard deviation for average monthly precipitation, minimum and maximum temperature was computer in SPSS version 14.0 and the values obtained was added to other indicators to calculate the exposure index for each household. Also the frequency of flood events experienced in a ten-year period (that is, from 2004 to 2014) was used. Ten years was chosen as the recall window for flood occurrences indicator because respondents are likely to inaccurately report disasters earlier than the ten-year period. Another reason is that, a serious flood disaster occurred in 2004 in communities sharing borders with the White Volta River due to the Bagre dam spillage (NADMO, 2007) and respondents in a FGD could recall that incident.

The outcome of the exposure index showed that 58% of households in Tampia had scores of 0.5 to 1 which placed them in the highly vulnerable category as showed in table 5.6. Kpalisogu- Kura also had about 31% of household in this category with Yoggu and Kpalgun having 9% household each. Again, Tampia had 17% of respondents in the vulnerable category against 63% in Kpalisogu-Kura, 28% in Yoggu and 29% in Kpalgun.

However, most of the households in Yoggu and Kpalgun were least vulnerable to floods exposure with 63% and 62% of households respectively falling in this category. 25% of households in Tampia were least vulnerable with 6% in Kpalisogu-Kura.

The results showed that, Tampia had the highest percentage of households who were highly exposed to floods. Their situation is so because, they had the highest record of six flood events from a ten-year period that is from 2004 to 2014, making them more exposed. Majority of households also reported having farms at floodplains which also exposed them to the vagaries of floods. Kpalisogu-Kura had the second highest percentage of households being more vulnerable with the community recording five floods in ten years with many of the households having farms in floodplains.

Table 5. 6: Percentage of households within exposure vulnerability ranges in the four study communities

Exposure vulnerability ranges	**% of HH in Tampia n= 12)**	**% of HH in Kpalisogu-Kura (n= 32)**	**% of HH in Yoggu (n= 60)**	**% of HH in Kpalgun (n= 45)**
Highly vulnerable (0.67 to 1)	58%	31%	9%	9%
Vulnerable (0.34 to 0.66)	17%	63%	28%	29%
Least vulnerable (0 to 0.33)	25%	6%	63%	62%
Total	100%	100%	100%	100%

(Source, Field survey, 2015)

5.4.1.1 Households' exposure flood vulnerability state.

The closeness of Tampia and Kpalisogu-Kura communities to the White Volta River as indicated in figure 1 (chapter four) exposes them to flooding due to continuous heavy rainfall and excess release of water from the Bagre Dam compared to Yoggu and Kpalgun which are further away from the White Volta.

Households in Yoggu and Kpalgun were least vulnerable in terms of their exposure to floods. This is because they are not drained by any river and so flood events are minimal. They indicated that, the low-lying areas are poorly drained and hence run-off water from continuous heavy rainfall flood their farms. Most households in these two communities scored low in their exposure to vulnerability and placed households under the least vulnerable to flood exposure category.

5.4.2 Household's sensitivity index estimated from LVI

With regards to sensitivity index score, 25% of households in Tampia were highly vulnerable to flood sensitivity, with 31% in Kpalisogu-Kura as depicted in table 5.7. Also, 20% of households in Yoggu were highly vulnerable against 22% in Kpalgun. Percentage of households who were vulnerable in Tampia were 50% and 53% in Kpalisogu-Kura. Yoggu and Kpalgun had 23% and 33% of household in this category respectively. Again, 25% of households in Tampia were least vulnerable to flood sensitivity against 16 in Kpalisogu-Kura, 57 in Yoggu and 42 in Kpalgun as indicated in table 5.7.

Table 5. 7: Percentage of households within sensitivity vulnerability ranges in the four study communities

Sensitivity vulnerability ranges	**% of HH in Tampia n= 12)**	**% of HH in Kpalisogu-Kura (n= 32)**	**% of HH in Yoggu (n= 60)**	**% of HH in Kpalgun (n= 45)**
Highly vulnerable (0.67 to 1)	(n = 3) 25%	(n = 10) 31%	(n =12) 20%	(n = 10) 22%
Vulnerable (0.34 to 0.66)	(n = 6) 50%	(n = 17) 53%	(n =14) 23%	(n = 15) 33%
Least vulnerable (0 to 0.33)	(n = 3) 25%	(n = 5) 16%	(n = 34) 57%	(n = 19) 42%
Total	100%	100%	100%	100%

(Source: Field survey, 2015)

5.4.2.1 Household sensitivity state

Majority of households in Tampia and Kpalisogu-Kura communities were highly sensitive to flood impacts due to the fact that, floods rendered their lands infertile and farmers usually left the non-fertile lands for some time to fallow before carrying out any agricultural activity. They also indicated that, the floods destroyed their crops especially sorghum and maize which they said did not require much water to grow (drought-tolerant). Again, they cited loosing domestic animals to flood events and some households also indicated that household members incurred injuries during floods. The greater the occurrences of floods, the more sensitive farmers are likely to be to flood impacts. Communities further away from the White Volta River were less exposed and households therefore were less sensitive to flood impacts as revealed in the household sensitivity index.

For households who lost their crops and livestock to floods, food availability has always been a problem. They indicated that they did not harvest enough maize and rice to feed their families all year-round when floods occurred. In the absence of floods, they were usually able to meet household food requirement up to the next harvest time. But when floods struck and affect their crops, they experience a lean season (usually from March to July) which is the critical time of the year where they lack sufficient food. The lean season occurred at the beginning of the raining season before harvest with variation across households. Majority of households in Tampia and Kpalisogu-Kura indicated that they lacked food sufficiency for five months or more when floods occurred and few households in Yoggu and Kpalgun complained of food insufficiency as a result of flood events.

Loss of crops, livestock and accompanying income lost varied in all households with impacts scaled from mild to severe. Even though sensitivity to floods in terms of crop damage, livestock loss and soil infertility were much higher in Tampia and Kpalisogu-Kura probably due to their proximity to the river, the 2007 and 2010 flood impacts were severe in all the four communities. This finding resonates with the work of Antwi-Agyei et al., (2012), which expounded that flood disasters come with massive impacts including severe injuries and property loss. Also, a later impact is likely to be followed by disease outbreaks and food shortages depending on the nature of the flood event. In the same regard, Harvey et al., (2014) indicated that farmers exposed to the vagaries of weather extremities lose crops, livestock and farmlands. They added that extremes weather events like floods impact on food security and also prolong lean season where rural farmers lack food sufficiency.

5.4.3 Household's adaptive capacity estimated from the LVI

Under adaptive capacity, five asset indicators were used which was derived from the DFID's SLF as explained in the conceptual framework in chapter 1. The five assets group included physical/technological, natural, human, financial and social assets. Indicators were identified under all the five asset groups through FGD with key community stakeholders. All indicators were standardized and computed using the LVI by Hahn et al., (2009) to obtain adaptive capacity index for each household. Again, adaptive capacity reduces vulnerability because it is negated in the IPCC concept unlike exposure and sensitivity which increases vulnerability. The range for adaptive capacity is the opposite of that of exposure and sensitivity. This was from 0. 67 to 1 (least vulnerable), 0.34 to 0.66 (vulnerable) and 0 to 0. 33 (highly vulnerable).

From table 5.8, the scores for adaptive capacity revealed that, households in Kpalgun had the highest asset possession with 71% of households being least vulnerable. Yoggu was the second community with 55% of households possessing more assets. This was followed by 31% of households in Kpalisogu-Kura and 25% in Tampia. Again, 17% of households in Tampia were vulnerable, 38% in Kpalisogu-Kura, 32% in Yoggu and 18% in Kpalgun. However, majority of households (58%) in Tampia had lower asset possession and fell within the highly vulnerable category followed by 34% of households in Kpalisogu-Kura. Few households (13%) in Yoggu were highly vulnerable with 11% in Kpalgun.

Table 5. 8: Percentage of households within adaptive capacity index ranges in the four study communities

Adaptive capacity vulnerability ranges	**% of HH in Tampia N = 12)**	**% of HH in Kpalisogu-Kura (n = 32)**	**% of HH in Yoggu (n =60)**	**% of HH in Kpalgun (n =45)**
Highly vulnerable (0.67 to 1)	(n = 7) 58%	(n = 11) 34%	(n = 8) 13%	(n = 5) 11%
Vulnerable (0.34 to 0.66)	(n = 2) 17%	(n = 12) 38%	(n =19) 32%	(n = 8) 18%
Least vulnerable (0 to 0.33)	(n = 3) 25%	(n= 10) 31%	(n = 33) 55%	(n = 32) 71%
Total	100%	100%	100%	100%

(Source: Field survey, 2015)

5.4.3.1 Household adaptive capacity state

In terms of physical/technological asset possession, most of the households in Tampia and Kpalisogu-Kura did not use improve crop variety which included flood tolerant varieties or early maturing crops. About 25% of farmers were engaged in dry season farming with local irrigational facilities in Kpalisogu-Kura which increased household adaptive capacity. However, there was absence of dry season farming in Tampia even though smallholder farmers had their farms closer to the river. Households in Tampia had no access to irrigational facilities and were therefore not able to engage in dry season farming. This was also absent in Yoggu and Kpalgun because of the absent of a river or other sources of water for irrigational purposes.

Figure 5. 1: Dry season okra farm in Kpalisogu-Kura

(Source: Field survey, 2015).

The households in Kpalisogu-Kura who engaged in dry season farming were of the view that, because of the frequent floods they had to do dry season farming to make up the losses. Some stated that they had good yields from dry season farming which helped them to remit their family and enhance household food availability. Findings from Yahaya (2002) postulated that, the availability of irrigational facilities in a savannah agro ecological area enables rural farmers who are dependent on rain- fed agriculture to increase food availability.

Almost half of farmers in all four communities had devices to access information and the remaining had none. The percentage of respondents who had radio and mobile phones were higher in Yoggu (67%) and Kpalgun (59%). And were lower in Tampia (6%) and 14% in Kpalisogu-Kura. Farmers indicated that, having a radio enables them to listen to news on local radio stations and get educated on agriculture related programmes discussed on air. Having a device to receive information on farming and flood related issues enables households to take proactive measures and plans for coping with flood risks and impacts. Households with devices to access information in the study communities were assigned weights which were added up in their total adaptive capacity score. In terms of natural assets possession, 19% of farmers interviewed had more than one farm in Kpalisogu-Kura, 25% in Tampia, 63% in Yoggu and 58% in Kpalgun. They stated that, having a number of farms at different locations reduces the probability of losses from flood events since the floods usually occur at specific locations.

For human assets, household's highest level of formal education, dependency ratio, and training received (agricultural related, climate change and vocational training) were used. Considering the highest level of education for household members, 24% of households in Kpalisogu-Kura had formal education, against 21% in Tampia. The percentage is comparatively higher in Yoggu (37%) and 35% in Kpalgun. But generally, the percentage of households without any formal education in all four communities was over 60% and those with formal education were 32%. This resonates with statistics from GSS (2008), that less than a third of adults in rural areas of the northern regions have some formal education. Illiteracy limits smallholder farmer's access to information especially from written sources, thereby increasingly their susceptibility to climatic stresses like floods. According to Stanturf et al., (2011) northern Ghana is relatively vulnerable to climate change as compared to the rest of Ghana mainly because of the high rates of illiteracy and relatively underdeveloped infrastructure. The dependency ratio of households was higher in Tampia and Kpalisogu-Kura with about 30% of households having a ratio of above 0.4 in Tampia and 24% in Kpalisogu-Kura, with Yoggu and Kpalgun having a higher percentage of 44% and 49% respectively. 9% of respondents indicated that they received some training on agricultural related issues and vocational training as against 11% on Kpalisogu-Kura, 29% in Yoggu and 31% in Kpalgun.

Farmers with some form of education are likely to adopt new methods of farming to reduce flood impacts and improve resilience. Training received on agricultural issues, flood management, and vocational training informs farmers and enable them take proactive measures during floods. Vocational training also equips farmers with skills to engage in other livelihood activities for economic gains which contribute to adaptive capacity. Under human asset possession, dependency ratio contributes negatively to adaptive capacity and hence reduced the score for household human asset indicator. A study by Piya et al., (2012) however, cited that enhancing human assets in terms of education and skill development trainings is necessary for farmers at the local level in order for them to utilize the existing physical and financial assets appropriately to build resilience to climate stress.

Under financial assets, access to credit facilities, income from non-farm economic activity and household saving were the indicators used. Rural banks were absent in communities however there was MASLOC credit facility and some farmers indicated they benefited but they complained that it was not easy to access it because of the long processes involved as well as high interest rates. There was the existence of *Susu* groups in Kpalisogu-Kura, Yoggu and Kpalgun communities that gave members some financial help. However, beneficiaries indicated that the amount they received in times of need was little. There were no Susu groups in Tampia community. Households who had access to both formal and informal credit indicated that, they borrowed money from *susu* groups and MASLOC for agricultural and other productive investments.

Farmers in general relied heavily on agricultural as their primary source of income with non-farm income being an alternative. 19% of respondents in Kpalisogu-Kura had income from non-farm economic activities, with 17% in Tampia, 48% in Yoggu and

42% in Kpalgun. Non-farm economic activities farmers engaged in included: petty trading, thatch weaving (see figure 5.2), smock weaving (see figure 5.3) and artisan work which were usually done by males. Females in household were engaged in *sheabutter* and *dawadawa* processing, petty trading, charcoal burning and fire-wood gathering. Farmers indicated that they generate additional money from non-farm economic activities which increases their household income portfolio. Adger, (1999) stated that households, who depended on only agricultural income, were very sensitive to climate impacts. He also added that building households' resilience to climate induced disaster should include diversifying livelihood.

With regards to household savings, majority of households in all the study communities did not have savings. A few had personal savings with *Susu groups* in the study communities or rural banks in nearby towns.

Households who did not have any savings, and non-farm income or who lacked access to credit facilities scored no value under this indicator. Those who had all or either one of the indicators had their values normalized to compute their score for their financial assets. Financial assets score was subsequently standardized with scores from the other assets to obtain adaptive capacity for each household. Piya et al., (2012), indicated that "financial asset is important as it is the most convenient form of asset that can be converted into other forms of asset when needed".

Figure 5. 2: Thatch weaving in Yoggu

Figure 5. 3: Smock weaving in Kpalgun

In the case of socio-political asset, membership in FBO's and CBO's, provision of emergency post-disaster aid and out migration were indicators measured. 21% of households said they were members of FBO's or CBO's in Kpalisogu-Kura, 57% in Tampia, 15% in Yoggu and 17% in Kpalgun. Membership in CBO and FBO improves social networks and access to information during contact with outside stakeholders, share ideas on flood risk measures, agricultural improvements and labour sharing. Community social networks were stronger in Tampia than it was in the other three communities. Farmers who were interviewed in Tampia indicated that, they built strong social networks after they were resettled to a safer site following the 2010 floods. They stated that the District Assembly and some NGO's provided them with building materials which helped them put up houses in their new settlement. They also engaged more with outside stakeholders during this time as they were given some ideas on how to reduce flood risk and improve agricultural productivity. They also relied on shared labour to build their houses. Even though, they indicated that social networks were low before the 2010 floods, it became stronger after the disaster and helped them in the recovering process. In the other three communities however, household membership in FBO's and CBO's was low.

In terms of getting disaster aid, all households in Tampia stated that they benefited from disaster aid from the district and other donors. 67% of households in Kpalisogu-Kura also indicated that they received disaster aid during flood shocks. With 20% and 29% of households in Yoggu and Kpalgun respectively responded in positive terms. Households indicated that they received grains such as rice, maize, beans, cooking oil, beverages, building materials amongst others as emergency relief from the district and other donors during flood shocks. Majority of households in Tampia scored high in receiving disaster aid as an indicator. Though households in Tampia scored higher in disaster aid received, they had low scores in other asset category making them highly vulnerable in adaptive capacity.

With migration as an indicator in adaptive capacity, 36% of households in Kpalisogu-Kura stated that able bodies in their households (usually either adult children or household heads) left the community to other communities or towns to work and send money to the family as remittances. 31% of households in Tampia reported having household members migrating against 13% and 16% in Yoggu and Kpalgun respectively. Households reported that, when times are difficult owing to flood disasters, household members within the working class group left the community to work in other communities and earn money for family sustenance. Comparatively, more households migrated in Tampia and Kpalisogu-Kura than in Yoggu and Kpalgun. This could be attributed to the severity of flood impacts, the non-engagement in non-farm economic activities and lack of financial assets in households and in the community at large.

In aggregate terms however, majority of households in Yoggu and Kpalgun scored higher in adaptive capacity with values above 0.5. Households in Tampia and Kpalisogu-Kura had low adaptive capacity with majority of households scoring below 0.5. Adaptive capacity was high in Yoggu and Kpalgun because households had more assets indicators, the product of which increased their total adaptive capacity. Whiles majority of households comparatively have lower assets in Kpalisogu-Kura and Tampia.

5.4.3.2 Perceptions of the effectiveness of household adaptive strategies to floods.

Twelve (12) adaptive strategies were used by household members in coping with flood events. These were put into five broad categories as showed in table 4. 4 in chapter four Out of the five broad categories, indicators under socio-political asset group were the most effective strategies household relied on to cope with flood situations. Most households in all study communities indicated that they had support (both in kind and in cash) from family, friends, district and NGO's. For example, the whole of Tampia community were relocated to a safer site following the 2010 floods. This observation implies that the magnitude and impacts of floods were probably higher in Tampia than the other three communities. The support for the relocation came from the district assembly, NGO's, family members and friends.

The second most effective strategy that respondents mentioned was their natural assets. Majority of respondents in the four communities asserted that their natural asset which included having multiple farms at different locations helped them to cope with floods events in the community. Having multiple farms at different locations was more dominant in Tampia and Kpalisogu-Kura. Households in these communities relied more on that as a strategy to manage flood impacts as compared to Yoggu and Kpalgun because floods events were frequent and much severe there. Having farms at different locations was seen as a way of reducing losses than having just one farm. Also, dry season gardening was common among households in Kpalisogu-Kura because of the presence of irrigational facilities. Even though Tampia was also closer to the river, households there didn't engage in dry season farming. This was because irrigational facilities were absent in the community.

Livelihood diversification was the third most effective adaptive strategy that was adopted to reduce flood impacts. This was more predominant in Yoggu and Kpalgun than in Tampia and Kpalisogu-Kura. As discussed earlier, majority of households in these communities engaged in non-farm income generating activities such as thatch weaving, smoke weaving, petty trading, and shea-butter processing amongst others. In the case of Tampia and Kpalisogu-Kura, majority of households rather depended solely on agriculture for their sustenance and did not have other alternative source of livelihood. This could be as a result of the relatively far distance to nearby markets and the limited market opportunities for households. Households with diverse long-term income generating activity were noted to be better placed to offset flood shocks than those who depended only on farm income. It was also found out that wealthier households engaged in alternative economic activities, whilst poorer households relied more on social networks.

Family savings and access to credit was another important and efficient adaptive strategy households used to cope with floods in the study communities. Households who were able to save with formal financial institutions or get credit from them do it in institutions located in nearby towns. Many Households did not also have savings to rely on in times of need. However, the few households that relied on credit facilities and family savings during floods said it was helpful as they relied on that to buy food stuffs to replace the lost ones.

5.4.5 Total household vulnerability estimated from the IPCC definition of vulnerability.

After estimating household vulnerability levels for exposure, sensitivity and adaptive capacity, total household vulnerability was computed. This was arrived at by summing up indices of exposure and sensitivity minus index of adaptive capacity (IPCC). When exposure and sensitivity of households exceeds adaptive capacity, households become vulnerable and vice versa. Households were also put into three categories based on their total vulnerability index which were in both positive and negative values. The categories ranged from highly vulnerable (that is from 0.50 to 1), vulnerable (from 0.49 to 0) and least vulnerable (from - 0.6 to - 0.1).

As shown in table 5.9, 100% of all sampled households in Tampia were highly vulnerable, meaning all households fell within 0.5 to 1 range on the vulnerability scale. Kpalisogu-Kura had the second highest percentage of households (63%) that were highly vulnerable as against 7% in Yoggu and Kpalgun each. 31% of households were vulnerable in Kpalisogu-Kura compared to 17% in Kpalgun and 18% in Yoggu. In the least vulnerable range, Kpalisogu recorded 6% in this category against 75% in Yoggu and 76% in Kpalgun.

Table 5. 9: Percentage of households within total vulnerability index ranges in the four study communities

Total vulnerability ranges	% of HH in Tampia n= 12)	% of HH in Kpalisogu-Kura (n= 32)	% of HH in Yoggu (n= 60)	% of HH in Kpalgun (n= 45)
Highly vulnerable (0.5 to 1)	(n = 12) 100%	(n = 20) 63%	(n = 4) 7%	(n =3) 7%
Vulnerable (0 to 0.4)	(n = 0) 0%	(n=10) 31%	(n = 11) 18%	(n = 8) 17%
Least vulnerable (- 0.5 to -0.1)	(n = 0) 0%	(n= 2) 6%	(n = 45) 75%	(n = 34) 76%
Total	100%	100%	100%	100%

(Source: Field survey, 2015)

From the results, majority of households in communities closer to the river were highly vulnerable as compared to households further away from the river. This implies that proximity to a river exposes people to the vagaries of floods that arise as a result of continuous heavy rainfall or the occasional spillage of water from the Bagre dam. Apart from a higher exposure to floods, households in these communities had a much lower adaptive capacity than households away from the river. This made them unable to reduce their total vulnerability. High adaptive capacity is required to adjust to the impacts of floods and if it is limited, vulnerability is likely to increase.

According to Piya et al., (2012), irrespective of the locations, households with limited adaptive capacity suffer higher exposure and higher sensitivity to climate change and extreme events. Households that are poor and have limited access to resources have high vulnerability anywhere regardless of their locations.

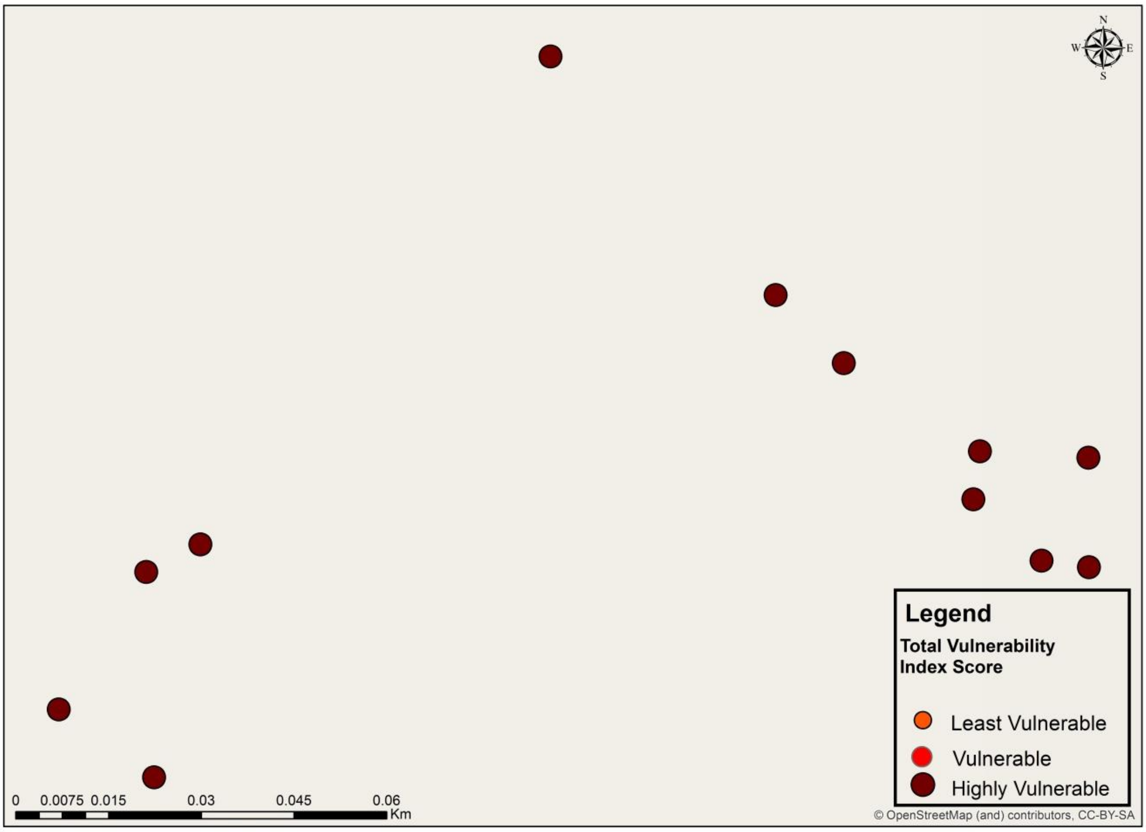

Figure 5. 4: Map showing the index score for total vulnerability in Tampia.

(Source: Field survey, 2015).

Households in Tampia were all vulnerable as depicted in figure 5. 4. This can be attributed to the fact that, households had higher exposure, higher sensitivity and lower adaptive capacity. Majority of the households in this community had farms very close to the river and as a result, the over flow of the river arising from continuous rainfall and spillage of water from upstream of the Volta River could trigger devastating flood disasters. Adaptive capacity was relatively low in households and was unable to offset their exposure and sensitivity. Higher score in exposure or sensitivity and a lower score in adaptive capacity increases vulnerability. Vulnerability is high in this community and it is not surprising they were relocated to a safer site owing to the 2010 flood disaster. Even though they were given a safer site away from the river to settle, they were not given lands further away from the river for farming and so they continued to farm around the floodplains making them highly exposed.

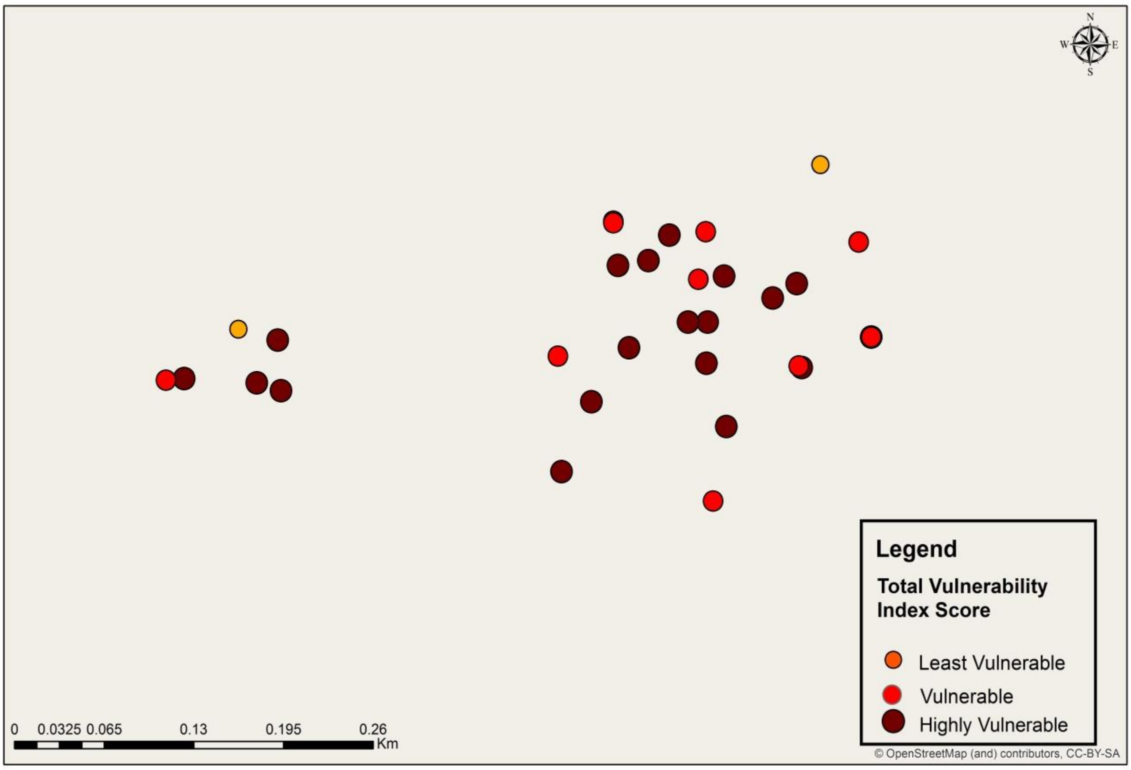

Figure 5. 4: Map showing the index score for total vulnerability in Kpalisogu-Kura (Source: Field survey, 2015).

Figure 5.5 presents the total vulnerability of households in Kpalisogu-Kura. The percentage of households who were highly vulnerable was more followed by those who were vulnerable with few households being least vulnerable. Although, this community shares boundaries with the White Volta, vulnerability is quite better here than in Tampia. Unlike Tampia, some households were engaged in dry season farming and other livelihood activities apart from farming and animal rearing. However, they are comparatively vulnerable than households in Yoggu and Kpalgun.

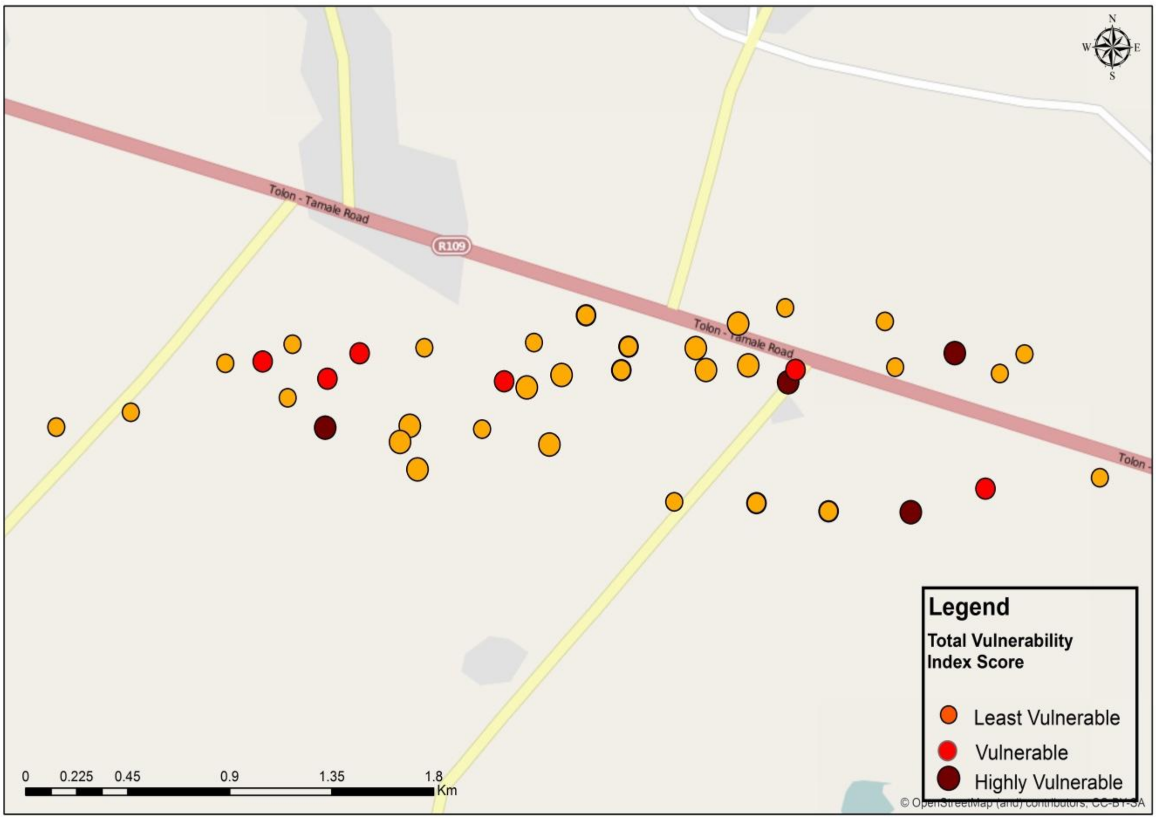

Figure 5. 5: Map showing the index score for total vulnerability in Yoggu

(Source: Field survey, 2015).

Contrary to Tampia and Kpalisogu-Kura, majority of households in Yoggu were least vulnerable as depicted in figure 5.6. This was so because; exposure and sensitivity were lower in majority of the households probably because the community was further away from the river. Adaptive capacity was generally higher here as many of the households had other alternative livelihood, access to financial services, having more farms, and devices to access information. Fewer households had lower adaptive capacity in this community and higher exposure and sensitivity thereby making them vulnerable. Having farms at low-lying areas was reported to be the cause of flood exposure and risk of flood disasters.

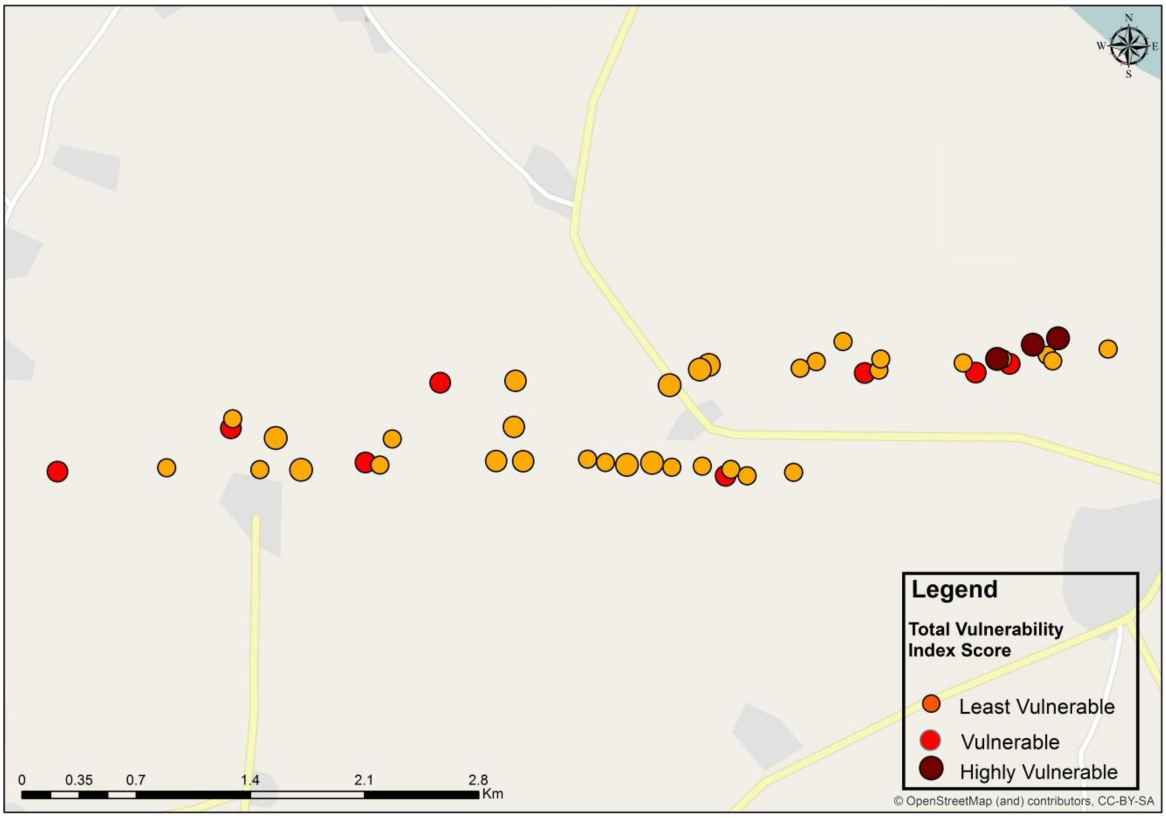

Figure 5. 6: Map showing the index score for total vulnerability in Kpalgun

(Source: Field survey, 2015).

From figure 5.7, there are similarities of vulnerability trends in Kpalgun just like in Yoggu. Majority of households were least vulnerable as compared to households in Tampia and Kpalisogu-Kura. Kpalgun community was far away from the White Volta River and hence flood exposure was limited to households who had farms at low-lying areas. Again, adaptive capacity was also high in most of the households in Kpalgun than in Tampia and Kpalisogu-Kura. Few households had low adaptive capacity which increased their flood vulnerability.

In general terms, 26% of the sampled households in all four communities were highly vulnerable. 27% were vulnerable and 47% were least vulnerable as depicted in table

5.10. This implies that those in the highly vulnerable range are at emergency levels and needs urgent help to recover from flood impacts. Those in the vulnerable category needs temporary assistant to adjust. Households in the least vulnerable group are equally vulnerable but are able to cope with floods using available assets.

Table 5. 10: Classification of all households according to their range of total vulnerability index

Vulnerability category	**Household situation**	**Vulnerability index**	**Percentage of household (n = 149)**
Highly vulnerable	Emergency levels	0.5 to 1	**26% (n = 39)**
Vulnerable	Requires immediate but temporary assistants to recover	0. 4 to 0	27% (n =40)
Least vulnerable	In a vulnerable situation but able to cope	-0. 5 to -0.1	47% (n= 70)
Total			100

(Source: Field survey, 2015)

5.5 Conclusion

From the above, it can be said that vulnerability differs from household to household as described by Deressa et al, (2009). The variation is shaped by the difference in terms of exposure and the socio-economic activities households engaged in. In this study issues of location played a critical role in determining the exposure levels of households in all four communities. Communities closer to the White Volta River were more exposed than communities far away from the river. Adaptive capacity also differed in households depending on their asset possession. Again, adaptive capacities were lower in households in communities closer to the river than those far away.

CHAPTER SIX: SUMMARY, CONCLUSION AND RECOMMENDATIONS.

6.1 Introduction

The study sought to investigate smallholder farmers' vulnerability to floods in the Tolon district and was guided by four objectives which were:

- To assess the spatial and temporal variations of flood events in the Tolon district
- To investigate the factors that trigger flood events in the district.
- To assess the adaptive capacity of smallholder farmers to floods in the district.
- To apply the household livelihood index to assess the degree of household flood vulnerability in the district.

The preceding chapter addressed these four objectives. This final chapter caps the study to a conclusion by summarizing key findings. Recommendations for improving adaptive capacity of farmers are made based on the research findings. And finally areas requiring further research are provided.

6.2 Summary of key findings

Generally, the study assessed smallholder farmers flood vulnerability across different farming households in the Tolon district. Four study communities including Kpalisogu-Kura, Tampia, Yoggu and Kpalgun were selected for the assessment. Field driven indicators were identified for indices of exposure, sensitivity and adaptive capacity through local opinions and experiences. The three indices as well as individual indicators were very insightful in capturing differential flood vulnerability at the household level. Each household score in individual indicators and composite indices revealed where interventions could be provided to increase their adaptive capacity and make them resilient in flood situations.

6.2.1 Spatial and temporal variations of floods.

There were spatial and temporal differences in the occurrence of flood events. Tampia and Kpalisogu-Kura which were communities closer to the White Volta River experienced more flood events than Yoggu and Kpalgun which were inland. This was so because communities sharing boundaries with the river experienced floods from the spillage of the Bagre dam in addition to torrential rains over many days, whiles households in communities further away from the river experienced floods from just torrential rainfall. Findings also showed that, farmers are usually not notified when water is to be spilled from the dam and as a result, spillage of water from the dam came all of a sudden and took farmers unaware. This made them unprepared to take measures that would minimize flood impacts. Also, with regards to the temporal variation of floods events, all communities experience floods from heavy continuous rainfall at the same period usually in July and August. However, Tampia and Kpalisogu- Kura experienced floods from the spillage of the Bagre dam in Burkina Faso around late September or in October.

Floods usually occurred at floodplains in communities closer to the river and at low-lying areas in communities inland. These areas were said to be fertile for farming purposes and when floods occurred, farms and crops were affected.

6.2.2 Factors that trigger flood events.

Findings also revealed that, torrential rainfall over several days, siltation and spillage of water from the Bagre dam are the main triggers of flood events in communities closer to the White Volta River. Occasional heavy and continuous rainfall pattern could also be attributed to climate change and variability which results in flood occurrences. Communities close to the river have farming taking place at the floodplains which makes the soil loose and easily silted into the river when there were heavy rainfalls. Also, the Bagre dam which is upstream of the Volta River is occasionally spilled when the dam is filled to capacity and this causes floods in the communities. In communities away from the river, repeated and heavy rainfall is the cause of floods especially around low-lying areas where crop cultivation took place.

6.2.3 Households' adaptive capacity.

Adaptive capacity trends were comparatively higher in Yoggu and Kpalgun. Majority of households engaged in non-farm economic activities, had access to rural banks, had more than one farms, social networks, had devices to access information amongst others which made them least vulnerable in the adaptive capacity index. On the contrary, more than half of households in Tampia were highly vulnerable in adaptive capacity. This was so because, they had limited access to assets to enable them respond to flood shocks. Having social networks and receiving disaster aid from the district and other donors were the strongest adaptive capacity in Tampia. Very few households were least vulnerable per their score in adaptive capacity index. In the case of Kpalisogu-Kura, most households were also highly vulnerable, lacking most of the indicators that made up adaptive capacity including lack of formal education, absence of alternative income generating activities, have device to access information, access to credit facilities, use of flood tolerant crop varieties and so on. The dominant indicators households had was dry season farming because of the presence of irrigational facilities and having multiple farms. Households having formal education and the use of flood tolerant crops were less in all communities.

6.2.4 Households' total vulnerability.

Tampia had all households being highly vulnerable with index scores above 0.50 against 63% of households in Kpalisogu-Kura and 7% in Yoggu and Kpalgun. Tampia and Kpalisogu-Kura were the two most vulnerable communities. Exposure and sensitivity were very high combined with a low adaptive capacity. The two are at high risk of flood disasters as a result of their close proximity to the White Volta River. Most households in Yoggu and Kpalgun were less vulnerable because they had lesser exposure and higher adaptive capacity compared to Tampia and Kpalisogu-Kura. However, having a higher adaptive capacity may not be fully utilized in the inland communities. So even with comparatively lower exposures, sudden flood events (like the 2007 and 2010 floods) can lead to significant damages.

6. 3 Conclusion

The study was inspired by the IPCC concept of vulnerability, the DFID'S sustainable livelihood framework of asset indicators and Hahn et al., (2009) livelihood vulnerability index to create the total household vulnerability index. The index impacted on the study in several significant ways. First of all, it incorporated local knowledge by engaging with community stakeholders in the selection of indicators. This helped in identifying such factors that enabled or constrained farmers' ability to adjust to flood disasters. The indicators identified had bearing on farmers including their exposure to floods, elements that are sensitive to flood impacts and access to assets. Involving community stakeholders in the assessment to was helpful in reflecting the conditions that put them in a vulnerable state and this played a significant role in framing the research.

The index also presents field based evidence that could serve as a tool for assessing flood vulnerabilities in other localities that are exposed to floods with modification to include indicators that are peculiar to such localities. Preston et al., (2011) evaluated that only 9% out of 45 vulnerability mapping addressed in their work used primary empirical data. A lot of the vulnerability assessments relied on secondary data from other sources to measure indicators which is likely to reduce the data quality. This approach used the livelihood vulnerability index based on empirical data, local perceptions and experiences which allow for comparison in different households to provide insights into the varying vulnerabilities that can inform policy.

Finally, the outcome of the study has revealed that a household's flood vulnerability is a product of their exposure, elements sensitive to floods and their adaptive capacity which are interconnected. Kpalisogu- Kura for instance was among the flood prone communities because of its close proximity to the White Volta River combined with great damages most households experienced from previous floods. However, there were some few households that had a higher adaptive capacity which made them least vulnerable. So a combination of exposure, sensitivity and adaptive capacity determined a household's vulnerable condition. The study also showed areas of adaptive capacity that needs to be enhanced based on the index score of households. Policy interventions could cover these areas to increase smallholder farmers' resilience to flood disasters.

6.4 Recommendations.

Assessment of smallholder farmers' vulnerability to floods have important policy relevance that could enable smallholder farmers in the Tolon district adapt better to flood disasters induced by climate change and variability. Elements of exposure such as high temperature, continuous heavy rainfall, and the occurrence of floods hazards are beyond immediate policy implication, as a result of the global effect of climate change and variability. Adaptive capacity however, has a direct policy influence which has an accompanying influence in improving sensitivity and total flood vulnerability.

The following recommendations are therefore made based on the findings presented above to enhance adaptive capacity, minimize flood impact and reduce flood vulnerability.

6.4.1 Education and vocational training.

As indicated earlier, the study communities are highly dependent on agriculture which is sensitive to flood extremes and places rural economy in a vulnerable position. This calls for the need for government through the District assembly and Ngos to provide vocational training like craft work, carpentry, and dressmaking especially in Tampia and Kpalisogu-Kura where majority of households were not engaged in non-farm economic activities. This will help them reduce their over dependence on agriculture and subsequently decrease their flood vulnerability. Households that are already engaged in other income generating activities should also be supported to grow their businesses. There is also the need to improve the literacy levels of farmers which were low in all the study communities by implementing informal educational programs in the region. Providing relevant training and vocational education will build their human assets and enable them utilize opportunities and assets present in the communities.

Aside training, Climate Change Research and education should be promoted as information is vital in the process of integrating climate change into development planning for long term adaptation measures. Appreciating research and information would be pertinent for a deep understanding of flood vulnerability and to bring to light aspects of adaptive capacity that needs to be improved. For example, agricultural

Research institutions should consider flood resistant varieties and other technologies like construction of levees which channels flood water for agricultural purposes.

6.4.2 Provision of financial assistance.

Access to financial resources is very important in strengthening the adaptive capacity of farming households exposed to floods. Lack of financial assistance was common to most of the households in the study communities and this is a major obstacle that reduced their adaptive capacity to floods. This is particularly binding on the very poor households who were typically the most vulnerable. Effort should focus on assisting the most vulnerable households with financial resources for them to make productive investments that can widen their income sources.

Even though, the government of Ghana through the MASLOC programme has made credit available at the district level, farmers stated that the process involved in acquiring credit is often very tedious and bureaucratic and interest rates are high as well. Government through the district assembly should therefore make credit cheap and easily accessible through the MASLOC programme so that households can assess it for productive investment and to serve as buffers in times of floods.

6.4.3 Provision of technical assistance.

The study also suggests the provision of technical assistance including, irrigation, voluntary resettlement programs, provision of agro-ecological extension packages, and inception of productive safety net programs. Provision of extension packages provides technical information on the best farm management practices in flood prone areas such as changing planting periods, encouraging farmer-to-farmer learning, and adoption of flood tolerant varieties. Changing planting schedules for instance enables farmers to skip floods impacts on their crops. Here farmers can be advised to plant either late or early depending on the period floods are likely to occur. Enhancing extensive services has the potential of convincing farmers to change farming practices to with the aim of adjusting to climate induced stresses. From the study, very few households indicated that they had received technical training on flood management at the farm level. Therefore, strengthening extension services will provide technical knowledge to farmers to take proactive measure to respond to flood extremes. However, providing extension packages should involve using participatory techniques to involve farmers and jointly identify options that can enhance their resilience to floods and also ensure that these options do not have side effects on their livelihoods.

Another way of providing technical assistance is to invest in small-scale irrigation system which will help increase crop productivity. From the field survey, farmers expressed their enthusiasm to develop local infrastructure but lack of finance constrained them. Granting small loans to farmers to invest in local irrigation system through the MASLOC programme is recommended to enable farmers partake in dry season farming to boost food availability. Irrigational systems were present in Kpalisogu-Kura with some farmers practicing dry season farming. This represented their strongest adaptive capacity. However, these should be provided in communities that lacked them and farmers should be encouraged to engage in dry season farming as well.

6.4.4 Early warning.

In addition, there is the need to develop a well-coordinated flood early warning mechanism to detect natural disasters and climate variability at the local level. In this regard, District Assembly (DA) through the National Disaster Management Organisation (NADMO) should effectively disseminate these warning to stakeholders at the local level especially when water is to be spilled from the Bagre dam in order for farmers to take proactive measures. They should also provide efficient mechanisms for disaster management.

6.4.5. Provision of post-disaster relief services.

The household vulnerability assessment indicated that, Yoggu and Kpalgun were least vulnerable to floods probably because they are located far away from the river. Notwithstanding, all communities are at risk of flooding and need support to help them adjust to flood impacts. Though Tampia and Kpalisogu-Kura are at high risk, due to their close proximity to the river, a sudden occurrence of continuous heavy rainfall could cause flooding and lead to property loss and infrastructural damages in Yoggu and Kpalgun (for example 2007 and 2010 floods). In terms of policy implication, post-flood disaster relief services should be put in place during emergency. These should include food stores and evacuation to saver sites.

6.4.6 Collaboration between traditional leaders and government.

Traditional leaders are pivotal in local level development as every development intervention needs to be consistent with local opinions. Again, traditionally, natural resources such as sacred grooves, shrines and rivers have some special spiritual significance. This forbids people from tempering with natural resources which in a way conserve the environment. In this light, it is vital to mention that the collaboration between traditional leadership and national government should be strengthened as this would enable the application of indigenous knowledge in fashioning ways to increase the adaptive capacities of those at risk of floods. Traditional leaders should also participate in decision making and development processes that affect them. Vulnerability assessment is place-specific as indicated in chapter two which should include involving local people in identifying such indicators that make them vulnerable and seek their opinions on how their adaptive capacities could be enhanced. Indigenous knowledge is an essential element in the development process and livelihoods of many local communities. A major challenge that government continue to face is how to reconcile indigenous knowledge and modern science without substituting each other. Respecting the two sets of values however, build on their respective strengths.

6.4.7 Protecting and conserving the environment

The environment is critical and vital to mitigating some of the challenges of flood impacts. Smallholder farmers in the study areas depend on the environment as their safety nets including farming, charcoal, firewood, water and materials for building their houses among others. These services are important all-year round and there is the need to conserve the environment to ensure continuous flow of these resources. It is therefore, important that the District assembly and community leaders concentrate on education on attitudinal change that in effect also promotes environmental best practices. Such actions may include tree planting along rivers, and adopting of better and improved farming methods that frown upon some negative traditional farming methods such as the 'slash and burn'

6.5. Implication for further research.

The study investigated the vulnerability of smallholder farmers to floods in the Tolon district. It specifically looked the spatial and temporal variations of flood events, causes of floods hazards, and the degree of smallholder farmers' vulnerability to floods. However, in the course of the study, a number of themes were noted to influence vulnerability especially in the physical sense. These areas include measuring flood magnitude and employing digital elevation modelling to analyse the biophysical aspect of flood vulnerability. These underlining issues critically impact on flood vulnerability but are beyond the scope of this research. Detailed assessment of flood vulnerability in these areas is hence recommended to provide a wider understanding of the physical elements that constitute flood vulnerability.

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APPENDICES

APPENXIX I: EXPOSURE, SENSITIVITY, ADAPTIVE CAPACITY AND TOTAL VULNERABILITY INDICES OF HOUSEHOLDS IN KPALISOGU-KURA

Kpalisogu-Kura				
Sampled households	Exposure score	Sensitivity score	Adaptive capacity	Total vulnerability
1.	0.40	0.50	0.51	0.40
2.	0.51	0.61	0.25	0.87
3.	0.39	0.40	0.35	0.44
4.	0.53	0.53	0.40	0.66
5.	0.54	0.67	0.38	0.83
6.	0.59	0.62	0.41	0.80
7.	0.51	0.52	0.43	0.60
8.	0.69	0.47	0.68	0.48
9.	0.39	0.67	0.58	0.48
10.	0.67	0.67	0.69	0.65
11.	0.39	0.67	0.33	0.73
12.	0.49	0.88	0.37	1
13.	0.51	0.55	0.22	0.84
14.	0.39	0.55	0.45	0.49
15.	0.79	0.7	0.69	0.80
16.	0.77	0.68	0.70	0.75
17.	0.54	0.55	0.32	0.77
18.	0.51	0.67	0.31	0.87
19.	0.52	0.87	0.67	0.72
20.	0.83	0.31	0.70	0.44
21.	0.29	0.31	0.38	0.22
22.	0.98	0.61	0.69	0.90
23.	0.77	0.60	0.67	0.70
24.	0.36	0.38	0.29	0.45
25.	0.52	0.21	0.26	0.47
26.	0.67	0.53	0.27	0.93
27.	0.34	0.35	0.31	0.38
28.	0.74	0.68	0.42	1
29.	0.51	0.52	0.37	0.66
30.	0.33	0.33	0.34	0.32
31.	0.49	0.41	0.09	0.81
32.	0.68	0.17	0.99	- 0.14

APPENDIX II

EXPOSURE, SENSITIVITY, ADAPTIVE CAPACITY AND TOTAL VULNERABILITY INDICES OF HOUSEHOLDS IN TAMPIA

TAMPIA				
SAMPLE HOUSEHOLDS	EXPOSURE SCORE	SENSITIVITY SCORE	ADAPTIVE CAPACITY SCORE	TOTAL VULNERABILITY
1.	0.89	0.66	0.68	0.87
2.	0.54	0.59	0.14	0.99
3.	0.67	0.67	0.36	0.98
4.	0.92	0.66	0.69	0.89
5.	0.31	0.71	0.35	0.67
6.	0.77	0.30	0.08	0.99
7.	0.96	0.29	0.25	1
8.	0.52	0.61	0.23	0.9
9.	0.89	0.60	0.68	0.81
10.	0.33	0.74	0.25	0.82
11.	0.73	0.32	0.22	0.83
12.	0.33	0.45	0.08	0.70

APPENDIX III

EXPOSURE, SENSITIVITY, ADAPTIVE CAPACITY AND TOTAL VULNERABILITY INDICES OF HOUSEHOLDS IN YOGGU

YOGGU				
SAMPLED HOUSEHOLDS	EXPOSURE SCORE	SENSITIVITY SCORE	ADAPTIVE CAPACITY SCORE	TOTAL VULNERABILITY
1.	0.30	0.09	0.93	-0.54
2.	0.09	0.67	0.66	0.1
3.	0.37	0.05	0.53	-0.11
4.	0.29	0.68	0.49	0.48
5.	0.29	0.67	0.62	0.34
6.	0.67	0.67	0.69	0.65
7.	0.29	0.07	0.62	-0.26
8.	0.29	0.67	0.61	0.35
9.	0.72	0.69	0.75	0.66
10.	0.31	0.13	0.68	-0.24
11.	0.29	0.18	0.81	-0.34
12.	0.32	0.15	0.63	-0.16
13.	0.39	0.21	0.79	-0.19
14.	0.37	0.32	0.83	-0.14
15.	0.16	0.68	0.52	0.32
16.	0.37	0.42	0.84	-0.05
17.	0.32	0.07	0.64	-0.25
18.	0.29	0.08	0.71	-0.34
19.	0.39	0.08	0.78	-0.31
20.	0.29	0.16	0.61	-0.16
21.	0.67	0.13	0.92	-0.12
22.	0.12	0.14	0.31	-0.05
23.	0.10	0.11	0.32	-0.11
24.	0.34	0.51	0.92	-0.07
25.	0.31	0.68	0.29	0.70
26.	0.23	0.32	0.66	-0.11
27.	0.31	0.09	0.79	-0.39
28.	0.31	0.49	0.84	-0.04
29.	0.37	0.33	0.95	-0.25
30.	0.34	0.43	0.86	-0.09
31.	0.29	0.32	0.78	-0.17
32.	0.67	0.34	0.98	0.03
33.	0.29	0.34	0.84	-0.21
34.	0.39	0.19	0.65	-0.07
35.	0.09	0.12	0.33	-0.12
36.	0.39	0.41	0.45	0.35
37.	0.70	0.13	0.23	0.60
38.	0.29	0.24	0.83	-0.3
39.	0.34	0.11	0.74	-0.29

40.	0.28	0.08	0.72	-0.36
41.	0.49	0.49	0.65	0.33
42.	0.35	0.08	0.65	-0.22
43.	0.31	0.17	0.71	-0.23
44.	0.31	0.43	0.93	-0.19
45.	0.13	0.35	0.66	-0.18
46.	0.34	0.56	0.96	-0.06
47.	0.29	0.14	0.29	0.14
48.	0.39	0.11	0.65	-0.15
49.	0.31	0.42	0.61	0.12
50.	0.37	0.67	0.68	0.36
51.	0.21	0.68	0.98	-0.09
52.	0.28	0.09	0.75	-0.38
53.	0.17	0.17	0.74	-0.40
54.	0.24	0.09	0.61	-0.28
55.	0.32	0.19	0.73	-0.22
56.	0.30	0.21	0.20	0.31
57.	0.31	0.44	0.93	-0.18
58.	0.29	0.37	0.83	-0.17
59.	0.13	0.67	0.96	-0.16
60.	0.19	0.10	0.31	-0.02

APPENDIX IV

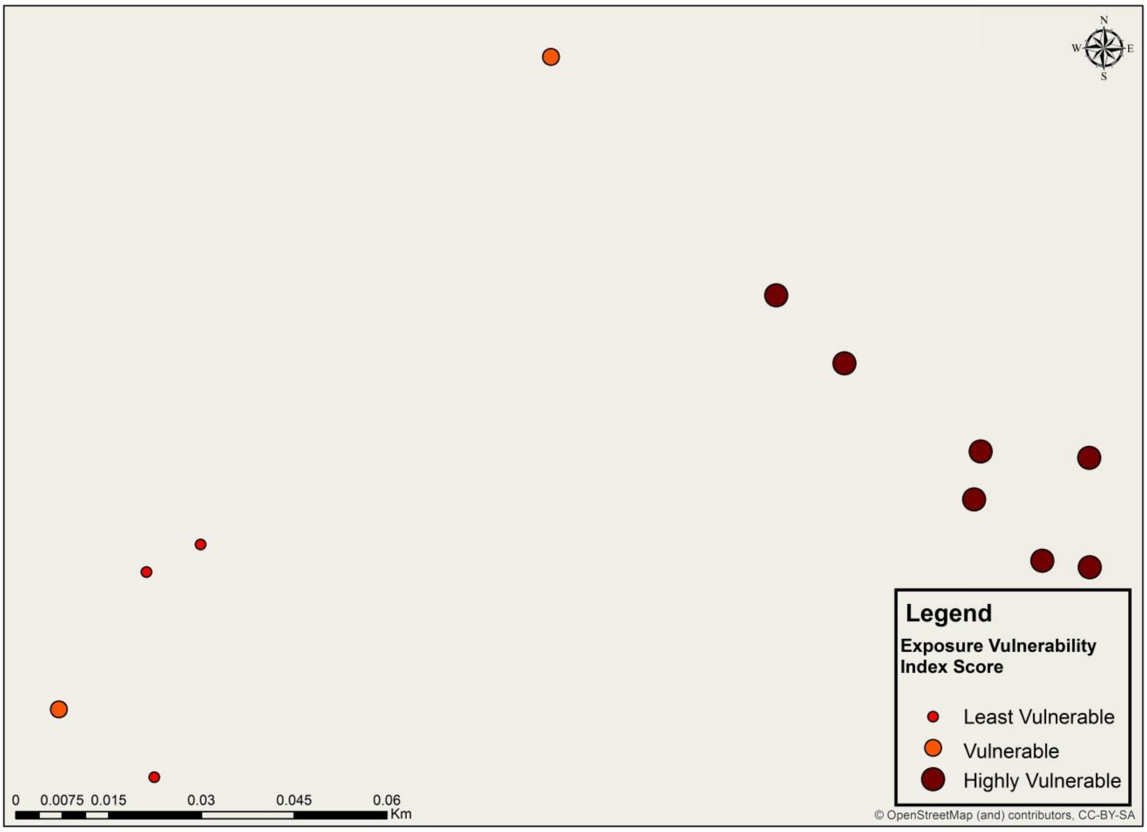
EXPOSURE, SENSITIVITY, ADAPTIVE CAPACITY AND TOTAL VULNERABILITY INDICES OF HOUSEHOLDS IN KPALGUN

KPALGUN				
SAMPLED HOUSEHOLDS	EXPOSURE SCORE	SENSITIVITY SCORE	ADAPTIVE CAPACITY SCORE	TOTAL VULNERABILITY
1.	0.31	0.09	0.30	0. 10
2.	0.31	0.14	0.56	-0.11
3.	0.39	0.21	0.75	-0.15
4.	0.29	0.16	0.72	-0.27
5.	0.67	0.67	0.69	0.65
6.	0.29	0.47	0.32	0.44
7.	0.31	0.67	1	-0.02
8.	0.30	0.36	0.86	-0.20
9.	0.34	0.68	0.92	0.10
10.	0.28	0.41	0.93	-0.24
11.	0.32	0.43	0.94	-0.19
12.	0.35	0.08	0.86	-0.43
13.	0.28	0.35	1	-0.37
14.	0.69	0.70	1	0.39
15.	0.68	0.67	0.78	0.57
16.	0.31	0.68	0.24	0.75
17.	0.35	0.47	0.53	0.29
18.	0.28	0.69	0.74	0.23
19.	0.28	0.33	0.95	-0.34
20.	0.29	0.67	0.98	-0.02
21.	0.09	0.08	0.29	-0.12
22.	0.30	0.09	0.74	-0.35
23.	0.39	0.12	0.83	-0.32
24.	0.37	0.25	0.91	-0.29
25.	0.26	0.41	0.97	-0.30
26.	0.29	0.45	0.94	-0.20
27.	0.35	0.42	0.94	-0.17
28.	0.29	0.09	0.64	-0.26
29.	0.28	0.15	0.64	-0.21
30.	0.30	0.35	1	-0.35
31.	0.39	0.37	0.85	-0.09
32.	0.37	0.09	0.93	-0.47
33.	0.29	0.42	0.89	-0.18
34.	0.12	0.68	0.93	-0.13
35.	0.37	0.09	0.89	-0.43
36.	0.29	0.37	1	-0.34
37.	0.31	0.25	0.78	-0.22
38.	0.23	0.30	0.65	-0.12
39.	0.39	0.09	0.79	-0.31

40.	0.31	0.16	0.31	0.16
41.	0.34	0.08	0.66	-0.24
42.	0.11	0.34	0.65	-0.20
43.	0.37	0.18	0.99	-0.44
44.	0.11	0.34	0.64	-0.19
45.	0.69	0.69	0.91	0.47

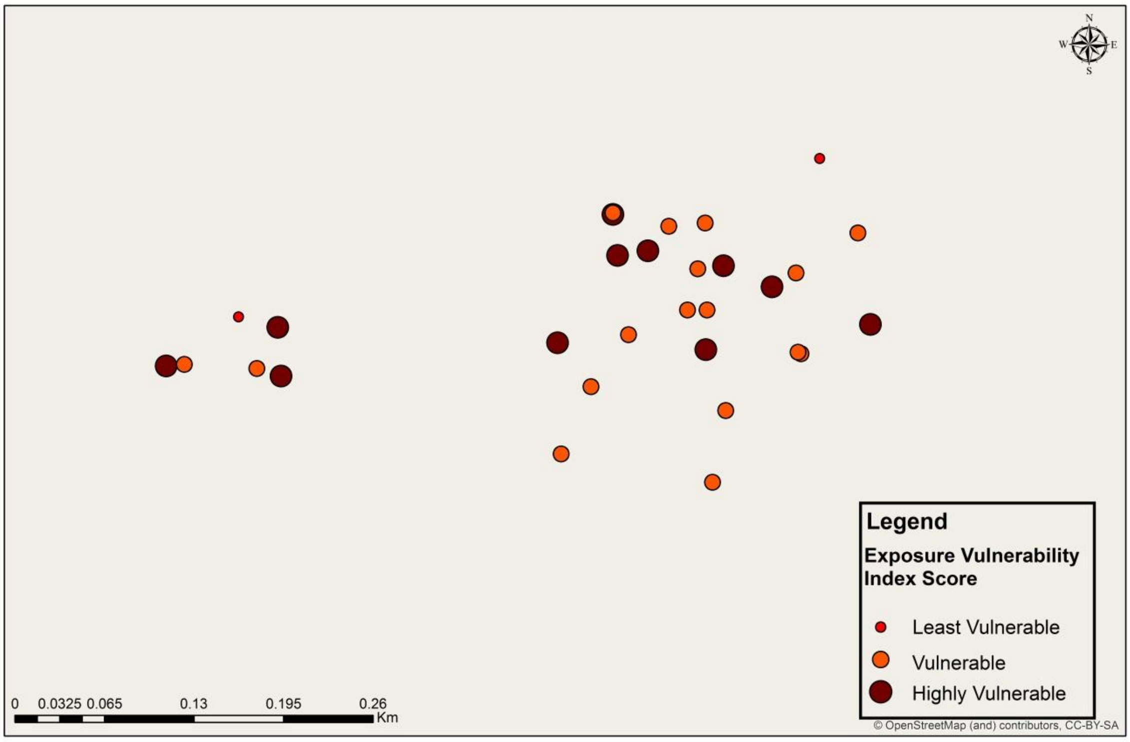
APPENDIX V

MAP SHOWING THE INDEX SCORE FOR EXPOSURE VULNERABILITY IN TAMPIA



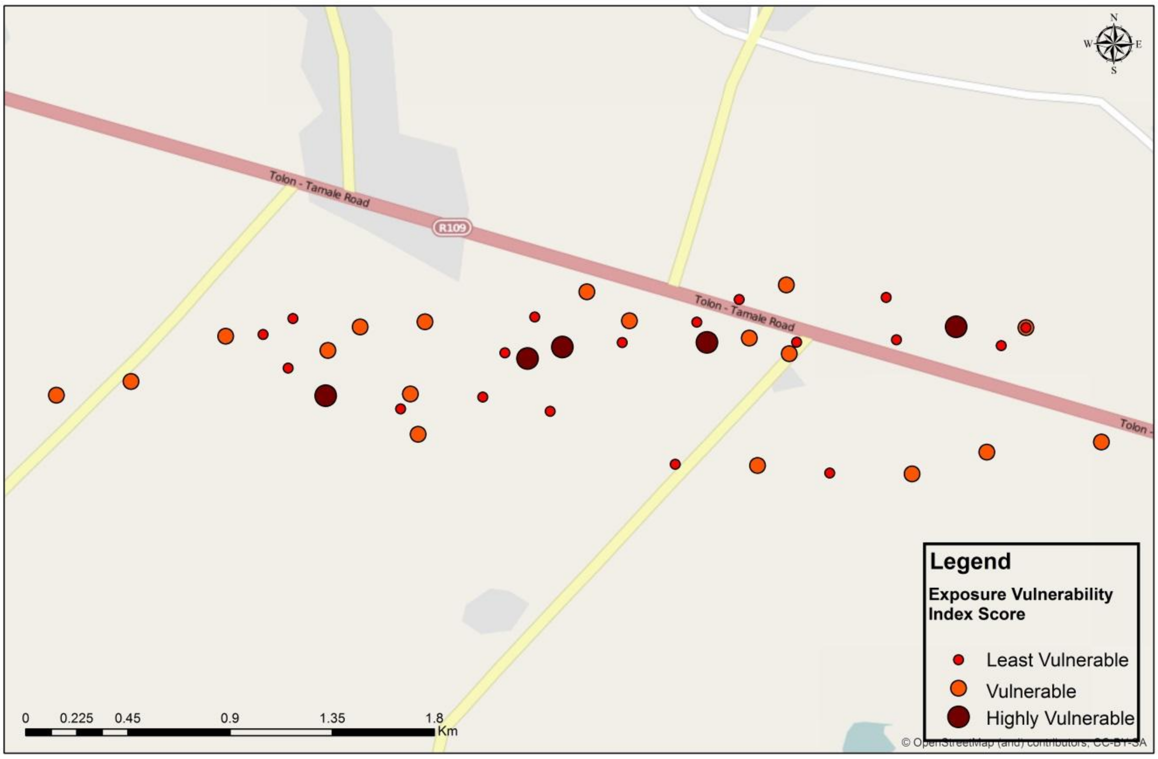
APPENDIX VI

MAP SHOWING THE INDEX SCORE FOR EXPOSURE VULNERABILITY IN KPALISOGU-KURA



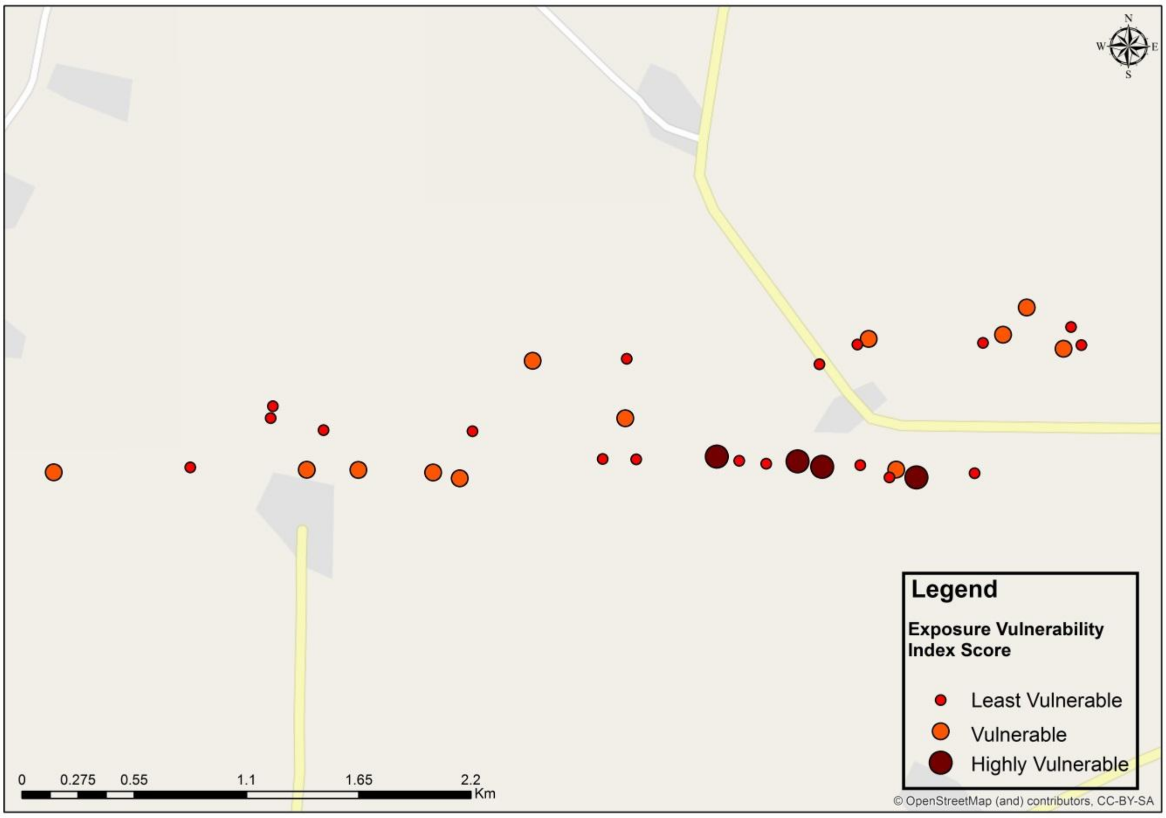
APPENXIX VII

MAP SHOWING THE INDEX SCORE FOR EXPOSURE VULNERABILITY IN YOGGU



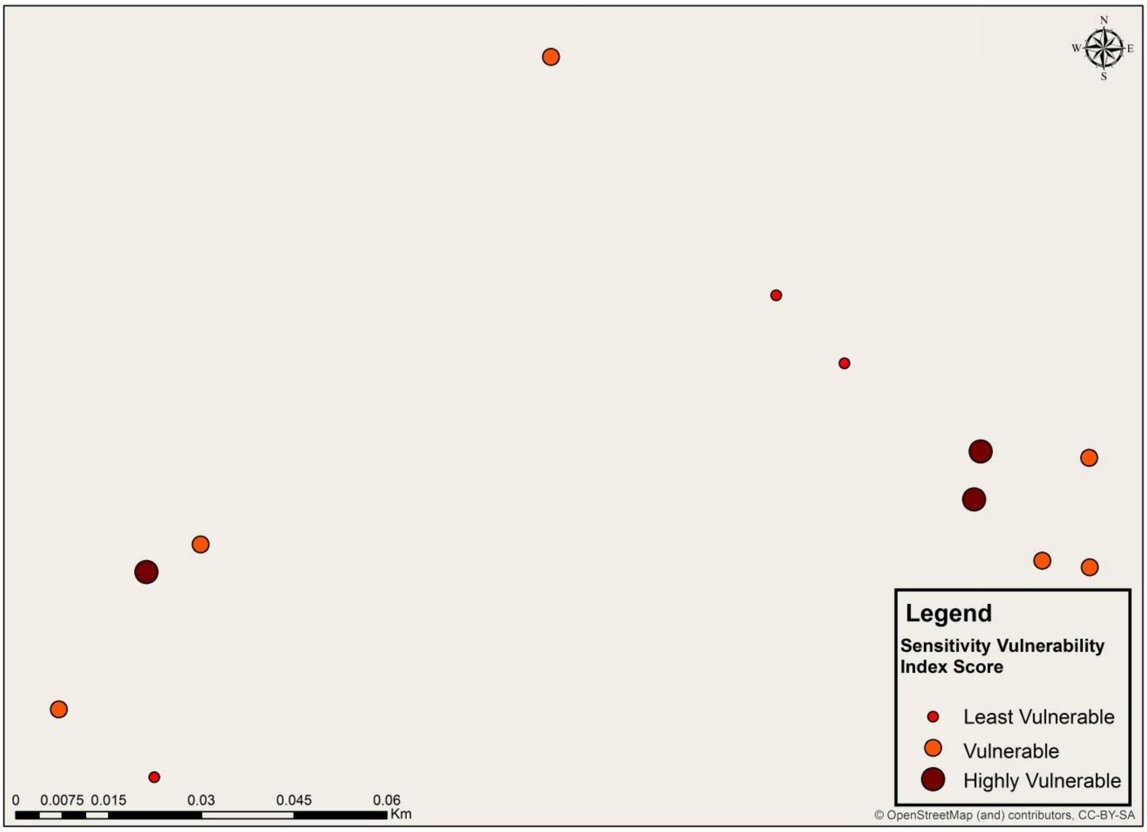
APPENDIX VIII

MAP SHOWING THE INDEX SCORE FOR EXPOSURE VULNERABILITY IN KPALGUN



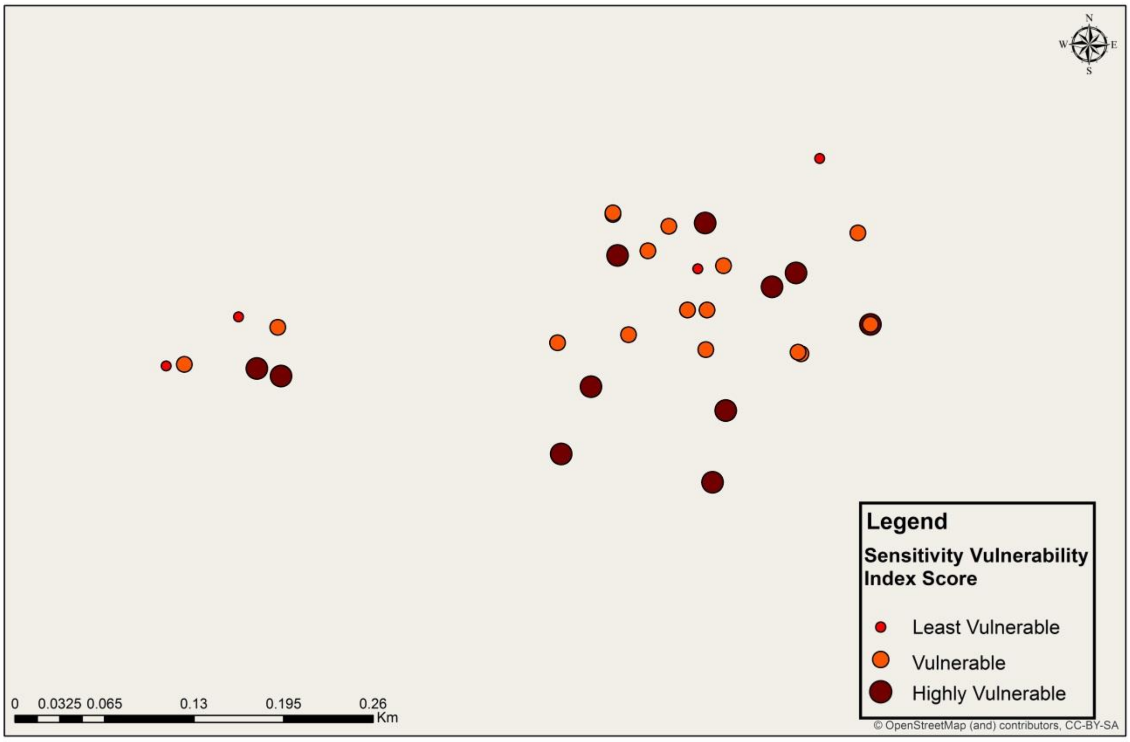
APPENXIX IX

MAP SHOWING THE INDEX SCORE FOR SENSITIVITY VULNERABILITY IN TAMPIA



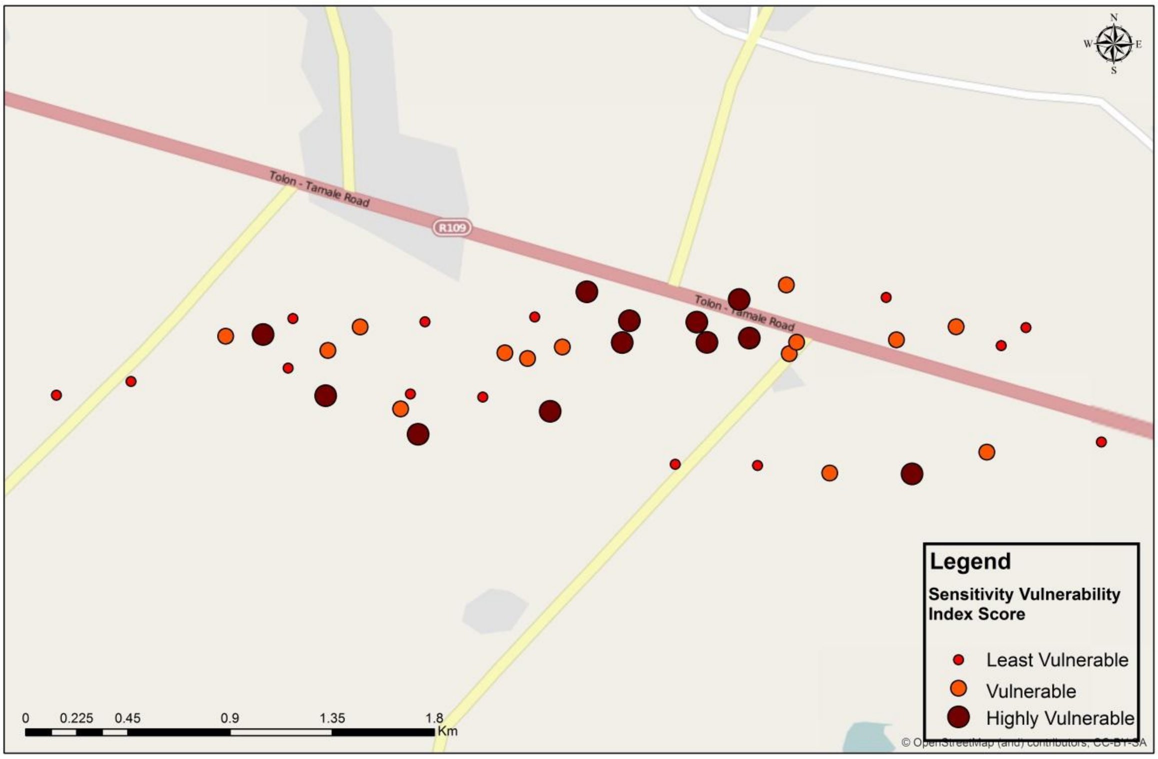
APPENXIX X

MAP SHOWING THE INDEX SCORE FOR SENSITIVITY VULNERABILITY IN KPALISOGU-KURA



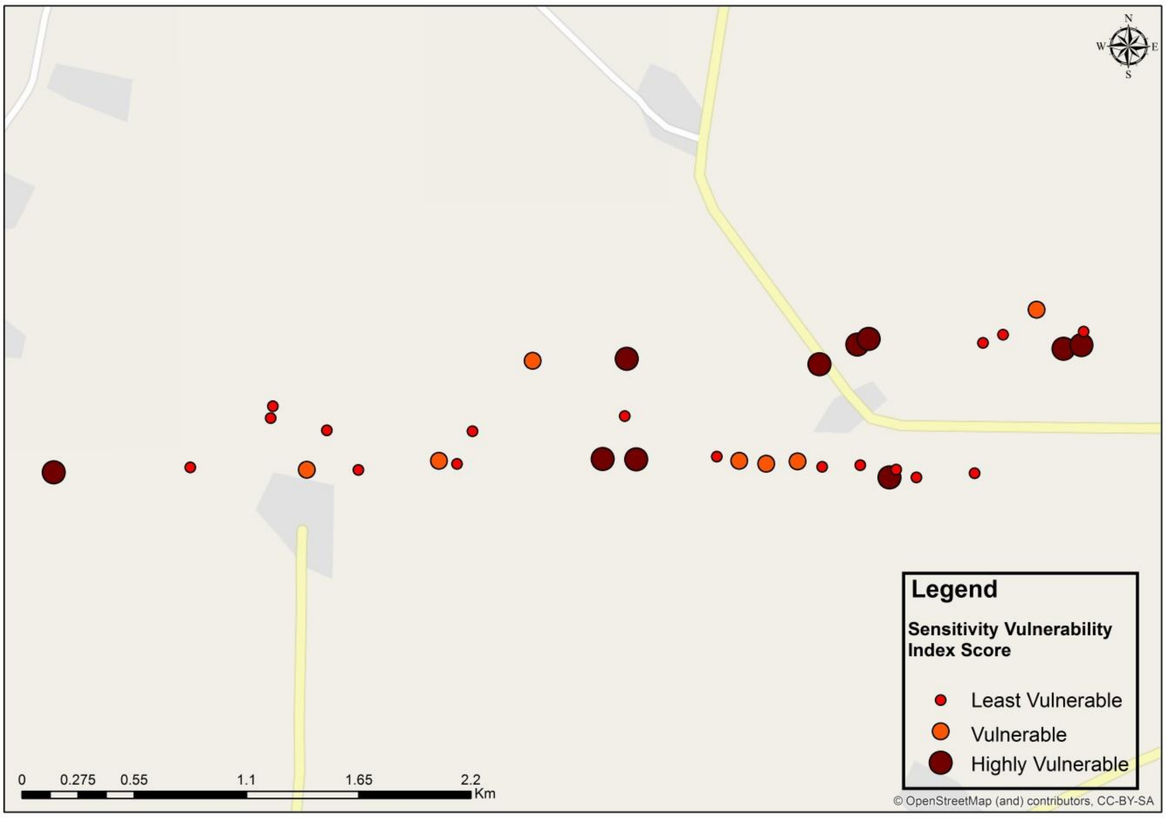
APPENDIX XI

MAP SHOWING THE INDEX SCORE FOR SENSITIVITY VULNERABILITY IN YOGGU



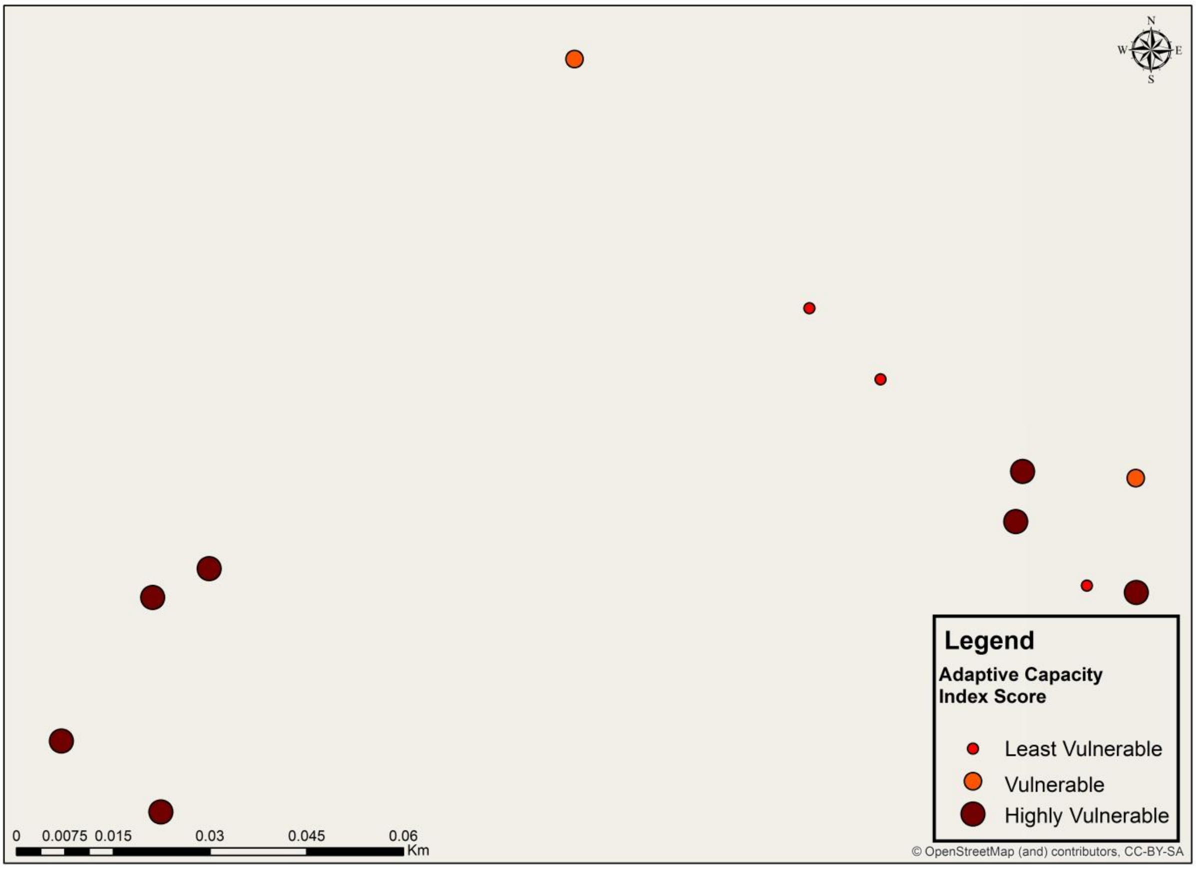
APPENDIX XII

MAP SHOWING THE INDEX SCORE FOR SENSITIVITY VULNERABILITY IN KPALGUN



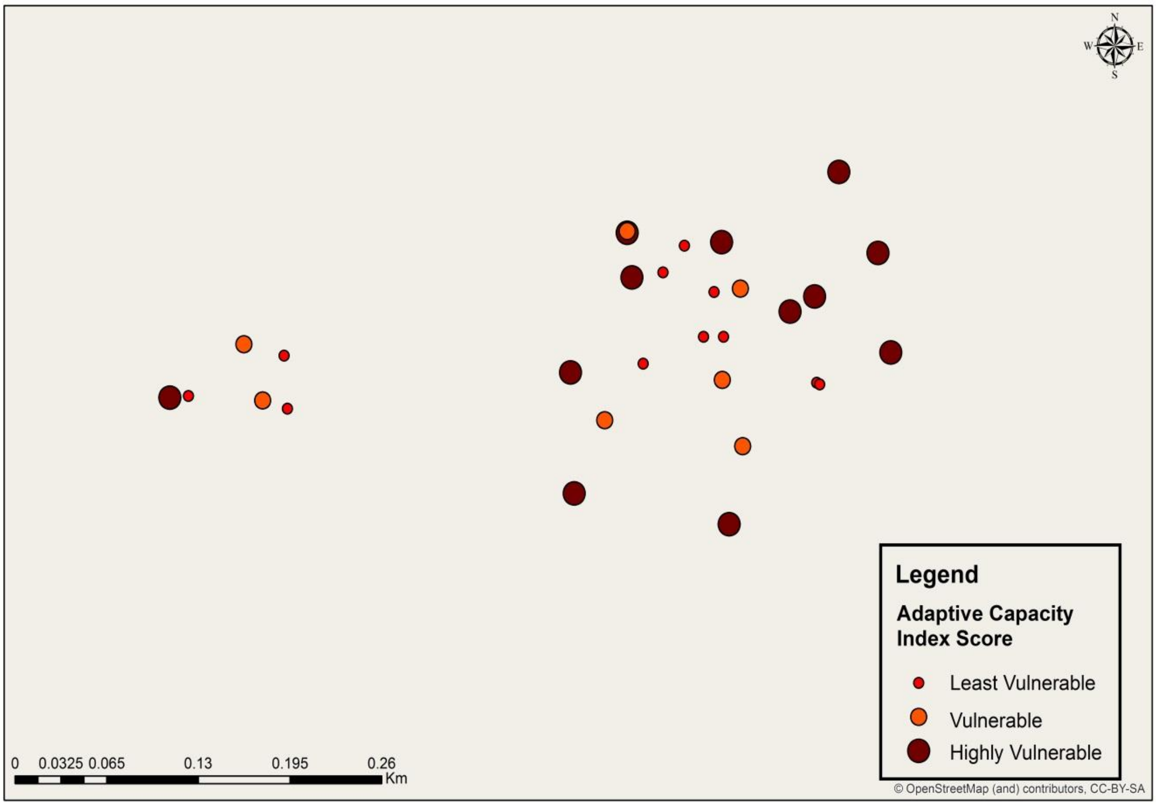
APPENDIX XII

MAP SHOWING THE INDEX SCORE FOR ADAPTIVE CAPACITY IN TAMPIA



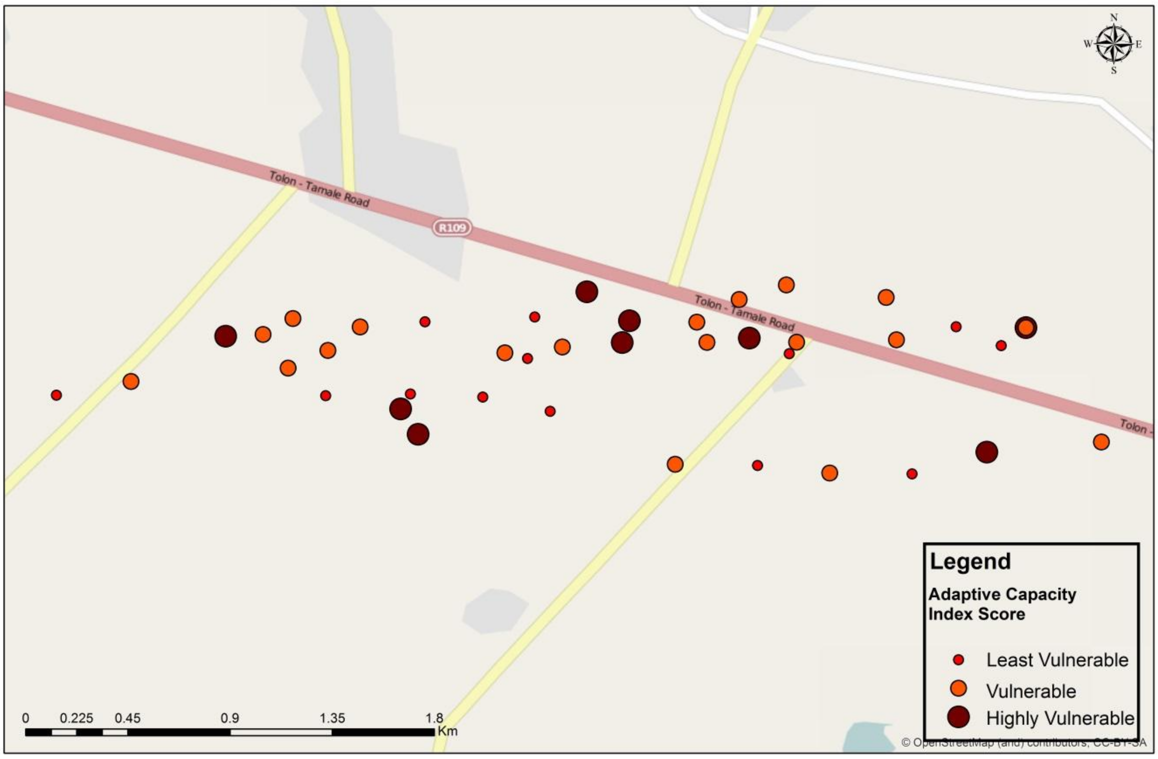
APPENDIX XIII

MAP SHOWING THE INDEX SCORE FOR ADAPTIVE CAPACITY IN KPALISOGU-KURA



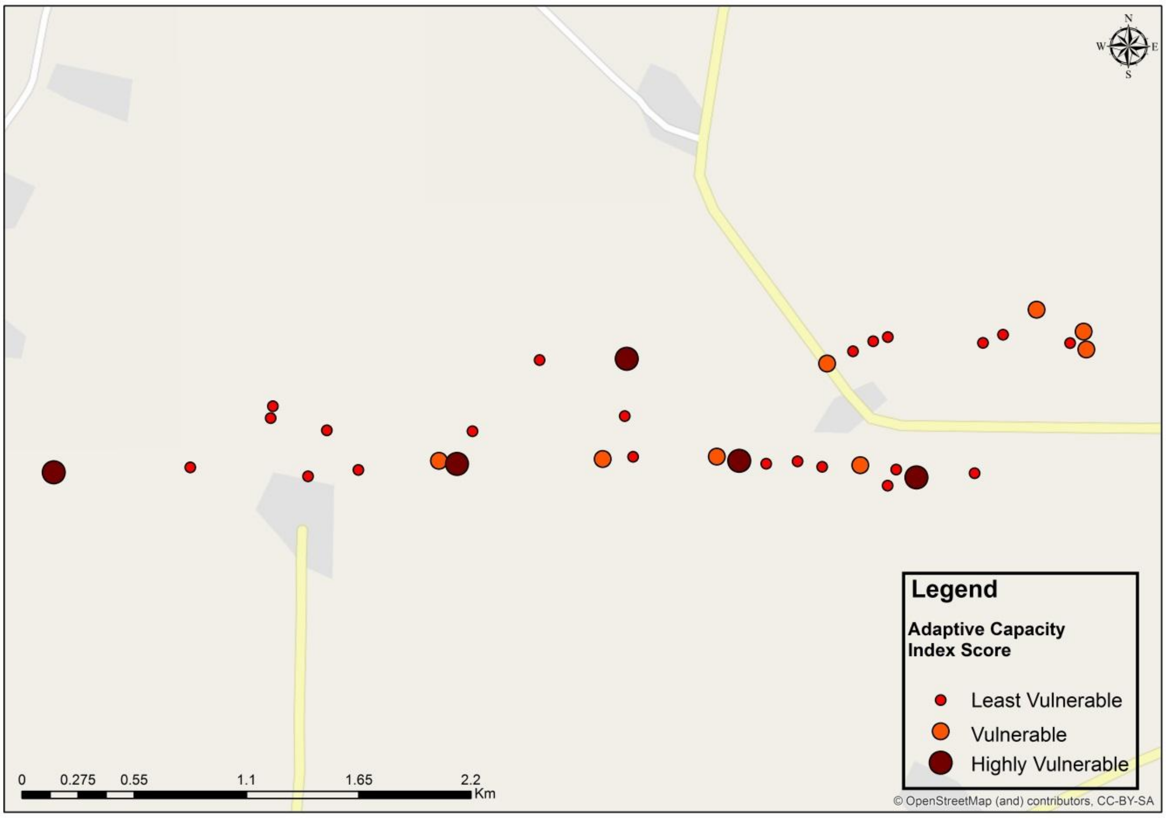
APPENXIX XIV

MAP SHOWING THE INDEX SCORE FOR ADAPTIVE CAPACITY IN YOGGU



APPENDIX XV

MAP SHOWING THE INDEX SCORE FOR ADAPTIVE CAPACITY IN KPALGUN



APPENDIX XVI

QUESTIONNAIRE FOR HOUSEHOLD SURVEY

UNIVERSITY OF GHANA- LEGON

DEPARTMENT OF GEOGRAPHY AND RESOURCE DEVELOPMENT

I am an M.Phil. (part II) student of the above mentioned university conducting a research on the theme **"Smallholder farmers' vulnerability to floods"**. This research is for academic purposes and responses will be confidential. Will you like to be a part of it? Tick if yes □

The research broadly seeks to assess Smallholder farmers' vulnerability to floods in the Tolon district. It specifically seeks to first identify the spatial and temporal variations of floods in the study area. Secondly, it seeks to investigate the causes of floods in the study area. And finally, it seeks to construct and apply household vulnerability index to assess farmers' vulnerability to floods.

Vulnerability is conceptualized in the study as a net effect of ***exposure, sensitivity and adaptive capacity*** (IPCC). Adaptive capacity will be assessed following the DFID's sustainable livelihoods framework which emphasis access to assets and resources.

Instruction: A smallholder farmer who is a household head is required to answer on behalf of the household. Tick or write in the spaces provided.

Name of community ……………………………………….

Questionnaire number …………………………………….

Date of interview ………………………………………….

Time interview started …………………………………….

Time interview ended ……………………………………..

House code ………………………………………………..

Mobile No.: ……………………………………………….

GPS code: Longitude …………………….. Latitude ………………………….

SECTION A: RESPONDENT'S PERSONAL CHARACTERISTICS

1. Age of respondent ………………………………….

2. Marital status

(1) Married (2) single (3) Widow (4) Divorce/Separated

3. Gender of farmer

(1) Male (2) Female

4. Educational status of smallholder

(1) No formal education (2) Basic School (3) SHS/TEC/VOC (4) Tertiary

5. Household size ……………………………………………………….

6. Household gender characteristics. (1) No of males ………. (2) No of females …………..

7. List the ages of household members ………………………………….

8. Years of stay in the community ………………………………………..

9. Years of farming experience in the community ………………………………………………………………………..

SECTION B: EXPOSURE TO FLOODS IN THE STUDY COMMUNITIES.

(B i) knowledge on climate variability

10. Have you observed any changes in temperature for the past 10 years?

(1) Yes (2) No

11. If yes, what changes have you observed? (1) Increase temperature (2) Decrease temperatures (3) Extreme fluctuation (4) No change (5) Do not know

12. Have you observed changes in rainfall pattern for the past 10 years?

(1) Yes (2) No

13. What changes have you observed? (1) Increase in rainfall (2) Decrease in rainfall

(3) Extreme fluctuation (4) Erratic (5) No change (6) Do not know

14. What do you think is responsible for the changes in temperature and rainfall?
……………………………………………………………………………………………
……………………………………………………………………………………………
…………

15. How was the rainfall pattern in the past like (before 2004)?
……………………………………………………………………………………………
……

(B ii) Nature of floods event in study community

16. Have you experienced floods in this community before?

(1) Yes (2) No

17. If yes, how many times in the last 10 years (from 2004 to 2014)?
……………………………………………………………………………………………

18. How severe have the floods been? (1) Mild (2) Moderate (3) severe (4) very catastrophic

19. Do the floods occur at a particular place or it spreads throughout the community?

(1) Occurs at particular places (2) It spreads throughout the community

20. If floods occur at particular places, which exact place do they occur?

(1) At floodplains (2) At low-lying areas (3) At steep slopes (4) Others, (specify)
……………………………………………………………………………………………
…

21. What period (month) in the raining reason do you experience floods?

(1) July/August (2) August/ September (3) September /October (4) others (specify)
……………………………………………………………………………………………
….

SECTION C: CAUSES OF FLOOD EVENTS

22. What do you think are the cause of floods in the community?

(1) Intensity/rate of rainfall (2) Longer duration of rainfall (3) River flow/spillage from the Bagre dam (3) Low land (4) Bare vegetation (5) Siltation

23. In your opinion, what human activities in the community trigger the occurrence of floods?

(1) Cutting down trees (2) Over grazing (3) Excessive cultivation (4) Bush burning

(5) Siltation (6) others (specify) …………………………………………………………

SECTION D: HOUSEHOLD FLOOD VULNERABILITY

I. Elements sensitive to flood impacts (cultivable crops)

24**.** What crop varieties do you cultivate?

Cereals	**Root/Tubers**	**Legumes**	**Others (specify)**
1.Maize	1.Yam	1.Groundnuts	
2.Guinea corn	2. cassava	2.Cowpea	
3.Millet		3.Soyabeans	
4.Sorghum		4.Roundbeans	
5. Rice		5. beans	

25. Do floods affect your crops? (1) Yes (2) No

26. If yes, estimate the **quantity lost** and their value in Ghana cedi for five recent flood events.

Year	Crops	Quantity in bags	Quantity in kg	Amount in Gh Cedis

27. Are there some types of crops that can withstand floods?

(1) Yes (2) No

28. (a). If yes, name these types ……………………………………………………

29. Do you use any of these flood resistant crops?

(1) Yes (2) No

30. Do you rear livestock? (1) Yes (2) No

31. If yes, has flooding caused you to loose livestock?

(1) Yes (2) No

32. What is the number and unit price of livestock lost due to floods?

Livestock type	**Number**	**Unit price**	**Dead due to flooding**
poultry			
Cattle			
Goats			
sheep			
Others (specify)			

33. What are the negative effects of floods on the environment?

(1) Loss of soil fertility (2) Loss of trees and shrubs (3) Pollutes water bodies
(4) Loss of farmlands (5) others (specify) ……………………………………………

34. What are the positive effects of floods on the environment?

……………………………………………………………………………………
……………………………………………………………………………………

SECTION E: ACCESS TO RESOURCES

(i) Financial assets:

35. How many bags of the crops are obtained after harvesting when there are **no floods**?

Years without floods	**Crop type**	**Number of bags**	**Quantity in kg**	**Amount in Gh cedis**

36. How many bags of the crops that you cultivate are obtained after harvesting when

39. Apart from farming, are you or any household member engaged in non-farm economic activity? (1) Yes (2) No

40. If yes, indicate the type of activity and how much you earn from it on monthly basis.

Non-farm income sources	**Average amount generated monthly**	**Average amount generated annually**
Petty trading		
Remittances		
Rent/hire		
Labour		
Charcoal sales		
Sheabutter processing		
Corn mill operation		
Gari processing		
Hunting		
Sales of wild fruits		

(ii) Social assets:

41. What social services are available in the community? (Please tick those available and their number)

Social services	Number
Clinics	
Schools (specify level)	
Markets	
Others (specify)	

42. Do you have Farmer based organisation (FBO) and Community based organisation (CBO) in your community?

(1) Yes (2) No

43. If yes, are you a member of any?

(1) Yes (2) No

44. What is the role of the group?

....

....

45. Do you get any form of support from any organization(s)? (1) Yes (2) No

46. If yes, what organization do you get support from? (1) The district (2) NGO's (3) Philanthropist (4) others (specify) …………………………..

47. What kind of support do you get from this/these organization (s)? (1) Financial support (2) Technical support (3) Inputs supply (4) Soil improvement workshops (5) flood management workshop

48. Are these supports sufficient? (1) yes (2) No

49. Specify the roles community leaders play in minimizing flood impact.

Assemblyperson:
………………………………………………………………………………………
………………………………………………………………………………………
………………………………………………………………………………………

Chiefs:
………………………………………………………………………………………
………………………………………………………………………………………
………………………………………………………………………………………

Others leaders (specify roles)
………………………………………………………………………………………
………………………………………………………………………………………
………………………………………………………………………………………

50. Does any household member moved out of community migration

(iii) Human assets:

51. Have you ever participated in any flood risk management or agricultural related activity at the district or community level? (1) Yes (2) No

52. If yes, what was the programme specifically about?
………………………………………………………………………………………
………………………………………………………………………………………

53. Who organized it? (1) The district assembly (2) NGO's (3) Community leaders

54. Was the programme beneficial to you? (1) Yes (2) No

55. If yes, in what way was it beneficial?
………………………………………………………………………………………
………………………………………………………………………………………

(iv) Natural assets:

56. Are there natural reserve areas or sacred grooves in the community? (1) Yes (2) No

57. What are the importance of natural reserves or sacred grooves in the community?
……………………………………………………………………………………………
……………………………………………………………………………………………

58. Are there rivers or streams? (1) Yes (2) No

59. How many farms do you have? (1) one (2) two (3) multiple

60. Are they close to each other or they are far apart? (1) Close (2) far apart

61. What is the average size of your farm(s) in acres?
……………………………………………………………………………………………

62. Are they all affected by floods? **(Answer if you have two or more farms)**

(1) Yes (2) No

(v) Physical/technological assets:

63. Is there an irrigational system in the community? (1) Yes (2) No

64. If yes, what types are available? (1) Dam (2) Hand dug-outs (3) others (specify)……………………………………………………………………

65. (a) Have you ever benefited from any soil improvement programme?

(1) Yes (2) No

66. (b) If yes explain
……………………………………………………………………………………………
……

67. Have you used any flood tolerant crop varieties? (1) Yes (2) No

68. If yes, what types? (1) Swamp rice (2) Exotic rice (3) others (specify)
……………………………………………………………………………………………

69. Do you do dry season farming?

(1)Yes (2) No

70. If yes, what crops do you grow and why?
……………………………………………………………………………………………
……………………………………………………………………………………………

71. Select the items you own from the table below.

Assets owned	(Tick if you own assets)
1. Traction livestock (e.g. mule, horse, oxen)	
2. Car	
3. Plough	
4. Gas/kerosene stove	
5. Television	
6. Radio	
7. Bicycle/tricycle/motorbike	
8. Iron roofed house	
9. Refrigerator	
10. Cellphone	

72. Have you experienced food shortages as a result of floods?

(1) Yes (2) No

73. If yes, what coping strategies are employed to manage food shortages?

(1) Reducing the amount of food per meal

(2) Reducing the number of meals taken in a day

(3) Eating food considered less valuable.

(4) Migrating outside the community to look for greener pastures

(5) Selling assets to meet household needs including food stock, shelter, health care and clothes.

(6) Others (specify)

……………………………………………………………………………………………
……………………………………………………………………………………………

74. Have there been measures put in place at the community level to prevent floods?

(1) Yes (2) No

75. If yes, what measures have been put in place by the community?

……………………………………………………………………………………………
……………………………………………………………………………………………

76. What are should be put in place to improve your ability to adjust to flood impacts?

(i)Individual level

……………………………………………………………………………………………
……………………………………………………………………………………………
……………………………………………………………………………………………

(ii) Community level

……………………………………………………………………………………………
……………………………………………………………………………………………
……………………………………………………………………………………………

Thank you