UNIVERSITY FOR DEVELOPMENT STUDIES

THE EFFECTS OF CLIMATE CHANGE ON LIVELIHOODS AND THE DETERMINANTS OF ADAPTIVE CAPACITIES AMONG SMALLHOLDER HOUSEHOLDS IN THE BONGO DISTRICT

BY

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DECLARATION

Student

I hereby declare that this Thesis is the result of my own original work and that no part of it has been presented for another degree in this university or elsewhere:

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I hereby declare that the preparation and presentation of this Thesis was supervised in accordance with the guidelines on supervision of thesis laid down by the University for Development Studies.

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ABSTRACT

Extreme weather events such as floods and drought in Africa are considered a major indication of climate change. Current climate change projections indicate progressively severe negative impacts on many countries across the world with the most severe impacts affecting the world's poorest countries with the weakest capacity to adapt. Crop yields in Ghana are estimated to reduce due to projected decline in rainfall and upsurge in temperature. The research combined qualitative methods (observation, FGD's and interviews) with quantitative method and analyzed the data using descriptive and inferential statistics such as percentages, tables, one way ANOVA, bivariate correlations, and binary logistic regression. The findings revealed that, smallholder households in the Bongo district perceive climate change to be characterized by erratic rainfall, reduced rainfall, late onset, short duration and high temperature which have resulted in significant crop failure. The findings also revealed that, livelihood activities such as crop farming, animal production, fishing, shea-butter processing and pito brewing were severely affected by climate change. The negative effects of climate change on households' livelihood activities included drought, flood, pest, disease, and poor germination of crops and have resulted about 65% decline in crop yield per acre and animal production. The findings further revealed that critical factors such as training, education, land size, belief system and farming experience were statistically significant in determining household coping and adaptive capacities. The study also showed that households employed coping measures such as sale of livestock to buy food, hunting forest products and premature harvesting of food, On-farm adaptation strategies such as use of indigenous knowledge in agronomic practices, alley cropping and dry season gardening and Off-farm adaptation strategies included livelihood diversification, support from Government and migration. As recommendations, strategies to strengthen resilience include integrating indigenous and scientific knowledge, credit and dam facilities.

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AAP	Appropriate Agronomic practices
ACDEP	Association of Church Development Organization
ANOVA	Analysis Of Variance
CECIK	Centre for Cosmovision and indigenous Knowledge
CID	Centre for Integrated Development
EPA	Environmental Protection Agency, Ghana
FAO	Food and Agriculture Organization
FGD	Focus Group Discussion
GSOP	Ghana Social Opportunity Project
GDP	Gross Domestic Product
GSS	Ghana Statistical Service
GMA	Ghana Meteorological Agency
IPCC	Intergovernmental Panel on Climate Change
MoFA	Ministry of Food and Agriculture, Ghana
NGO	Non-Governmental Organization
SLF	Sustainable Livelihood Approach
SUFAEP	Sustainable Family Agricultural and Educational Support Programme
SPSS	Statistical Package for Social Sciences
SSA	Sub-Saharan Africa
UN	United Nations
UNFCCC	United Nations Framework Convention on Climate Change

CHAPTER ONE

1.1 BACKGROUND OF THE STUDY

Extreme weather events such as floods, unusual precipitation, erratic rain falls and drought in Africa are considered a major indication of varying climatic conditions by many scholars and climate experts (FAO, 2008; IPCC, 2014). Climate change is a major concern of all governments in the world and it is currently receiving thoughtful consideration at the global, national, regional and local levels (Abate, 2011). These extreme weather events result in potentially unexpected and permanent disruptions of life and livelihood-sustaining natural systems, leading to socio-cultural, economic and environmental disruptions (UNSCEB, 2008).

Current climate change projections by climate experts indicate progressively severe negative impacts on many countries across the world (IPCC, 2014). However, the most severe impacts are affecting the world's poorest countries with the weakest capacity to adapt (IPCC, 2014). Impacts of climate-related extremes include ecosystem alterations, disruptions of food production and water supply, destruction of settlements and infrastructure, human well-being and mental health challenges, mortality and morbidity (IPCC, 2014). These projected challenges pose a negative threat to the accomplishment of SDGs in less developed countries (UNSCEB, 2008; Abate, 2011).

The agriculture sector in Ghana employs about 57% of the population and it is the major source of income for the majority of low income Ghanaian families most especially rural households (GSS, 2014), not all, the sector also contributes significantly to the foreign exchange earnings of the country and develop by

means of providing raw materials to local industries (MoFA, 2007). Despite these enormous contributions, the sector is sensitive to climate change through its reliance on rain-fed cultivation (Antwi-Agyei, 2012). The volume and pattern of rainfall determine to a large extent agricultural productivity (Haile, 2005). Crop yields in Ghana are estimated to reduce by 7% by 2020 due to projected decline in rainfall and upsurge in temperature linked to climate change (Antwi-Agyei, 2012). Food and livelihood security will be severely affected (EPA, 2008;Yaro, 2010; Antwi-Agyei, 2012).

For the past 30 years, Ghana has encountered increasing prevalence of extreme events such as droughts, floods and bush fires which are linked to climate change (Yaro, 2010) and these have often resulted in severe food and livelihood insecurity (MoFA, 2007). Ghana suffered droughts in 1968–73, 1982–84, 1990–1992 but the drought of 1983/84 is among the most major droughts in the country's history as it triggered major hydrological imbalances that affected crop productivity throughout the country (Yaro, 2010). Ofori-Sarpong (1986) particularly observed a great decline in cereal production as a result of the major drought in 1983 that led to extensive food and livelihood insecurity.

In the Upper East region of Ghana, changes in the natural vegetation are observed (for instance the steady loss of the economically vital dawadawa and shea trees), lesser water availability/reliability and an alteration in the planting season (Dietz et al., 2004). Over the years, countless farmers used to start planting in April, or even late March, but a lot has changed to May or even June (Dietz et al., 2004) due to erratic rainfall regime.

Rural communities across the Bongo district have long adapted to extreme weather events, be economic, societal, or climatic to reduce their vulnerability to climate change (Aniah et al., 2014) since climate change endangers to create a further burden on the already vulnerable groups. As the amount of evidence on climate change impacts and vulnerability grows, so too does the consciousness of the need to adapt to climate change (Brockhaus et al., 2012). It is therefore not surprising that some rural households in the Bongo district have implemented adaptation options.

However, decreasing socio-ecological system's vulnerability to climate change is a problem for individuals, groups and organizations from the local level to the national and global levels (Adger, 2006; Ribot, 2010). Since adaptation starts at the local level, it is imperative to comprehend what ''adaptation'' means, locally and how socio-ecological systems respond to manifold stresses, including climate change (Van der Geest and Dietz, 2004; Mertz et al., 2009). Perceptions and experiences of adaptation and its significance vary across levels and scales (Brockhaus et al., 2012). National adaptation planning processes and their outputs, such as the NAPAs (National Adaptation Programs of Action, a process for Least Developed Countries), usually do not apprehend local requirements which are a crucial aspect for assisting current adaptation efforts and indigenous institutions in planning sustainable adaptation strategies (Agrawal, 2009; Stringer et al., 2009). This imparity can lead to upsurge vulnerability and maladaptation by extremely burdening the most vulnerable, creating high opportunity cost, or generating path dependencies that will constrain the choices of forthcoming

generations (Barnett and O'Neill, 2010). To Eriksen et al. (2011), because of unforeseen consequences and negative externalities, ''not every adaptation is a good one'' (Eriksen et al., 2011:1).

Smallholder households in the Bongo district have also been adjusting their actions to variations in climate as coping strategies to weather variability, although such actions may not be resilient (Aniah et al., 2014; Dietz et al., 2004). Resilience building into existing agricultural operations maybe a significant aid to farmers' abilities to adapt to weather unpredictability related to climate change (Pearce, 2009). Therefore, the Bongo district of the Upper East Region is a suitable case study context to carry out more detailed adaptation strategy assessment, and the findings will have wider significance for dryland farming systems in Ghana and Africa as a whole.

1.1 STATEMENT OF THE PROBLEM

Ghana's temperature is projected to increase, based on future climate change scenarios using General Circulation Models, by 0.6^0C, 2.0^0C and 3.9^0C by the years 2020, 2050 and 2080 respectively (EPA, 2007). Rainfall on the other hand, is projected to decrease by 2.8%, 10.9% and 18.6% during the same period (EPA, 2007; Antwi-Agyei, 2012). Food and rural livelihoods in the UE/R and Ghana as a whole will therefore be placed under considerable stress due to climate change (FAO, 2010). Cereals including millet and sorghum which serve as important staple food crops are extremely vulnerable (particularly to drought) (Schlenker and Lobell, 2010) since these crops require an appreciable quantity of rainfall for their growth. In addition, the livelihoods of poor smallholder farmers are

disrupted by drought and floods due to climate change, thereby increasing their vulnerability to food and livelihood insecurity (MoFA, 2007).

Rural smallholder households in less developed countries are the primary victims whose livelihoods are substantially at risk or endangered by climate change (Abate, 2011). The impacts of climate change are anticipated to disproportionately affect the well-being of the poor in rural communities, such as female-headed households and people with limited access to land, advanced agricultural inputs, infrastructure, and education (IPCC, 2014).

Although several researches have been conducted with regards to the impacts of climate variability, efforts have disregarded the potential role of smallholder farmers in adaptation (Yaro, 2010; Antwi-Agyei, 2012). Also, most of the researches on adaptations are very general and with larger spatial recommendation domain and as a matter of fact, adaptation strategies are peculiar to a locality. International conventions such as the United Nations Framework Convention on Climate change (UNFCCC) believe that developing countries need internal solutions instead of the top-down approach. Webb and Reardon (1992: 230) argue that most studies have tried to identify general patterns of coping rather than differentiating between agro-ecological zones, villages and types of households. Moreover, adaptation practices are not yet completely explored and little is known about the rationality and/or determinants of local adaptation strategies due to inadequate knowledge and documentation.

The Climate change Research Community has identified different adaptation approaches, however the specific climatic characteristics of the area, prescribe the need for a specific adaptation method to climate variability. Following from the discussion above, the problem that has engaged the attention of this research is that, crop yields are declining due to rising temperatures and variation of rainfall patterns. For instance, EPA, (2008) noted that, maize yields in Ghana are projected to decrease by 7% by 2020 due to projected decreases in rainfall and increases in temperature linked to climate change (EPA, 2008). Climate change has resulted in the failure of the agriculture sector, hence a threat to the attainment of food and livelihood security. Yet the potential role of smallholder households in climate change adaptation is not fully explored. The research therefore seeks to examine the strategies that are adopted by smallholder households to manage the negative effects of climate change on the livelihoods of smallholder households in the Bongo District.

1.3. RESEARCH QUESTIONS

1.3.1 GENERAL RESEARCH QUESTIONS

The main research question is: What are the effects of climate change on livelihoods and the adaptation strategies by smallholder households in the Bongo District?

In order for the study to have a comprehensive answer for the main question, answering the following questions is essential.

1.3.2 SPECIFIC RESEARCH QUESTIONS

1. How do smallholder farmers perceive climate change in the Bongo district?

2. What are the effects of climate change on the livelihoods of smallholder households in the Bongo district?
3. What are the factors that determine the adaptive capacity of smallholder households to climate change in the Bongo district?
4. What are the adaptation strategies that smallholder households use to manage the negative effects of climate change on livelihoods in the Bongo district?
5. What can be done to strengthen the resilience of households towards the impacts of climate change in the Bongo district?

1.4. OBJECTIVES OF THE STUDY

1.4.1 GENERAL RESEARCH OBJECTIVE

The overall goal of the research is: To examine the effects of climate change on livelihoods and the adaptation strategies by smallholder households in the Bongo District?

1.4.2 SPECIFIC OBJECTIVES

1. To explain smallholder farmers perceptions about climate change in the Bongo district.

2. To examine climate change effects on the livelihoods of smallholder households in the Bongo district.

3. To examine the factors that determines the adaptive capacity of smallholder household to climate change in the Bongo district.

4. To explore the adaptation strategies that smallholder households use to manage the negative effects of climate change on livelihoods in the Bongo district.

5. To identify strategies to strengthen the resilience of households towards negative impacts of climate change in the Bongo district.

1.5 RELEVANCE OF THE STUDY

The study explored the negative effects of climate change on rural smallholder farmers' livelihoods and the adaptation strategies of indigenous people especially the most vulnerable in the Bongo district. The findings will help with a better understanding of the vulnerabilities of rural communities' livelihoods to adverse effects of climate variability. The findings will also contribute to scientific debates by increasing our understanding of how rural households are coping with the challenges posed by climate change thereby contribute to more targeted and effective policy and program options aimed at addressing climate and related issues. Hence, what makes this problem worth studying is to have a clear understanding of variations in weather, its impact on agricultural production of smallholder farmers and the indigenous adaptation strategies that fit the available resources of their locality. It is also intended to identify and recommend appropriate strategies to strengthen the resilience of households towards negative effects of climate change as well as the areas of collaboration among the traditional and formal institutions in climate related issues. The outcome of the study is again expected to contribute to theory building by providing a theoretical understanding of food production, the significance of the belief system in influencing adaptation and rural livelihood vulnerability that will help guide more general discussions of the sorts of livelihood systems that should be better able to adapt to future climate variability.

1.6 SCOPE OF THE STUDY

The study was conducted in the Gowrie Kunkua and Soe Kabre communities in the Bongo district of the Upper East Region of Ghana between May 2014 to June 2015 to examine the negative effects of climate change on livelihoods and how rural smallholder households adapt to these effects. This is because the Bongo district is highly vulnerable to climate change.

1.7 ORGANIZATION OF THE THESIS

The study was organized into seven (7) interrelated chapters, chapter one presents general background of the study, the problem statement, research questions and study relevance. Chapter two reviews the literature and conceptual issues. Chapter two (2) has established that climate change presents negative effects on livelihoods of smallholder households. Chapter three (3) was devoted to research methodology and profile of the study area. This chapter has established that the use of mixed-method approach allows validation and deep understanding of different dimensions of issues. Chapter four (4) dealt with socio-demographic characteristics and smallholder households' perceptions about climate change. There are strong indications that climate change poses serious constraints and risk for smallholder households' livelihoods. Chapter five (5) dealt into issues of climate change effects on livelihoods. This chapter revealed that, households livelihood activities were severely affected by climate change which has resulted in significant declines in crop and animal production. Chapter six (6) was devoted to the determinants of adaptive capacities for coping and adaptation to climate change. This chapter revealed that, belief system, education, farming experience,

land size were significant elements that determined household adaptive capacities. On-farm and off-farm adaptation strategies were employed by households to manage the negative effects of climate change on livelihoods. Finally, chapter seven (7) was devoted to conclusion and recommendation. Strategies such as irrigation, providing credit and subsidizing agric-inputs and livelihood diversification were strategies identified to strengthen the resilience of households against the negative effects of climate change.

CHAPTER TWO

LITERATURE AND THEORETICAL CONCEPTS ON VULNERABILITY AND ADAPTATION TO CLIMATE CHANGE

2.1 INTRODUCTION

This Chapter first defines key concepts and expressions, proceeds with discussions on some theories on climate change and weather extremes, debates about people's vulnerability to hazards in general and climate related hazards in particular, which will be followed by an outline of theory of rural people's strategies to offset risk, and to pursue food and livelihood security in times of unpredicted and erratic weather and a conceptual framework.

2.2 DEFINITION OF FUNDAMENTAL CONCEPTS AND EXPRESSIONS

There are no generally accepted explanations of concepts and expressions. Expressions such as adaptive capacity, adaptation, vulnerability and resilience have contested definitions. As a result of this challenge in having a generally accepted definition, the study will apply the following working definitions throughout this thesis.

Climate change: Climate change refers to 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. UNFCCC defines climate change as: 'a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods.' FAO (2008:85) defines climate variability as deviations of climate statistics over a given period (such as

during a specific month, season or year) from the long-term climate statistics relating to the corresponding calendar period. In this sense, climate variability is measured by those deviations, which are usually termed anomalies. The UNFCCC thus makes a distinction between climate change and climate variability where climate change is attributable to human activities altering the atmospheric composition, and climate variability attributable to natural causes (UN, 1992).

Vulnerability: vulnerability to climate change and variability is defined as "the degree to which an environmental or social system is susceptible to and unable to cope with adverse effects of climate change, including climate variability and extremes" (IPCC, 2007:883). The IPCC indicates that vulnerability is a function of a system's exposure, sensitivity and adaptive capacity.

Adaptation: this thesis adopts Smith et al. (2000) definition of adaptation as the process by which stakeholders reduce the adverse effects of climate on their livelihoods. It involves adjustments in lifestyle, behavior and economic structure aimed at reducing the vulnerability of a system to climate change and variability, thereby increasing its sustainability (Smith et al., 2000).

Resilience: the thesis adopts Walker et al. (2006) definition of resilience which is referred to as the ability of a system to withstand shocks in order to maintain its structure and identity. Resilience is defined as being present in situations where major changes and variability (such as drought) result in insignificant loss of crop yield in a particular community.

Adaptive capacity: Adaptive capacity in the context of climate change and variability has been defined by the IPCC (2007:869) as "the ability of a [food

production] system to adjust to climate change (including climate variability and extremes) to moderate potential damages, to take advantage of opportunities, or to cope with the consequences." This thesis adopts the definition by the IPCC because it permits an extensive theorization of what smallholder households and communities are doing and the resources they draw upon in adapting to climate variability.

Coping capacity: coping capacity refers to short-term strategies taken by farming households and communities to counteract the immediate negative effects of climate change including drought (Campbell et al., 2011). Coping capacity and adaptive capacity are mostly distinguished with reference to timescale. Adaptive capacity is linked to long-term strategies whilst coping strategies may include short-term strategies (Smithers and Smit, 1997).

Food security: this study adopts the FAO (2002) definition of food security as a "situation that exists when all people, at all times have physical, social and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life."

Drought: this thesis adopts the IPCC (2007:873) definition of drought as a "phenomenon that exists when precipitation is significantly below normal recorded levels causing serious hydrological imbalances that adversely affect land resource production systems." This thesis is concerned with meteorological drought, which refers to lack of precipitation over a particular period, and

agricultural drought, which refers to "periods of declining soil moisture and consequent crop failure" (Mishra and Singh, 2010:206).

Livelihoods: "A livelihood comprises the capabilities, assets (stores, resources, claims and access) and activities required for a means of living" (Chambers and Conway, 1992:7). An assessment of livelihoods offers the opportunity to highlight the various adaptations that might be available to determine how smallholder households and communities can cope with declining crop yields due to drought.

Household: A household is defined as a person or a group of persons, related or unrelated, who lived together in the same house or compound and share the same house-keeping arrangements, commonly provide for food and regularly take their food from the same pot or share the same grain store ("bare"), or who pool their income for the purpose of purchasing food. Normally, a household consist of a man, his wife, children and some other relatives or a household help who may be living with them. However, it is important to emphasis that members of a household are not necessarily related (by blood or marriage) because non-relatives (e.g. house helps) may be part of a household (GSS, 2012: x).

Smallholder: The definition of "smallholder" is based on rural classification and socioeconomic status, and varies according to region. This thesis defines "smallholders" as households that own less than two (2) ha of land and live on their farms (they are small family operations). All the farmers sampled in this study fit this criterion. The terms smallholder households will be used interchangeably with farm families or farmers.

2.3 CAUSES OF CLIMATE CHANGE IN SUB-SAHARA AFRICA

Climate change in Sub-Saharan Africa occurs due to internal variability within the climate system and external factors. The external causes could be natural or induced by human activities. The basic cause of climate change is the increase in the concentration of carbon dioxide and other Greenhouse Gases (GHG) in the atmosphere as a result of human activities mostly by fossil fuel burning and clearing of forests (Abate, 2011). The other major causes of GHG emissions is from carbon dioxide (70%), largely from burning of fossil fuel (petroleum) from industrialized countries, while the other sources of GHG are methane (CH_4) and nitrous oxide (N_2O) triggered by agricultural activities and deforestation specifically the use of chemicals and pesticides (Michael and Kifle, 2009; Abate, 2011). The general effect of human activities on climate has been a heating influence since the beginning of the industrial era (about 1750 years). The human impact on climate during this era considerably exceeded that of natural causes as a result of known changes in natural processes, such as solar changes and volcanic eruptions (IPCC, 2007; Abate, 2011).

2. 4 FLOODS AND DROUGHTS IN GHANA

Droughts have received much more attention in the literature than floods. Wet years are usually referred to as good years: 'the wetter the better' (Van der Geest, 2004). Excess rainfall (floods) is, however, harmful to crops like millet and sorghum during particular phases of plant growth when excessive rainfall causes very severe floods in which people lose their houses, harvests, grain stores, livestock or even their lives, it becomes a critical issue (Tschakert et al., 2010). Recent examples of dramatic flood events in Ghana are the 2011 floods in Accra

and floods in the three Northern Regions that has killed 56 people and affected 330,000 people (Danquah, 2013). More recent is the June 3rd, 2015 flood disaster that claimed over 200 lives, displaced 9,255 and affected 46, 370 people (IFRC, 2015). The less extreme circumstances, where excess rainfall at inappropriate periods results in severe declines in yields for particular crops or even sometimes complete crop failure are usually ignored. This is undoubtedly because of prevalent disasters like the Sahelian famines of the late 1970's and early 1980's were triggered by shortages of rainfall (drought) rather than excess rainfall. When there is abundant rain, although some crops may fail, other crops like rice and sweat potatoes does very well (Van der Geest, 2004; Tschakert et al., 2010). Mishra and Singh (2010:5) differentiate four (4) types of drought. The physically measurable droughts are meteorological drought, agricultural drought, and hydrological drought. Groundwater drought and socioeconomic droughts constitute the non- physically measurable droughts.

A meteorological drought is a temporary impermanent shortage of rainfall significantly below the regular or expected amount in a month, season or year. The analysis of meteorological droughts is comparatively easy because they are chiefly defined in statistical terms (National Weather Service, 2008; Mishra and Singh, 2010). A meteorological drought in a certain area can, for instance, be defined as a situation in which the rainfall is deficient by at least two times the standard deviation of the average (Mishra and Singh, 2010)

Agricultural droughts happen when crops have inadequate water to grow fuller and produce satisfactory yields. Since diverse crops and grasses have distinct

moisture needs at different stages of plant growth, the arrival of an agricultural drought in a particular area is difficult to describe, particularly when a large variety of crops is being cultivated. Drought can also be defined by associating drought to the crops or fodder cultivated in an area (Van der Geest, 2004; Mishra and Singh, 2010:5). Descriptions and explanations' of agricultural drought can be expressed in drought indices like the Palmer drought severity index, rainfall anomaly index, crop moisture index, Bhalme and Mooly drought index, surface water supply index, national rainfall index, standardized precipitation index, and reclamation drought index (Mishra and Singh, 2010). Monitoring agricultural drought is difficult, since soil moisture needs of crops depend among other son the type of crop, the seed variety, the sowing date, the stage of plant growth and physical and chemical characteristics of the soil on which the crop is cultivated (Mishra and Singh, 2010).

Hydrological drought deals with the consequence of inadequate rainfall on water bodies like streams, lakes, rivers, dams and ground water tables. While agricultural droughts normally happen soon after meteorological drought, there is a time interval in the advent of a hydrological drought (National Weather Service, 2008; Mishra and Singh, 2010). When the agricultural drought ends, the hydrological drought can still remain a long time because it takes longer time for streams, lakes, rivers, dams and groundwater to be replenished than for soil water (Mishra and Singh, 2010).

The socio-economic drought arises when a lack of precipitation results in the inadequate supply of any goods in comparison with the demand for that particular

good. In contrast with the first three categories of drought, socio-economic droughts are not measurable in physical terms. Socio-economic droughts depend on the market conditions of that particular area (Mishra and Singh, 2010).

Groundwater droughts generally occur on a time scale of months to years. For groundwater drought, the total amount of water available is difficult to define. Even if it can be defined, in most groundwater systems, negative impacts of storage depletion can be felt long before the total storage is depleted. Therefore, most often a groundwater drought is defined by the decrease of groundwater level. However, groundwater storage, or groundwater recharge or discharge can be and has also been used to define or quantify a groundwater drought (Mishra and Singh, 2010).

Van der Geest (2004) citing Mortimore (1989) also identified an ecological drought, which happens "when the primary productivity of a natural or managed eco-system (...) falls significantly owing to reduced precipitation." For all these categories of drought, the impact is particularly severe when many following years are dry (Van der Geest, 2004).

A single stress/shock can have various impacts, of diverse nature and time scale, droughts reduces the availability of water and grass – both directly and indirectly because, as the watering points and moisture content are reduced, grasses and crops cannot grow well, also, some pastures are no longer accessible and animals cannot grow fully and produce satisfactorily – and so increases in demand for agriculture goods at the very moment when there is less goods available (Gitz and Meybeck, 2012). Prolonged or repeated drought also has long lasting degrading

effects on land: a combination of drought and over cultivation and overgrazing, particularly near watering points, destroys the vegetative cover, increases soil erosion and degrades the land (Gitz and Meybeck, 2012). These combined effects of droughts reduce productivity (crops and livestock), increases household vulnerability. Moreover, they reduce the value of assets (crops and livestock) and the productive capital for the future and consequently food and livelihood insecurity. Assessing potential impacts of a stress on a system requires not only evaluating the potential impact of each of the components of the system, but also how it will change the relationships between the components of the system. It is particularly difficult for complex systems involving biophysical factors, as these cannot be totally reduced to a single dimension (Gitz and Meybeck, 2012)

2. 5 TYPES OF RAINFALL VARIABILITY

The three types of rainfall variability - spatial variability, inter-annual variability and intra-annual variability or seasonal concentration are discussed below.

2.5.1 SPATIAL VARIABILITY

Spatial variability has to do with the differences in rainfall received between places, either structurally or proximately. Spatial variability is high when wide disparity happens between places that are relatively close to each other. When two nearby localities are disjoined by a mountain range, structural differences are expected in precipitation and hence the greater spatial variability. The area located on the weather side will experience great wet/rains whereas the area located on the shelter side will experience less wet. In the non-existence of mountains, rainfall amounts can still differ considerably over short distances (Moron et al.,

2008). A situation of this kind can lead to different drought consequence within a small area which has repercussions for the use of agro-climatological information to forecast stress in agricultural production and for designing effective early warning systems against famine (Van der Geest, 2004). High spatial variability is advantageous with regards to coping with food stress. The failure of crops in one area due to drought can be supplemented by neighboring villages if their crops do not fail. The idea of filling food gaps is referred to as inter-village transfers. Moreover, the probability of food prices increasing suddenly would be low, as would be in the case of a region-wide crop failure (Van der Geest, 2004). Affected households can therefore purchase food easier. There is an inverse relationship between spatial variability and mean annual rainfall. Rainfall variation amounts between places in moderate dry regions are normally great (Van der Geest, 2004).

2.5.2 INTER-ANNUAL VARIABILITY

Inter-annual variability refers to the annual divergence from a long-term average, or the deviation in rainfall between years. The evaluation of inter-annual variability is normally limited to an assessment of total annual amounts of rainfall in different years, while the year-to-year variation in the rainfall distribution is neglected (Moron et al., 2008). This is not familiar since it is the year-to-year variation in the distribution of rainfall that subjects rain-fed agriculturalists to insecurity and risk. The evaluation of inter-annual variability should as a matter of fact comprise the annual amounts of rainfall and the distribution of rainfall. Average annual rainfall and inter-annual variability of annual rainfall have an

inverse relationship (Van der Geest, 2004). Inter-annual variability amounts to above 50% in arid regions, whereas it is around 30% in semi-arid regions and less than 30% in sub-humid regions. However, greater average rainfall does not inevitably mean lesser inter-annual variability in aggregate rainfall (Van der Geest, 2004).

2.5.3 INTRA-ANNUAL VARIABILITY

Intra-annual variability or seasonal concentration indicates the distribution of rainfall within a particular year. Inter-annual variability could be zero if day by day –or month by month go through precisely identical amount of rainfall (Moron et al., 2008). Rainfall pattern is unimodal in the semi-arid and most of the sub-humid regions of Sub-Saharan Africa, i.e. rainfall is in tensed in one wet season where the rain fed farming activities transpire, leaving the dry season for other activities. This implies that farmers can only harvest once a year, making the time span between two harvest periods very long, and concentrating risk into one in place of the two harvests. The periods and the months immediately before the harvest are often hard for farmers since food stocks run low and consumption has to be reduced while at the same time intense agricultural work has to be carried out. The seasonal concentration of rainfall generates seasonality in the agricultural cycle, labor demands, food availability, food prices, the prices of consumer goods and labor, health, births, deaths and migration patterns (Van der Geest, 2004). Devoid of seasonal concentration, crop production would be unachievable in several West African areas because an equal distribution would imply that the monthly rainfall throughout the year would in no period be adequate to sustain plant growth (Van der Geest, 2004). Intra-annual variability can present

difficulties to farmers when it is so great that farmers get a considerable high amount of rain in a short period while the rest of the year does not experience adequate rainfall for crops and livestock to fully develop. These situations usually occur in some years. However, the distinction between inter-annual and intra-annual variability should again be made clear (Van der Geest, 2004).

2.6 CLIMATE OVERVIEW OF GHANA

The climate of Ghana is dominated by the interaction of the Inter-Tropical Convergence Zone (ITCZ) and the West African Monsoon. The ITCZ, also known as the Equatorial Convergence Zone or Inter-Tropical Front, is a region of calm winds separating the northeasterly and southeasterly trade winds. The location of the ITCZ annually moves, reaching its northernmost extent during the northern hemisphere summer and its southernmost extent during the northern hemisphere winter (Stanturf, et al., 2011). The principal feature of the climate of Ghana is the alternate wet and dry seasons caused by the movements of the ITCZ and West African Monsoon. In southern Ghana there are two distinct wet seasons, but Northern Ghana has only one. Available temperature data indicate a warming climate in Ghana with the drier northern area warming more rapidly than southern Ghana (Stanturf, et al., 2011). For Ghana as a whole, since the last five decades, mean annual temperature rose by 1.0°C. The rate of increase was more rapid in the northern than southern regions (Stanturf, et al., 2011). The frequency of “hot” nights and days in Ghana increased for the past five (5) decades. Rainfall in Ghana was particularly high in the 1960’s and decreased to particularly low levels in the late 1970’s and early 1980’s. According to The World Bank Group (2011),

the major rainfall and temperature patterns form the basis of the agro-climatic zones, namely, the Sudan Savanna zone, the Guinea savanna zone, the transition zone, the semi-deciduous rainforest zone, and the high rainforest zone. Each zone is represented geo-climatically by Navrongo, Tamale, Wenchi, Kumasi, and Axim respectively.

2.7 CLIMATE CHANGE PROJECTIONS IN GHANA

Several studies (The World Bank Group, 2011; Stanturf, et al., 2011; Ghana National Communication to the UNFCCC; IPCC 4th Assessment Report and UNDP Climate Profiles.) have been undertaken to reveal overall climate trends for Ghana in the future. These include the World Bank study of the Economics of Adaptation to Climate Change Study (looking at the 2010-2050 period) and the 2000 UNDP Climate Profile of Ghana (looking at the 2060-2090 period). The following are their predictions

- The mean annual temperature is projected to increase by 1.0°C to 3.0°C by the 2060's, and 1.5°C to 5.2°C by the 2090's. The projected rate of warming is most rapid in the northern inland regions of Ghana.
- Total annual rainfall is projected to decline by 1.1%, and 20.5% in 2020 and 2080, respectively.
- Seasonality is projected to change, with early termination of rainfall in the transitional zone, and is likely to convert the current bi-modal regime to a uni-modal one.
- The projections for precipitation indicate a cyclical pattern over the period 2010–2050 for all regions, with high rainfall levels followed by a drought every decade or so. The wettest parts of the country are expected to be the

Tropical and Moist Deciduous Rain Forest zone (in the Ashanti and Western regions) and Coastal zone (Volta, Eastern, Central, and Greater Accra regions).

- Savannah zones are projected to be relatively dry. (The World Bank Group, 2011).

2.8 CLIMATE CHANGE EFFECTS ON LIVELIHOODS OF SMALLHOLDER HOUSEHOLDS

Climate change and extreme weather events alter the livelihoods and lives of countless poor people (IPCC, 2012b). Insignificant fluctuations in the amount of precipitation or transitory circulation, even minor changes in precipitation amount or temporal distribution, short phases of intense temperatures, or localized heavy winds can damage the livelihoods (IPCC, 2014). Livelihood activities such as cropping, livestock, fishing, agriculture labor, business and hawking/vending, non-agricultural labor, weaving, industry, and construction are disrupted by climate change. Livelihood activities peculiar to women such as weaving, pito brewing and malt processing as well as shea butter processing are severely disrupted by climate change.

Climate change and extreme weather conditions are eroding households/farmers livelihoods through decreases in crop yield (IPCC, 2014), and periodically complicated by the proliferation of insect infection, pathogens, parasitic weeds, reduced availability of and access to non-timber forest products and medicinal plants and biodiversity loss (IPCC, 2014).The most severe form of natural assets erosion is the absolute disappearance of people's land, worsening livelihoods

vulnerability and risk as a result of damage to social and economic assets (IPCC, 2014).

Climate change and extreme weather conditions, destruction of physical assets such as the destruction of homes by flood water as well as disrupted water supply and sanitation services have been reported (Douglas et al., 2008). Flooding often negatively affected cities in Africa, especially in areas that are mostly crowded informal communities due to poor drainage, and health infrastructure (UNDP, 2011c). Climate change also damages human assets such as food and livelihood, malnutrition, famine and persistent hunger as a result of crop failure and spikes in food prices usually rigorously experienced by poor populations (IPCC, 2014).

2.9 THEORETICAL FRAMEWORKS FOR EVALUATING VULNERABILITY TO CLIMATE CHANGE

The goal of research in vulnerability is to present a universal understanding of the reasons that give rise to vulnerability with the purpose of enhancing the discovery and recognition of a variety of prospects that could be used to adapt and cope with the basic causes of climate change (Miller et al., 2010). An understanding of this nature can assist to build on strategies and policies that will in turn minimize the risks presented by climate change (Füssel and Klein, 2006). Evaluating vulnerability is not an easy task; it has always been difficult given the dynamic nature of vulnerability regarding its spatial and temporal dimensions (Eriksen and Kelly, 2007).

2.9.1 THE ENTITLEMENT APPROACH TO VULNERABILITY ANALYSIS

Vulnerability to food and livelihood insecurity is explained, through the entitlement theory, as a set of linked economic and institutional factors. Entitlements are the actual or potential resources available to individuals based on their own production, assets or reciprocal arrangements (Adger, 2006). Food and livelihood insecurity are therefore a consequence of human activity, which can be prevented by modifying behavior and by political interventions. Vulnerability is the result of processes in which humans actively engage and which they can almost and always prevent. The theory of entitlements as an explanation for famine causes was developed in the early 1980s (Sen, 1981, 1984) and displaced prior notions that shortfalls in food production through drought, flood, or pest, was the principal cause of famine. It focused instead on the effective demand for food, and the social and economic means of obtaining it (Adger, 2006). Entitlements are sources of welfare or income that are realized or are latent. They are 'the set of alternative commodity bundles that a person can command in a society using the totality of rights and opportunities that he or she faces (Sen, 1984:497 in Adger, 2006). Essentially, the vulnerability of livelihoods to shocks occurs when people have insufficient real income and wealth, and when there is a breakdown in other previously held endowments.

The advantage of the entitlements approach is that it can be used to explain situations where populations have been vulnerable to famine even where there are no absolute shortages of food or obvious environmental drivers at work. Famines and other crises occur when entitlements fail (Adger, 2006). This approach

enabled this study to assess a range of packages/fortunes that smallholder households are entitled to, hence offer a better way of elucidating how households safeguard against negative effects of climate change on their livelihoods. This approach enabled this study to explore the diverse capital assets that smallholder households can have access to in order to ameliorate the negative effects of climate change. The entitlements approach often underplays ecological or physical risk, as a result of this weakness; the study employed the sustainable livelihood framework to enable a better understanding of physical, ecological and natural vulnerable and risk in the study area. The study however employed the entitlement approach because it succeeds in highlighting social differentiation in the cause and outcome of vulnerability (Adger, 2006) which the sustainable livelihood approach also fails to recognize.

2.9.2 SUSTAINABLE LIVELIHOOD FRAMEWORK FOR VULNERABILITY ANALYSIS

This framework focuses on how people use livelihood assets (human, natural, financial, social, and physical) in a context of shocks, trends and seasonality. The choice of strategies is mediated by structures (e.g. Government, NGO's) and processes (e.g., laws, policies, culture, institutions) and results in livelihood outcomes, such as income, well-being, or food and livelihood security (Chambers and Conway, 1992; Ellis, 2000). Agyeman(2013) indicated that, the unique feature of the sustainable livelihood perspective is the appreciation that the root of development is livelihoods. It is a people-centered paradigm which recognizes people`s inherent capacities and knowledge. Again, it signifies a multi-sectoral character in real life, integrating environmental, social and economic issues into a

holistic framework. It highlights the development of short- and long-term adaptive capacities that enhance the abilities of individuals and communities to deal with changing circumstances (Paavola, 2008).

The sustainable livelihood framework conceptualizes and enables better understanding of the livelihood processes in the study area (Figure 2.2). Vulnerability is seen not simply as the result of an event or stress, but as a function of the socio-economic characteristics of a population which determine the degree to which their life and livelihood is put at risk by a distinct and identifiable event in nature or in society. The sustainable livelihood framework contends that households reliant on agriculture could be capable of lessening their complete susceptibility to climate change through diversification of strategies within the range of their livelihood and specializing to gain advantage of a niche (Ellis, 1998; Fraser et al., 2005). The SLA has been criticized for failing to recognize resource allocation and distributional issues (Swift et al., 2001). For example, although it emphasizes the significance of raising the prospect obtainable and accessible for the poor to accomplish their livelihoods, it fails to recognize and advance issues of equity (Yaro, 2004), which are vital to coping and adapting to climate change.

This research overcomes this weakness by employing a multi-scale climate change susceptibility appraisal by mapping vulnerability at the district, community and household levels. Concerns relating to temporal dimensions are taken into consideration in the choice of research methods. For instance, participatory methods are used to explore the temporal dimensions of livelihood

susceptibility to climate variability. This thesis builds on this by combining livelihood theory with a temporal element through local level participatory approaches (Antwi-Agyei, 2012).

The SLF offers people-centred approach to the understanding of livelihood susceptibility and inequalities faced by various households hence helps to shape development objectives. The SLF allowed better understanding of how smallholder households usually respond to negative effects of climate change. This study adopted the SLF because it permits the assessment of livelihoods which allows the identification of diverse coping and adaptation strategies (planned and unplanned, on-farm and off-farm) which highlights how smallholder households ameliorate the negative effects of climate change.

2.10.1 CLIMATE CHANGE ADAPTATION CONCEPT

Adaptation to climate change is not a new issue (Vogel, 2005) and it no longer needs rationalization, however, its explanation is required (Somah, 2013) because climate change and its attendant impacts add a new component to the challenge of livelihood insecurity (Burton, 2009). Human societies have always managed with climate change and extreme climate events such as droughts and floods to enable societies cope with varied areas across the globe. However, adaptation to climate change is in contrast to past experiences, this is because anticipating rapid frequency of climate change will likely examine the coping and adaptive capacity of the human population, and the fact that the present scientific capacity enables humans to adapt in anticipation of future change as opposed to only react to current conditions and engaging in planning based on historical climate trends and

risk (Somah, 2013). Globally, adaptation has played a potential role in reducing the effects of climate change.

Adapting to climate change is important for impacts assessments (estimating which adaptations are likely to occur) as well as advising on or prescribing adaptation (policy development). On the basis that the climate has been already variable and inevitable, particularly in Sub-Saharan Africa, it is necessary to think about and act on adaptation now. It is evident that climate change impacts are felt currently, and greater impacts are unavoidable in the future. Adaptations are vital in reducing human and social costs of climate change, and to development and poverty alleviation (Somah, 2013). Therefore, adaptation is vital in order to reduce the adverse impacts of climate change on agriculture (Yohe, 2000). Failure to implement appropriate adaptation strategies for the most vulnerable groups, could lead to serious problems including significant deprivation, social disruption and population displacement, and even morbidity and mortality (Downing et al., 1997).

Although agriculture is the most broadly researched sectors in relation to the impacts of climate change, studies have ignored the potential contribution of farmers' adaptation through indigenous knowledge (Schipper and Burton, 2009). The term adaptation was rarely used in relation to climate change until the period 1992 (Schipper and Burton, 2009). The focus of the global community was on mitigation, which entails decreasing the emissions of GHG and increasing carbon sinks, thereby slowing the rate of global climate change (IPCC, 2007). The global interest was outlining bench marks and timetable for emissions reductions to slow

down the rate of global warming (Burton, 2009). As a matter of fact, Stringer et al. (2009:750) emphasized that "… proponents of adaptation were viewed as rather defeatist and were thought to demonstrate a lack of faith in countries' abilities to limit emissions". Several authors (Smit and Skinner, 2002; Ford, 2007; Pielke et al., 2007) are of the view that recent global efforts seeking solutions to the threat of climate change have acknowledged the vital contribution of adaptation as a policy option. Smit and Skinner (2002) for example, tinted that adaptation as a response to climate change has been covered extensively by IPCC and UNFCC and they have precisely underscored the potential contribution of adaptation to reduce the adverse impacts of climate variability.

2.11.2 TYPES AND FORMS OF ADAPTATION TO CLIMATE CHANGE

Adaptations come in a huge variety of forms (Smit and Pilifosova, 2001). Adaptation to climate change in agriculture may be autonomous or unplanned (Dinaret al., 2008; Smith et al., 2000). Autonomous adaptations are coping strategies which are usually temporary and responsive in nature and can be implemented by individuals, agents and institutions (Dinar et al., 2008). Autonomous adaptations (also called spontaneous adaptations) are considered to be those that occur consistently in reactive response (after the initial impacts are manifest) to climatic stimuli as a matter of course, without the directed intervention of a public agency. Estimates of these autonomous adaptations are now used in impact and vulnerability assessment (Smit and Pilifosova, 2001). For instance, in response to a changing precipitation pattern, a household could choose to alter the crops or use separate harvest and planting dates (FAO, 2007).

Hence, the usefulness of an autonomous adaptation strategy hinges on the availability and accessibility of resources to cope with sudden climate change (Dinar et al., 2008).

Alternatively, "planned adaptation strategies are conscious policy options or response strategies, often multi-sectoral in nature, aimed at altering the adaptive capacity of the agricultural system or facilitating specific adaptations" (FAO, 2007:5). Planned adaptations can either be reactive or anticipatory (commenced before the impacts are noticeable) (Smit and Pilifosova, 2001). Indeed, planned adaptation (also called anticipatory adaptation) seeks to address future climate stresses and could be based on predicted future climate adverse impacts or past experiences (Smit and Pilifosova, 2001). While there is dissimilarity between planned and autonomous (reactive) adaptation, in practice, the line between these two is blurred (Fisher et al., 2010). Planned adaptation often is interpreted as the result of a deliberate policy decision on the part of a public agency, based on an awareness that conditions are about to change or have changed and that action is required to minimize losses or benefit from opportunities (Pittock and Jones, 2000). Autonomous adaptations are widely interpreted as initiatives by private actors rather than by governments, usually triggered by market or welfare changes induced by actual or anticipated climate change (Leary, 1999). Smith et al.(1996) describe autonomous adaptations as those that occur "naturally," without interventions by public agencies, whereas planned adaptations are called "intervention strategies". This research studied, both autonomous and planned adaptation strategies employed by farming households and communities to reduce

the adverse impacts of climate change on their livelihoods. For instance, planting drought-tolerant and early maturing varieties of crops are examples of the planned adaptation while resorting to a reduction in food consumption by the households because of climate related food and livelihood insecurity could be considered as an autonomous adaptation strategy. Many researchers admit that climate change is generally a problem but that adaptation of households can reduce the impacts of climate change on agriculture (FAO, 2007). Most agricultural systems, like many other ecosystems, have some level of inbuilt adaptive capacity, but this may be weakened because of the rapid rate of climate change (Ziervogel et al., 2008). This becomes even more serious because secondary changes induced by climate change have the potential to constrain the capability of people and ecosystems to cope with the impacts of climate variability. It is based on this justification that the IPCC support 'planned adaptation': conscious pace targeted at creating the capacity to cope with the impacts of climate change (IPCC, 2007). The IPCC also makes dissimilarity between private and public adaptations. McCarthy et al. (2001) define private adaptation as those adaptations that are implemented by individuals or households whilst public adaptation is introduced and executed by the government and its agents. Whilst private adaptations produce benefits exclusive to the individuals or households that carry out those decisions, public adaptations target communal needs (Dinar et al., 2008). This thesis examines both private adaptations (that are taken by households) and public adaptations (that are introduced by the government and its agents at the national, regional, district, zonal and community levels).

In addition, in the view of UNEP (1998) and Smit and Pilifosova (2001), adaptations can be a short or long term, localized or widespread, and they can serve various functions and take numerous forms. Adaptations have been distinguished according to individuals' choice options as well, including "bear losses," "share losses," "modify threats," "prevent effects," "change use," and "change location" (Rayner and Malone, 1998). The choice typology has been extended to include the role of community structures, institutional arrangements, and public policies (Downing et al., 1997; UNEP, 1998; Smit and Pilifosova, 2001).

2.11.3SYSTEMS, SCALES, AND ACTORS OF ADAPTATION TO CLIMATE CHANGE

Adaptations do not occur in a vacuum. In unmanaged natural systems, adaptation is autonomous and reactive and is the means by which species and communities respond to changed conditions. In these situations, adaptation assessment is essentially equivalent to natural system impact assessment**.** Human system adaptation can be motivated by private or public interest (i.e., who adapts?). Private decision makers include individuals, households, businesses, and corporations; public interests are served by governments at all levels. The roles of public and private participants are distinct but not unrelated.

Smit and Skinner (2002) identified four major categories of agricultural adaptation pathways "(1) technological developments, (2) government programs and insurance, (3) farm production practices, and (4) farm financial management" (p. 95). Categories 1 and 2 involve strategies pursued by public institutions and

organizations (Smit and Skinner 2002). Examples of Category 1 pathway include the development of new crop varieties, development of early warning systems that provide weather predictions and seasonal forecasts and the development of irrigation techniques to address moisture deficiencies. Examples of Category 2 pathways include agricultural subsidy support programs, the development of private insurance to reduce climate related risk, and the development of policies to influence farm-level production. On the contrary, Categories 3 and 4 are undertaken at the level of the individual farmer or farmers' group. Examples of Category 3 pathways include diversification of crop types/varieties and livestock types, changing land use practices to address environmental variations and changing timing of farm operations such as planting and harvesting dates (Smit and Skinner, 2002). Using crop insurance, participation in appropriate income stabilization programs and diversification of household income are examples of Category 4 pathways.

In terms of scale of agricultural adaptation, Kandlikar and Risbey (2000) differentiate farm-level adaptation from regional and national level adaptation. Regional- and national-level adaptation involve changes in infrastructure as well as support systems, whereas farm-level adaptation covers the range of farm management practices undertaken on the farm or field level by the farmer in an attempt to moderate the adverse impacts of climate change (Kandlikar and Risbey, 2000). Adaptation may also be characterized by timing (reactive or anticipatory), duration (short or long term), as well as its spatial occurrence (i.e. whether it is localized or widespread) (Smit et al., 1999). The success of

agricultural adaptation to climate change should not be measured only by economic outputs in terms of yields, but also by ethical considerations relating to distribution and social issues such as equity and fairness (Kandlikar and Risbey, 2000). This thesis adopts a multi-scale approach by exploring adaptation measures at the national, regional, community and household scales.

Distinguishing among the various decision makers involved in adaptation is important. The case of African agriculture and water resources illustrates that stakeholders and potential adaptors range from vulnerable consumers to international organizations charged with relief and research (Downing et al., 1997). Poor and landless households have limited resources, yet failure to adapt can lead to significant deprivation, displacement, morbidity, and mortality (Downing et al., 1997). Subsistence farmers do not have the same adaptation options as commercial producers. Water supply adaptations may involve landowners, private traders, local authorities, water-dependent businesses, national governments, and international organizations. Each stakeholder has distinct interests, information, risks, and resources and hence would consider distinct types of adaptive responses (Downing et al., 1997; Smit and Pilifosova, 2001).

2.12 DETERMINANTS OF ADAPTIVE CAPACITY

Smit and Pilifosova, (2001) are of the view that determinants of adaptive capacity concerns with the economic, social, institutional, and technological circumstances that accelerate or constrain the development and deployment of adaptive measures. Adaptation to climate change and risks takes place in a dynamic social,

economic, technological, biophysical, and political context that varies over time, location, and sector. This complex mix of conditions determines the capacity of systems to adapt (Smit and Pilifosova, (2001).Adger et al. (2007) identified five universal classifications of impediments to adaptation, they include financial, technological, cognitive, cultural, and institutional. Moser and Ekstrom (2010) enumerated communication and information. Moser and Ekstrom (2010), Jones and Boyd (2011) identified values, beliefs, and norms as well as physical and ecological factors have been recognized as impediments to adaptation **(**Burnham, 2014). Other researchers have also revealed that adaptive capacity occurs when a society is able to function collectively, referred to as social capital. A build up of social capital can give rise to both opportunities for and constraints to adaptive actions (Adger, 2003). Adaptive capacity is disputed by the outcome of access to resources, the manner in which resources are distributed among communities and the institutions that administer the resources (Adger, 2003). Identified social and cognitive barriers to adaptation comprises, the manner in which people understand risk and their self-efficacy, knowledge, emotions, and cultural factors such as place of fondness and identity (Adger et al., 2013). Present time research has precisely supported the notion that, the ability of smallholder households to conquer risk is influenced by circumstances such as access to crop insurance (Panda et al., 2013), the availability of credit (Bryan et al., 2013), local government and market based institutions (Wang et al., 2013), property ownership (Below et al., 2012), and access to technical information about agricultural management and climate change through agricultural extension

services (Bryan et al., 2013). All these circumstances augment adaptive capacity **(**Burnham, 2014). Lack of land and human capital are frequently echoed impediments to adaptive capacity (Piya et al., 2012; Young et al., 2009).

Grothmann and Patt (2005) argued that previous research has not fully taken into account the cognitive factors that impede individual adaptive actions. The model (model of proactive adaptation to climate change) developed by Grothmann and Patt (2005:5) identified two "bottlenecks" in an individual's decision-making process about undertaking adaptive actions. "Risk appraisal," is the first and consists of two components: (1) an individual's determination of the likelihood that he/she will be "exposed to some kind of threat" and (2) an individual's determination of the quantity of harm the threat will do to the possessions they value. "Adaptation appraisal," as the second bottleneck is seen as a person's appraisal of the optimistic and pessimistic outcome that would arise from embarking an action and their power to perform the action. Adaptation appraisal may arise provided that an individual's appraisal of the risk presented by climate change surpasses the lowest threshold.

The adaptation assessment procedure has three components: (1) an individual ascertains if an adaptive action will flourish in protecting them from the threat (i.e., "perceived adaptive efficacy"); (2) an individual ascertains if he/she has the ability to carry out the adaptive action (i.e., "perceived self-efficacy"); and (3) an individual ascertains the costs of taking the action (i.e., "perceived adaptation costs"). According to Grothmann and Patt (2005), perceived self-efficacy, in part, determines an individual's perceived adaptive capacity. Thus, a better

understanding of the factors that increase or inhibit perceived self-efficacy can help identify mechanisms to enhance how smallholders perceive their own adaptive capacity, possibly enhancing the likelihood they will adapt **(**Burnham, 2014).

2.13CLIMATE CHANGE ADAPTATION IN SUB SAHARAN AFRICA

Rural households across Sub-Saharan Africa dry lands are challenged by multiple stressors including droughts, floods, lack of ready markets for farm produce, high illiteracy and unfavorable economic development (Nielsen and Reenberg, 2010b). Even though adaptation may be prompted by climate events such as droughts and floods, it is important to recognize that these adaptation strategies are carried out in reaction to the multifaceted interaction of both climatic and non-climatic circumstances including political, economic and socio-environmental changes (Mertz et al., 2010). As such, it is very complex to assign exact adaptation strategies to climate variability. Notwithstanding, climate change (particularly drought) is the main threat to the livelihood of smallholder households (UNDP, 2007), hence, the ability of the small-scale farmers in Africa to endure drought is seen as crucial in coping with other non-climatic stressors.

Planned adaptation strategies employed by households to deal with drought in the Upper East Region can generally be categorized into two main classifications. The first classification is on-farm adaptation strategies that comprise a series of agricultural management practices that are implemented by households on the farm site intended to reduce the adverse impacts of climate variability. The second, off-farm adaptation strategies comprise activities that are implemented

outside the farm in order to minimize household's vulnerability to climate change (Antwi-Agyei, 2012).Households employ on-farm adaptation measures which comprise varying the planting time, early maturing varieties being planted, crop diversification, cultivating drought-tolerant crops, whiles off-farm adaptation measures include migration, depending on remittances from family and friends, receiving assistance from the government, changing nutrition and decreasing food consumption to manage climate change (Van der Geest, 2011; Antwi-Agyei, 2012; Aniah et al., 2014). This implies that the majority of the households uses coping strategies that are linked to livelihood diversification. Most of these households undertake several non-arable farming livelihood activities as efforts to forestall destitution owing to crop failure connected to climate change (particularly drought). Socio-economic factors such as gender, age, perceived wealth, educational level and land tenure system as well as agro-ecological setting could influence the choice of adaptation strategies by households (Antwi-Agyei, 2012).

Substantial researches have pointed to the benefit and use of livelihood diversification as an adaptation strategy to reduce food and livelihood insecurity risk accompanying climate change in many parts of Ghana and Africa at large (Paavola, 2008). In Ghana, Antwi-Agyei (2012) revealed that, households in vulnerable communities made use of a variety of non-farm livelihood activities which have diverse risk attributes as supplementary strategies to safeguard them against the adverse impacts of drought on livelihoods. Livelihood diversification has also been accounted in many parts of the world, including Nigeria (Dabi et al.,

2008), in Namibia (Newsham and Thomas 2011), in India (Datta and Singh, 2011), in Sri Lanka (Esham and Garforth, 2012) and Jamaica (Campbell et al., 2011).

Notwithstanding the potential of livelihood diversification in reducing risks, many researchers have pointed out possible weaknesses with the livelihood diversification as an adaptation strategy (Barrett and Swallow, 2005; Eriksen et al., 2005). Eriksen et al. (2005) argues that concentrating on one livelihood activity has the potential of yielding higher economic returns compared to households employing a number of livelihood activities. Additionally, Bryceson (2002) contested the presumed optimistic correlation between livelihood diversification and climate adaptation hence livelihood and food security enhancement. Ellis (1999 in Antwi-Agyei, 2012) contends that the loss of productive labor has been yet another possible weakness of livelihood diversification. He noted, for example, the migration of male youth (the able men,) as a result of livelihood diversification into far places/markets have the possibility of dwindling/reducing the local productive labor force which could subsequently reduce their economic returns.

2.14.1 RESILIENCE TO CLIMATE CHANGE

Conceptualizations of resilience in the ecology literature are two—one recognizes resilience as the capability of a system to revert to some original state (the steady state view point) while the second comprehends resilience as the capability of a system to not only spring back but change on to one of numerous possible new states (multiple stability domains) (Holling and Gunderson 2002). The limitation

of the steady state viewpoint is that it is not of necessity or desirability of a system, mainly a social system, to revert to a previous state as the status quo may be maladapted (Barnett and O'Neill 2010) or otherwise unfeasible in varying circumstances.

In contrast, the social scientists have proposed several alternative frameworks to understand the conception of resilience (Davidson 2010), the domineering connotation in the social science literature is synonymous to ecological resilience: "…the magnitude of disturbance that can be absorbed before a system changes to a radically different state as well as the capacity to self-organize and the capacity for adaptation to emerging circumstances" (Adger 2006:269: Newman, 2013:13). One valuable contribution of the emerging social science resilience framework is that it illuminates dynamic social-environmental processes and differences/interactions among nested scales. For example, resilience thinking provides the theoretical basis behind adaptive ecosystem management, a flexible, context-specific approach that is increasingly replacing the generalized, top-down, command-and-control management style that dominated much of 20th century environmental governance (Newman, 2013). Another advantage of this emerging resilience framework is that it integrates economic, ecological, and institutional perspectives (Gunderson and Holling 2002).

Serious shortcomings become apparent when trying to impose ecological notions of resilience of social systems as it overextends natural systems concepts at the expense of explaining social processes. In reality, social and natural sciences have developed separately and are based on different underlying assumptions and

methods. Hence, these realms of knowledge are not easily integrated, and the resilience paradigm sometimes overstates similarities between the systems. The critical point of contention is that, unlike ecology, social theory must account for the fact that human actors can consciously influence their socio-environmental contexts, have the ability to learn, and have the capacity to anticipate outcomes (Newman, 2013).Pathways to climate-resilience is development trajectories of combined adaptation and mitigation to accomplish the objective of sustainable development that assist in avoiding "dangerous anthropogenic interference with the climate system" as specified in Article 2 of the United Nations Framework Convention on Climate Change (UNFCCC). Climate-resilient pathways consist of two all-encompassing attributes: (1) actions to reduce climate change and its effects, including both mitigation and adaptation, and (2) actions to ensure that effective risk management institutions, strategies, and choices can be identified, implemented and sustained as an integrated part of the development process (Edenhofer et al., 2012).

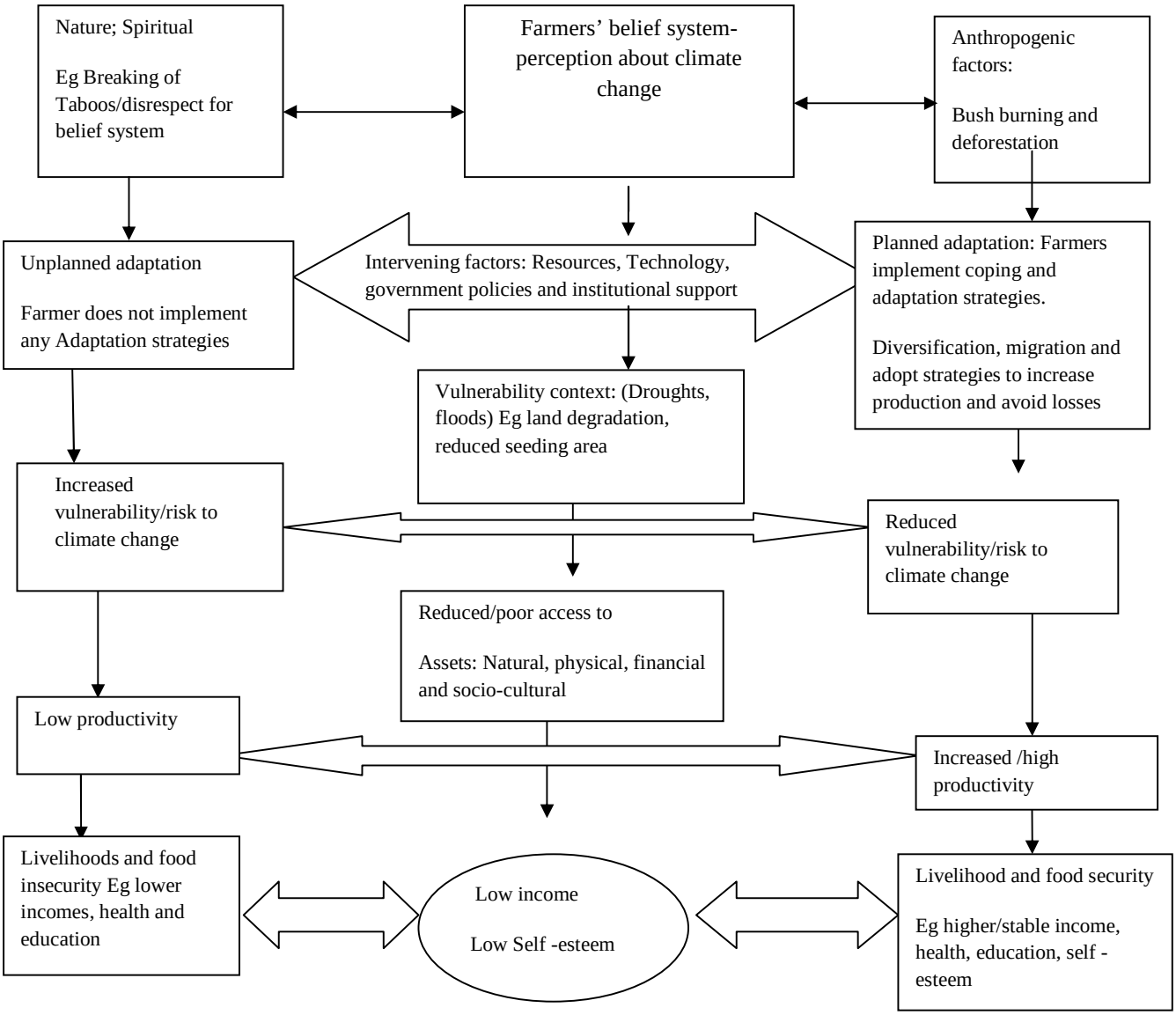
2.15 CONCEPTUAL FRAMEWORK ON THE DETERMINANTS OF ADAPTIVE CAPACITY

The conceptual framework argues that, farmers' belief system about climate change influences their coping and adaptation strategies. As argued by the Social representation theory, behavior is not causally related to beliefs rather, beliefs and behavior coexist as part of the system of meaning used to understand an issue (Moloney et al., 2014:2).Farmers' who believe (perceive) climate change as being caused by human/anthropogenic factors such as bush burning, fossil fuel emissions and deforestation usually implement planned adaptation strategies to

strengthen their resilience. This to a large extent will reduce their vulnerability/risk to climate change thereby increasing their productivity and subsequently secure livelihoods: higher and stable income, health and education.

On the other hand, farmers who believe that climate change is caused by "the will of the gods": i.e. spiritual, due to the misuse of supernatural power or disrespecting the life forces, for instances, ill use of resources which include having sexual intercourse on sacred sites, farm lands, shedding innocent blood on the earth which is considered holy, refusal to perform rituals, disrespect to the gods, ancestors and spirits(Aniah and Yelfaanibe, 2016) will not implement planned adaptation strategies (anticipatory adaptation).

FIGURE 2.2: CONCEPTUAL FRAMEWORK ON THE DETERMINANTS OF HOUSEHOLDS ADAPTIVE CAPACITY



Source: This study.

They will rely on the gods through the performance of sacrifices, pouring of libations and congregational prayers to avert the situation (e.g. droughts). This will increase such households/farmers vulnerability/risk to climate variability. Their productivity will be low and subsequently results in livelihood and food insecurity; lower incomes, health and education.

2.16 CONCLUSION

The literature reviewed has established that climate change presents negative effects on livelihoods of smallholder households. The literature has attempted establishing different theoretical frameworks to assess the vulnerability of livelihoods to climate change. Although SSA is anticipated to be severely affected by climate change, specific case studies highlighting the extent of vulnerability of livelihoods to climate change is lacking. This knowledge gap hampers proper understanding of the determinants of adaptive capacity of households to climate variability. For instance, the adaptive capacity of farming communities is often ignored, hence, there is the need for this study to be conducted to clearly understand the factors that determines the adaptive capacity of smallholder households to climate variability. These gaps are addressed in this thesis by examining the factors that determines the adaptive capacity of smallholder households and their indigenous adaptation strategies employed to ameliorate the negative effects of climate variability.

CHAPTER THREE

3.0 PROFILE OF THE STUDY AREA AND RESEARCH METHODOLOGY

This chapter presents an overview of the profiles of the Bongo District. It also covers the methodology that was employed to gather the relevant data for this study. The methodology focused mainly on the research design, the concept of population and sampling, sources and methods of data collection and processing, as well as analysis and management of field data.

3.1 PROFILE OF THE BONGO DISTRICT

The study will be conducted in the Bongo district of the Upper East Region of Ghana. The Bongo district is one of the 13 administrative and political districts of the Upper East Region of Ghana. The district spans a total land area of 488km^2 which constitutes approximately 5.52% of the total landmass of the region. The Bongo district shares borders with Burkina Faso to the North, Bolgatanga Municipal to the South West, Nabdam District to the South East and Kassena-Nankana West District to the West. It lies between longitudes 0.45^o W and latitude 10.50^o N to 11.09^{o}N. It lies within the onchocerciasis-freed zone. The predominant economic activity in the district is subsistence farming. According to the 2010 population and housing census of Ghana, Bongo district has a total population of 84, 545 people which represents 0.34% of the Ghanaian population. 48.8% of the total population are males and 72% live in rural areas (GSS, 2013).

The Bongo district (vulnerable district) lies within the Sudan Savannah Ecological Zone. The Bongo district, like many other districts in Northern Ghana experiences a uni-modal rainfall pattern from May/June–Sept/Oct, which constitutes the main

farming season (Dickson and Benneh, 1988). The average annual rainfall ranges from 800mm–1000mm, with maximum temperatures of 35^{o}C and mean monthly minimum temperature of 21^{o}C and maximum temperatures of 35^{o}C (EPA, 2003) The Sudan Savannah Zone is characterized by potential evapo-transpiration of 1652mm per annum and relative humidity of 61% (EPA, 2003; Antwi-Agyei, 2012). Though, tree cover is low, the major trees of economic importance in the district include the baobab (Adansonia digitata), the dawadawa tree (Parkia biglobosa), shea tree (Vitellaria paradoxa), and the fig tree (Ficus spp.). The major crops grown in this district include sorghum (Sorghum bicolor), millet (Pennisetum glaucum), rice (Oryza sativa), groundnut (Arachis hypogea), guinea corn (Sorghum vulgare) and maize (Zea mays) (MoFA, 1997; Aniah et al, 2014b; Antwi-Agyei, 2012). The ethnic composition is mainly Frafra.

3.2 SOIL AND DRAINAGE

The district's soil is "upland soil" mainly developed from granite rocks. It is shallow and low in soil fertility, weak with low organic matter content, and predominantly coarse textured. Erosion is a major problem in the region. Valley areas have soils ranging from sandy loams to salty clays. They have higher natural fertility, but are more difficult to till and are prone to seasonal water logging and floods. Drainage is mainly by the White and Red Volta and Sissili Rivers (GSS, 2013).

3.3VEGETATION AND CLIMATE

The natural vegetation is that of the savannah woodland, characterized by short scattered drought-resistant trees and grass that gets burnt by bushfire or scorched

by the sun during the long dry season. Human interference with ecology is significant, resulting in near semi-arid conditions. The most common economic fruit trees are the shea nut, dawadawa, baobab and acacia (GSS, 2013).

The climate is characterized by one rainy season from May/June to September/October. The mean annual rainfall during this period is between 800 mm and 1,100 mm. The rainfall is erratic spatially and in duration. There is a long spell of dry season from November to mid-February, characterized by cold, dry and dusty Harmattan winds. Temperatures during this period can be as low as 14 degrees centigrade at night, but can go to more than 35 degrees centigrade during the daytime (GSS, 2013).

Humidity is, however, very low, making the daytime high temperature less uncomfortable. The region is entirely within the “meningitis belt” of Africa. It is also within the onchocerciasis zone, but with the control of the disease, large areas of previously abandoned farmlands have been declared suitable for settlement and farming (GSS, 2013).

3.4 LIVELIHOOD ACTIVITIES IN THE BONGO DISTRICT

According to the GSS, (2013), agriculture, hunting and forestry are the main economic activities in the Bongo district of the UER. About eighty percent (80%) of the economically active population engages in agriculture. The main produce is millet, guinea-corn, maize, groundnut, beans, sorghum and dry season tomatoes and onions. Livestock and poultry production are also important sources of livelihood for the people. There are two main irrigation projects in the UER, the Vea Project in Bongo covering 850 hectares and the Tono Project in Navrongo

covering 2,490 hectares. Altogether they provide employment to about 6,000 small-scale farmers. Other water-retaining structures (dams and dugouts) provide water for both domestic and agricultural purposes (GSS, 2013).Industrial activity in the region is generally low, with only one industry in operation at the moment. This is the cotton ginnery at Pusu-Namongo (near Bolgatanga). Other industrial establishments are the Tomato Canning Factory (GIHOC) at Pwalugu, the Meat Processing Factory (GIHOC) at Zuarungu and the Rice Mills at Bolgatanga, which are not operational and have been earmarked for divestiture (GSS, 2013).

3.5 GENERAL APPROACH TO THE STUDY

A researcher needs a hold of the enormous variety of research methodologies so as to choose the highly suitable design or mixture of designs most appropriate for a specific study (Groenewald, 2004). This observation validates with that of Meetoo and Temple (2003) who contend that, applying diverse methods permit the researcher to explore the diverse means of approaches that are built up. Again, it aids to detect data discrepancies (Twumasi, 2001). Diverse methods may be used to confirm each other, but they could be complementary or contradictory. Complementarity does not simply suggest that findings must be identical and contradictory does not also suggest that the findings should be different (Meetoo and Temple, 2003).

A rising number of researchers in the diverse fields of behavioral and social sciences have been supporting the mixture of qualitative and quantitative approaches to the study of social occurrence. What has become known as the mixed methodology was born out of this new movement. Theoretically, this

movement has moved beyond the current paradigm conflict by presenting a rational and feasible option. This makes use of realistic method and systems of attitude. Its rationale of investigation includes the use of induction (or discovery of patterns), deduction (testing of theories and hypothesis), and abduction - revealing and depending on the superlative set of clarifications for understanding the research results (Johnson and Onwuegbuzie, 2004). According to Johnson and Onwuegbuzie, (2004), the mixed methodology approach is normally the category of research in which the researcher combines or mixes qualitative and quantitative research approaches into a single study. In the opinion of Kellaher et al., (1990:121; in Yelfaanibe, 2011), both quantitative and qualitative data can cross validate each other around "a common reference point". Qualitative methods have traditionally been described as interpretative or phenomenological whereas quantitative methods are associated with positivist approaches (Meetoo and Temple, 2003). Recognizing that all methods have limitations, researchers felt that biases inherent in any single method could neutralize or cancel the bias of other methods. This gave rise to a triangulation of data sources -a means of seeking convergence across qualitative and quantitative methods (Creswell, 2009). A vital distinction between qualitative and quantitative methods is their flexibility. Pertaining to quantitative methods via questionnaires and surveys, the researcher asks all respondents in the same sequence identical questions. The classifications of responses from which respondents may select are –closed ended or fixed/rigid, thus it is not flexible (Mack et al., 2005). On the other hand, qualitative methods are normally more flexible since qualitative methods permit

superior spontaneity and adaptation of the interaction between the researcher and the study participant(s). Qualitative methods ask mostly ―open-ended questions that are not necessarily worded in precisely the same way with each participant. Open-ended questions have the tendency to evoke responses that are importantly prominent to the participant and unexpected by the researcher. Qualitative methods are also rich and explanatory in nature (Creswell, 2009). As such, participants are at liberty to answer in their own words with open-ended questions, and these responses tend to be more complicated and probing than simply ―yes or no ― like the case with quantitative methods. Open-ended questions also permit the researcher the flexibility to probe preliminary participant responses by asking follow-up questions (such as 'why' or 'how'), listening carefully to what they say, engaging with them according to their individual personalities and styles, and using further probes to inspire them to elaborate on their answers (Creswell, 2009). One of the strengths often put forward for using qualitative methods include the fact that, they permit the researcher to deliberate the opinions of research participants and to reflect on the influence of their own social location on their perspective (Sarantakos, 2005:45; Meetoo and Temple, 2003). Mack et al. (2005) and Sarantakos (2005) are of the view that, in qualitative research, participants have the chance to answer more elaborately and in greater detail than is normally the case with quantitative methods. In turn, what the participants say, the researcher has the chance and privilege to respond directly and without delay to subsequent questions tailoring of information the

participant has previously provided. An important contribution of this method is the culturally specific and contextually rich data that it produces.

This research will combine qualitative method (observation, FGD's and interviews) with quantitative method - traditional survey. The researcher acknowledges that both qualitative and quantitative methods have limitations and biases inherent in one method could offset biases in other method. Creswell (2003) and Slee et al. (2006) indicated that, mixed research approach minimizes some of the limitations of using a single method because quantitative or qualitative research methods are not sufficient to address the complex social phenomena when they are treated independently. This implies that, qualitative methods suffer from the limitations of generalizing the results beyond the specific research area and go through subjectivity during data collection and analysis (Berlie, 2013). The quantitative method, on the other hand, always fail to capture an in-depth understanding of intra and inter-household dynamics, especially when the household head is in a position to speak on behalf of his family and/or neighbors (Tsegaye, 2012). Hence, using the epistemology of mixed research approach in a case study research design helps to address the research questions and to check the validity of the results (Habtemariam, 2003). When quantitative and qualitative research methods are used in combination in one study, they complement each other and allow for a more complete analysis of the research problem (Migiro and Magangi, 2011).

3. 6 THE RESEARCH DESIGN AND PROCESSES

The selection of appropriate, suitable design of a research is instituted in the researcher's own capability to recognize and isolate the research issues and apply suitable methods, tools and techniques to enable him/her reach rational conclusion. The study will employ concurrent mixed research methods for the grounds that both quantitative and qualitative data will be collected simultaneously and the results will be comprehensive during the analysis. Within the framework of mixed methodologies, this research is therefore designed to blend a case study and survey tools and techniques in order to gather suitable data. The case study method generally pictures a phenomenon under investigation as a unique and exceptional case within a given physical, socio-cultural, economic and political context. In the view of Yin et al. (2006), a case study is a comprehensive understanding of complex instances obtained through detail description and analysis of a whole or a part. Comprehensive means obtaining a complete picture of what is going on at a moment, while, extensive description and analysis refer to the involvement of rich information that comes from multiple data sources such as interviews, observation, survey questionnaire and document analysis (Yin, 2002). The term whole, means the size of the instances that can be referred to, as small as one individual, or as large as a community, a region, a nation or larger geographical area in a case study (Singh, 2006; Maree, 2010). Sarantakos (2005) and Creswell (2009) suggested that, in case studies, the researcher explores in depth the phenomena under study and collects detailed information over a sustained period of time. Therefore, the Bongo district is

chosen to investigate the multifaceted problems rural communities encounter in achieving household livelihood security. The case study method is chosen because the research seeks to gather concrete data in order to clarify patterns and relationships under specific context. Case study could be quantitative and qualitative methods in a single study. According to Kohn (1997), it is common for researchers to combine case studies with quantitative analyses that use larger data sets. Bryman (2008) also showed that case study could examine the mixing of quantitative and qualitative research methods within a single study. Applying a combination of research methods in the livelihood security study is believed to be imperative, as it is the most appropriate way to explore the complex and multi-dimensional nature of rural livelihoods, vulnerability to food insecurity, climate change and households' response to the predicaments (Berlie, 2013). Yelfaanibe (2011), affirmed that, cases exist within their given contexts and the researcher needs to search for clarifications concerning certain events and processes, how they occur, and why they occur the way they do, in each given context. This study views indigenous adaptation strategies within different cultural environments and local settings as well as different institutional arrangements as distinctive. In view of the above assertions, a multiple case study approach becomes more relevant as the principle of the peculiarity of facts and circumstances surrounding each case category will be more appropriately studied in-depth. The complex interaction of the various actors and processes in each case study will also be easily identified. Sarantakos (2005) observed that an advantage of a (multiple) case study is that the method permits the researcher to have comprehensive coverage and in-depth

probing, collect a rich mix data which complement each other and lastly, the researcher recognizes, understands and appreciate the complexities of factors at work by bringing together all the cases under investigation in a cross case analysis.

Throughout the research journey, the study made sure it maximizes the benefits of the approach which generally seeks to offer in a variety of ways. By using a case study method, I gained deeper knowledge and insights on the diversity of the worldviews of local communities and their epistemologies of the intricate nature of relationships between people, their institutions (both formal and informal) and their adaptation strategies to climate change as a livelihood strategy. These constituted a community-wide and cultural specific type of data at three (3) levels of data collection—community (using FGD's), intermediate community (using FGD's and key informant interviews involving formal/informal community institutions) and individuals/household farmers (using survey questionnaires and key informant interviews) as they will be encountered during the fieldwork.

According to Sarantakos (2005) and Creswell (2009), a survey normally enables the researcher to infer the corresponding characteristics in a population or the opinions of a population by studying a sample of that population with the aim of generalizing from the sample to the population. In view of this, individuals from the different cultural backgrounds will be sampled and interviewed. It is intended to ascertain information on individuals within the context of a locality and changing cultural practices in an arena of varied livelihood and adaptation options. Thus, a synthesis of case study and survey research data provides an

opportunity to collate and compare strategies at both the individual and community level standpoints by inferring from the different data sources and making informed judgments. It also provides a basis for identifying points of departure between individual actions and the general community worldview and belief system as well as provided some opportunities for exploring the reasons why some individuals may depart from the general community norm(s).

3.7.0 SELECTION OF SITES AND INFORMANTS

Diverse sampling methods were engaged in this research project subject to the kind and source of information required. Earlier studies profiled the UER as the most vulnerable in Ghana hence its selection (Antwi-Agyei, 2012:117).The selection of the studied district (the most vulnerable district) in the Upper East Region was based on the analysis of rainfall and crop yield/production data. Expert and stakeholder interviews were used to select study communities (Bryman and Bell, 2007). Purposive sampling was used to select key informants and participants for FGDs.

3.7.1 SELECTION OF THE STUDY DISTRICT

This research conducted a quantitative vulnerability appraisal of drought to crop production to detect districts in the Upper East Region of Ghana which have been "vulnerable" in time past (described as the times when relatively minor perturbations in rainfall had large impacts on crop yields) (Simulation et al., 2009; Antwi-Agyei, 2012). The appraisal revealed that, within Ghana, the UE/R profiled the topmost mean vulnerability index for the period 2007 to 2010and the Bongo district the most vulnerable district in the UE/R which confirms previous

studies (Antwi-Agyei, 2012). Therefore, the appraisal tinted the Bongo district as the most vulnerable districts in the UE/R of Ghana based on the scrutiny of rainfall and production/yields data obtained from MoFA (from 2000 to 2014).

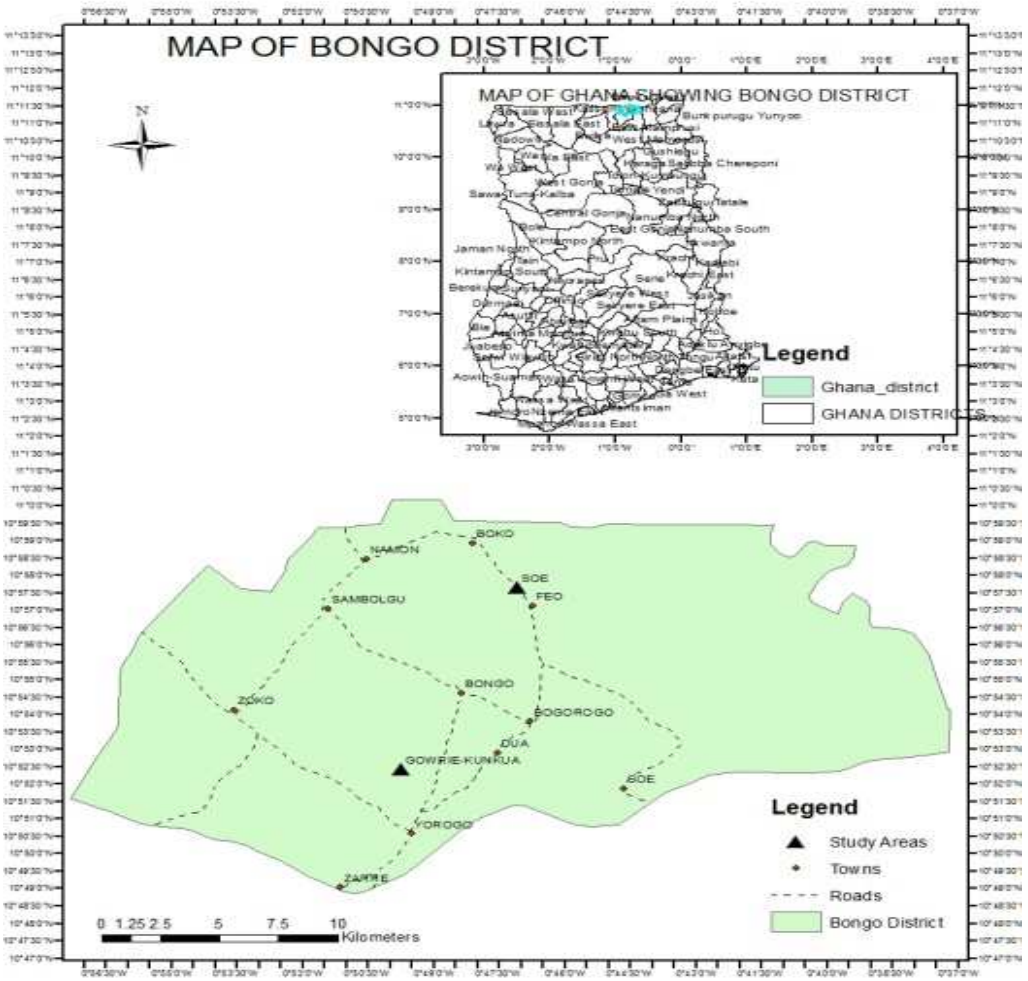
3.7.2 SELECTION OF STUDY COMMUNITIES

After selection of the district, a pilot study was conducted and selected specific communities. Stakeholder and expert interviews were conducted by organizing meetings with the MoFA director at the Bongo district, agriculture extension officers and NGOs working with rural communities in the district (e.g. SUFAEP, CID, and NABOCADO). Grounded on available information, the following criteria were used for the selection of specific farming communities; (i) the community should have been or is being exposed to some sort of climate anomaly (particularly drought); (ii) it should have characteristics that could be researched in line with the study's objectives; and (iii) the community must be prepared to partake in the study during its entire period. Based on consultation with local experts and advice that was provided by agricultural extension officers, stakeholders such as NGOs, and local census data where this exists, two (2) specific communities via vulnerable (Gowrie Kunkua) and resilient (Soe Kabre) farming communities were selected from the district for the study. These communities were selected because, according to the experts and stakeholders, they were exposed to some degree of climate anomaly (i.e. Drought) and have either developed appropriate innovative strategies to deal with these or have not been able to deal with this climate anomaly. The two (2) communities were selected from the district to allow for the opportunity for in-depth qualitative

analysis. Selected communities across district included Gowrie Kunkua and Soe Kabre communities.

One of the selected communities (Gowrie Kunkua) has a **Community Farmer field school/model farm:** This was a project that was jointly initiated by SUFAEP and the Harstra foundation of the Netherlands. The research ascertained the community people's views on such interventions vis-à-vis their potential for reducing livelihood insecurity to climate change.

Figure 3.1 Map showing the study communities in the Bongo district



Source: This study

3.7.3 SELECTION OF RESEARCH PARTICIPANTS

Household questionnaire surveys were sampled based on a simple random sample. A total of 75 households were randomly selected and 75 questionnaires were administered in each of the two (2) selected farming communities, giving a total sample of 150 households/survey questionnaires. In each community, purposive selection was used to identify traditional informal institutions (Chiefs/Elders, Tindaanas, Soothsayers and Diviners), government and NGOs that were working either directly or indirectly in climate change mitigation and/or adaptation or a related area were selected. Apart from these people, only native community people who have lived in their respective communities for at least 15 years were recruited in each community for interviews. To ensure that women are not left out in the process of administering the questionnaire, I specifically asked for women to be recruited and interviewed during the process of the data collection.

3.8 DATA SOURCES

Both primary and secondary sources were used to gather data. Leedy (1997:101) defines primary data, as the data that lie closest to the source of the "ultimate truth" underlying a phenomenon. Beyond the region of primary data lies the region of secondary data (Yelfaanibe, 2011). Hence, the primary sources were the individuals and groups who were interviewed using various tools and techniques at the different levels of the data collection process. The secondary sources, however, was drawn from documented evidence which included normally books, journals, publications, office reports and profiles of districts as

well as speeches from important personalities relating to the subject. The internet was also used.

3.9 METHODS OF DATA COLLECTION

For the purpose of obtaining primary data, participatory rural appraisal (PRA) techniques such as focus group discussions and interviews were used to collect data from the respondents**.** PRA tools have been largely recommended by many scholars on the grounds that they are convenient for doing research, particularly in rural areas and they also permit the researcher to adapt his/her research tools or even invent new ones in the field during the process of data collection (Millar and Apusigah, 2003; Yelfaanibe, 2011). Thus, it is this flexibility that gave the approach an added advantage as compared to other conventional methods for collecting information in the field. Its flexibility equally made it appropriate for collecting both qualitative and quantitative data. The main tools used in the field were semi-structured questionnaire, observation and the checklists and interview guides for focus group discussions (FGD's) and key informant interviews (KIIs) respectively. The applications of these tools are discussed in the subsequent units of these sections.

3.9.1 QUESTIONNAIRES

Questionnaires were used to collect data that assessed the diversity of individuals both within and across the socio-cultural, economic and political spheres in the research locations. Questionnaires were also used to carry out interviews using other methods. It is often argued that questionnaires are a research instrument of quantitative rather than qualitative investigators. But as Sarantakos (2005:262)

notes —this is particularly so for standardized questionnaires which are mostly used for large survey. Qualitative researchers on the other hand, employ unregulated and unstructured questionnaires rather than standardized questionnaires. Unregulated and unstructured questionnaires, containing open-ended questions and permitting subjectivity and flexibility in the way questions are constructed and answered, are in accord not only with epistemological principles but also with common practice (Sarantakos, 2005). As a method, questionnaires are less expensive, produce quick results and also offer stable, consistent and uniform measures which are free of variation particularly within groups. A serious limitation of this method, however, is that it does not create room for probing, prompting and clarification of questions into much detail as provided by other methods. In each of the communities, semi-structured questionnaires were administered in order to collect data from individual household/respondents. The total number of households in the two (2) communities was about 400, for a sample population of about 400, using the sample size table at 95% confidence level and a 5 % margin of error, the sample was 146 households (Gang, 1999; Barrett et al., 2001). For fear of missing data, 150 sample size was determined to fill the questionnaire. To support this view, Naing et al. (2006) indicated that it is wise to oversample 10% - 20% in case there is missing data. In all, 150 household surveys were conducted in the two (2) study communities (75 questionnaires in each). Although random sampling was used, factors such as age, gender, and experience of the farmers were considered in order to have a representative of the various social groups within each community

and to ensure people with in-depth knowledge on the theme are recruited (the aged) hence a minimum of 30 years was the age limit.

3.9.2 FOCUS GROUP DISCUSSIONS

According to Mack et al. (2005), focus groups are effective in eliciting data on the cultural norms of a group and in generating broad overviews of issues of concern to the cultural groups or subgroups represented. They are a qualitative data collection method effective in helping researchers learn the social norms of a community or subgroup, as well as the range of perspectives that exist within that community or subgroup. It is a method in which one or two researchers and several participants, usually numbering between six (6) to twelve (12) people, meet as a group to discuss a given research topic. These sessions were usually tape recorded, and sometimes videotaped. During focus group discussions, the researcher (the moderator) led the discussion by asking participants to respond to open-ended questions – that is, questions that require an in-depth response rather than a single phrase or simple ―yes or no ― answer for detailed notes to be taken on the discussion. In this research, six (6) FGDs were conducted, three (3) at Gowrie Kunkua and three (3) at Soe Kabre). Discussions were audio-recorded and field notes were taken at the same time, so as to capture and report the details of the discussions as accurately as possible. A principal advantage of FGDs was that, they yielded a large amount of information over a relatively short period of time and because it seeks to illuminate group opinion, the method is especially well suited for social-behavioral and cultural specific research that will be used to develop and measure interventions that meet the needs of a given population

(Mack et al., 2005:64). Another advantage of the focus group is that, it enables the research to collect information about a general or communal opinion of the study population.

The main concern was to have a guided discussion with local community representatives on local adaptation practices, worldviews, and perceptions about changes in rainfall and temperature, and local epistemologies and also to explore how culture and spirituality hinges on issues of climate change and its related hazards. The people's perceptions and relationship with external interventionists were also discussed.

3.9.3 KEY INFORMANT INTERVIEWS

Key informant interviews were used to target individuals who exhibit considerable understanding and familiarity on climate change and indigenous adaptation strategies to increase household livelihood were selected for further interviews. A total of fifteen (15) key informant interviews were conducted. These interviews were complemented by field visits to model farms and farmer field schools (SUFAEP Farmer Field School). Community leaders such as the Tindaana, chiefs, elders and assembly members as well as chief/model farmers as well as institutional heads such as MoFA director, EPA and GMA were interviewed. These interviews permitted comprehensive and detailed discussion and substantiation/authentication of the focal issues that were tainted by the household questionnaire survey and focus group discussions. Key informant interviews were conducted on an individual basis and it was face to face. During

the interviews, the consent of participants was sought before audio-recording their views as they narrated them.

3.9.4 DIRECT OBSERVATION

Observation enables a researcher to study all observable social phenomena, so long as such phenomena are accessible (Sarantakos, 2005). The advantages associated with observation are that, it offers first hand information without relying on the reports of others, especially when respondents are unable or unwilling to offer information (Sarantakos, 2005). Direct observations were used in the field to observe the impacts of climate change on the livelihoods of households in the Bongo district. Direct observations were used to gather data on the susceptibility of agriculture, water resources and infrastructure to climate change extremes and impacts. Some of the phenomena observed were marketing activities in market places, settlement patterns, agricultural activities (planting, weeding and harvesting), private and communal grazing lands, water points, natural resources degradation, water-harvesting techniques, and available wild fruits, various social and cultural occasions and rituals relating to feasts, wedding and funeral ceremonies. Direct observation enabled the researcher to view/watch and take photographs of the impacts of drought/floods on agriculture and the impacts of climate change on water bodies (Vea dam) and other catchment areas. Direct observations again were used to collect primary information on household adaptation strategies and coping mechanism in the Bongo district.

3.10 DATA ANALYSIS

Panneerselvam (2004:14) and Yelfaanibe (2011) asserted that ―after data is gathered, proper tools and techniques should be used for classification and analysis of data. For this research, both descriptive and inferential tools and techniques were used to present and analyze the results. According to Osuala (2005), descriptive tools and techniques of research are that which specify the nature of a given phenomena—be that phenomena simple or complex. But, the need for systematic ways of telling what a situation is, means that the situation is no longer simple (Osuala, 2005).

During the fieldwork, interviews and focus group discussions were audio-recorded and notes were also taken with the help of a field assistant. After each field visit, the reports were written based on the field notes and all the audio recordings were transcribed in the exact words of the respondents. These were then classified into themes under the different case categories and synthesized using descriptive narratives to reflect the collective worldview of communities as the basis for evaluating adaptation strategies within and outside communities. According to Osuala (2005:99), the use of descriptive tools in assessing a situation is a prerequisite to inferences and generalization. Literally, the theory of knowledge which serves to decide how social phenomena should be studied is essentially every researcher‘s epistemology (Sarantakos, 2005; Creswell, 2009). One way to achieve this is to conceive of data as being contained within the perspectives of people that were involved in the phenomenon and those who were being studied within the context of the phenomenon as representatives from the

group and must be engaged at their different capacities in relation to the problem under investigation to collect the requisite data (Groenewald, 2004). This notion was used as a framework to guide the analysis of qualitative data.

The quantitative data analysis, on the other hand, was a process of tabulating, interpreting and summarizing empirical and numerical data for the purpose of describing or generalizing the population from the samples. Upon completion of the data collection, the data were coded, edited, digitized and entered into the statistical package SPSS (Statistical Package for Social Scientists) and analyzed using descriptive and inferential statistics such as frequencies, percentages and tables. Inferential statistics such as paired t- test, one way ANOVA, chi-square and bivariate correlations were used to investigate the relationships and differences of the variables. In general, to analyze the quantitative data, descriptive statistics and inferential statistics (bivariate correlation, linear regression and binary logistic regression modeling) were used. To determine the magnitude of climatic variability in the Bongo district, a time series analysis was conducted for temperature and rainfall information obtained from the Ghana Meteorological Agency spanning the period 1982 -2012. The time series analysis was done using excel. The time series analysis has validated assertions via oral history as well as climate timelines that were constructed during focus group discussions with households/farmers. In addition, time series analysis was used to estimate linear trends of yields to establish the vulnerability of crop yield to climate variability.

The logistic regression model was used for the identification of determinants of adaptive capacity of farm households in the Bongo district. Maddison (2006), Seo and Mendelsohn (2008) and Hassan and Nhemachena (2008) studied the impact of climate change and factors affecting the adaptation measures in livestock and mixed crop livestock production. There were several factors that accounted for the practicing of different adaptation strategies at the farm level. Decision to practice different adaptation strategies might be influenced by several socioeconomic, demographic, institutional and financial conditions (Deressa et al., 2009; Regmi, 2010).

The probability of adopting adaptation strategies was expressed as,

$P(Y_i = 1) = P_i = \frac{1}{1+\exp^{-z}}$ ………………………………………………….. 1

This can be operationalized as,

Logit $P(Y_i^*) = \beta_0 + \sum_{i=1}^{n} \beta_0 X_i + \varepsilon_i$

……………………………………………2

Logit $(Y_i^* = Adopt = 1) = \gamma' K + \varepsilon_i$

Thus, the binary logit regression model is expressed as;

$Y(Adopt = 1) = \beta_0 + \beta_1.sex_i + \beta_2.familySize_i + \beta_3.landSize_i + \beta_4.training_i + \beta_5.education_i + \beta_6.credit_i + \beta_7.climateInfo_i + \beta_8.farmingExperience_i + \beta_9.beliefSystem_i + \beta_{10}age_i + \beta_{11}memberOrg_i \varepsilon_i$ ……………3

Y_i^* = a latent variable representing the propensity of a farm household i to adopt adaptation strategy (1 if farmer adopt, and 0 otherwise)

β_0 = a constant term

X_i = K= the vector of farm households' asset endowments, household characteristics and location variable that influence the adoption decision (Set of variables explaining the adoption decision including respondent's perception of climate change, rainfall and exposure)

β_i= parameters to be estimated

Exp (β_i) indicates the odds ratio for a household having characteristics i versus not having I

ε_i = error term of the i^{th} farm households

i = 1, 2, 3 … n farm households.

3.9 CONCLUSION

This chapter has described how the study communities that will participate in this research will be selected. The research design as well as the use of participatory methods in this study has been justified. The use of a mixed-method approach allows validation and deepening of understanding of the main issues involved in the vulnerability of farming systems and livelihoods to climate change through triangulation, thus providing a significantly richer understanding of the different dimensions of the problem through its exploration across scales. Combining different methods with valuable insights from local farmers provides local insights that will enhance learning by the researcher and members of the study communities.

CHAPTER 4

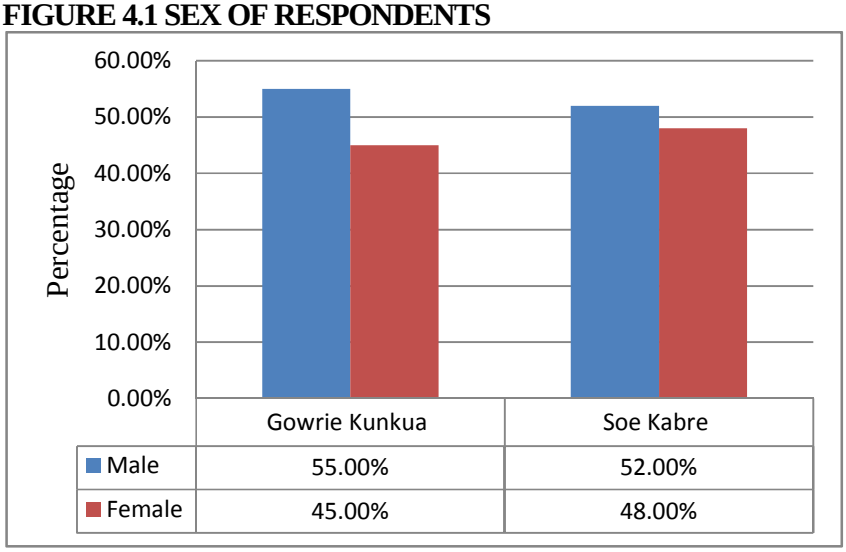
4.0 SOCIO-DEMOGRAPHIC VARIABLES AND PERCEPTION OF CLIMATE CHANGE

This chapter presents and discusses the perceptions of the research participants in the field. The chapter begins with some analysis of the socio-demographic characteristics of the research participants. The influences of key variables such as the sex, age, education, household size and religion on the adaptation decision were discussed. These variables have implications on household adaptation practices and they are used as background information for the succeeding chapters. This is followed by a presentation and discussion on households' perception about changes in rainfall and temperature.

4.1.1 SEX DISTRIBUTION OF RESPONDENTS

Gender, defined as a social construction or ascription of what constitute a male or female is vital in climate change adaptation and livelihood security deliberations of rural communities.

FIGURE 4.1 SEX OF RESPONDENTS



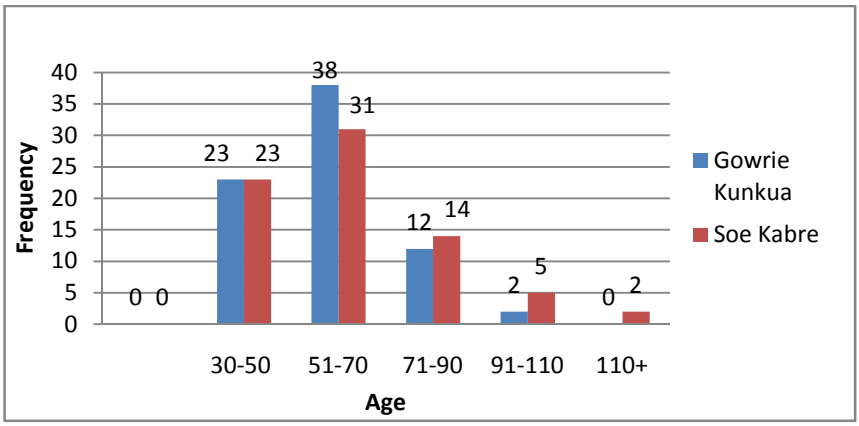
Source: Field Survey, July 2015.

With regards to the sex of respondents as shown in Figure 4.1, the survey revealed that, the vulnerable community (Gowrie Kunkua) had 55% of (or 41) sampled households being males and 45% of (or 34) of sampled households being females. The resilient community (Soe Kabre) had 52% of (or 39) households being male and 48 % of (or 36) households being females. This gives a total of 80 (53%) males and 70 (47%) females. Insofar as sex ratio of the household is concerned, males and females are relatively equivalent with minor differences in which males are greater than females by 6%. GSS 2013 indicated that male births outnumber female births, but the mortality rates for females have a tendency to be lower than that of males throughout the lifespan, especially at advanced ages. Therefore, the sex ratio of this study does not reflect the expected pattern. The high percentage of males over females are contrary to the findings of GSS (2013) which indicated that females are more than males in the Bongo district with 48.8% of the total population being males and 51.2% being females. In the communities where this research was conducted, patriarchy is the norm, thus an impartial and rational illustration of the opinions of women have a tendency to reveal the means by which gender is showcased in climate change adaptation and coping range of small holder households. The study revealed that, the sex of a respondent did not have any influence on adaptation decisions of the households statistically significant (at $P < 0.05$).

4.1.2 AGE DISTRIBUTION OF RESPONDENTS

Age is a reasonable component that determines the deepness and profundity of one's wisdom or knowledge pertaining to climate change adaptation and coping measures as well as traditional knowledge system and practice.

FIGURE 4.2: AGE DISTRIBUTION OF RESPONDENTS



Source: Field Survey, July 2015.

Since climate events take a good number of years to detect and notice, it was imperative to target respondents or households that lived for at least the past 30 years and more. The postulation was that the aged (more years a person lived) have the tendency to retain and possess a great deal of valuable form of knowledge that reflects the diverse cultural belief and practices that shapes the worldview and coping range than the young. Also, the aged will be in a better position to give an accurate and detail information about the climate and its trend over three decades ago. The aged during interviews all indicated that, indigenous knowledge, belief and practices are gradually eroding away due to increasing insurgence of Western values, education and migration from the study

communities and for these reasons, the younger generation is denied of vital information and rich cultural practices, knowledge and belief.

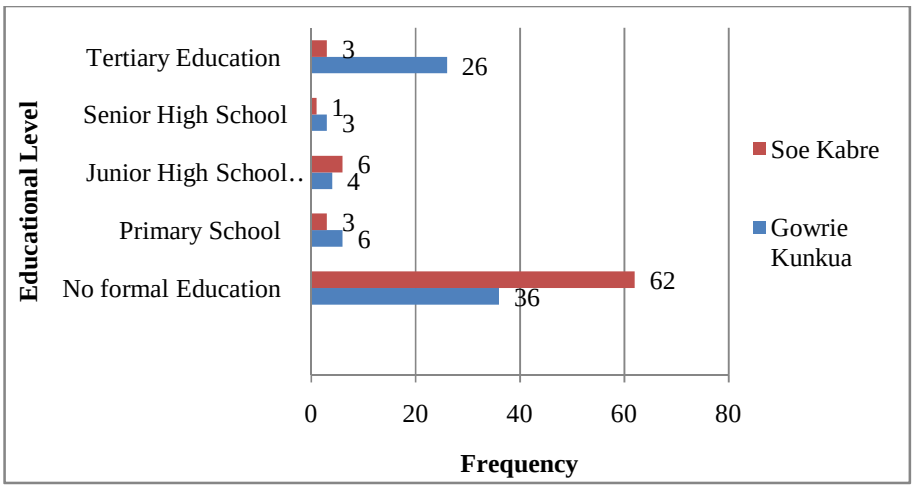
The age structure of the studied households showed that about 30.7% (or 23 respondents) in the vulnerable community was between the age of 30-50 years and none was more than 110+ years. For the resilient community, 30.7% of the respondents (or 23) were between the age category 30-50 years and 2.7% were above 110+ as shown in Figure 4.2. While considering the two sexes separately, 35% of the males were between the age group of 30-50 and 25.7% of the female respondents were between the ages 30-50. Significant age differences were observed between the two studied communities. The minimum age of the sample household was 34 years and the maximum age was 116. Studies conducted in other part of the world (see Ayalneh et al., 2003; Sepahvand, 2009) affirmed that, the higher the age of a household, the better the chances of becoming non-poor. This is attributed to the fact that, older households have gained considerable farming experience. This assertion is consistent with the research findings which revealed a positive relationship (at $p < 0.001$) with a bivariate correlation that, the older a household, the higher the farming experience and hence the lower the vulnerability. This is particularly true because, the research revealed that, young and female headed households were more exposed to vulnerability to livelihood insecure since such households lack farming experience and adequate land for cultivation. The survey , revealed that about 39.1% of the young household (between the age group of 30-50) farm/possess the land size or holding of 1- 5 acres, while 43% of female headed households own land/farm holding of 1-

5acres. The young headed households have more land holding/size compared to the female headed households; this is due to the patriarchal nature of the study communities.

4.1.3 LEVEL OF EDUCATION

The educational status of the households revealed that, the vulnerable community had a high literacy rate that the resilient community.

FIGURE 4.3: EDUCATIONAL LEVEL OF RESPONDENTS



Source: Field Survey, July 2015.

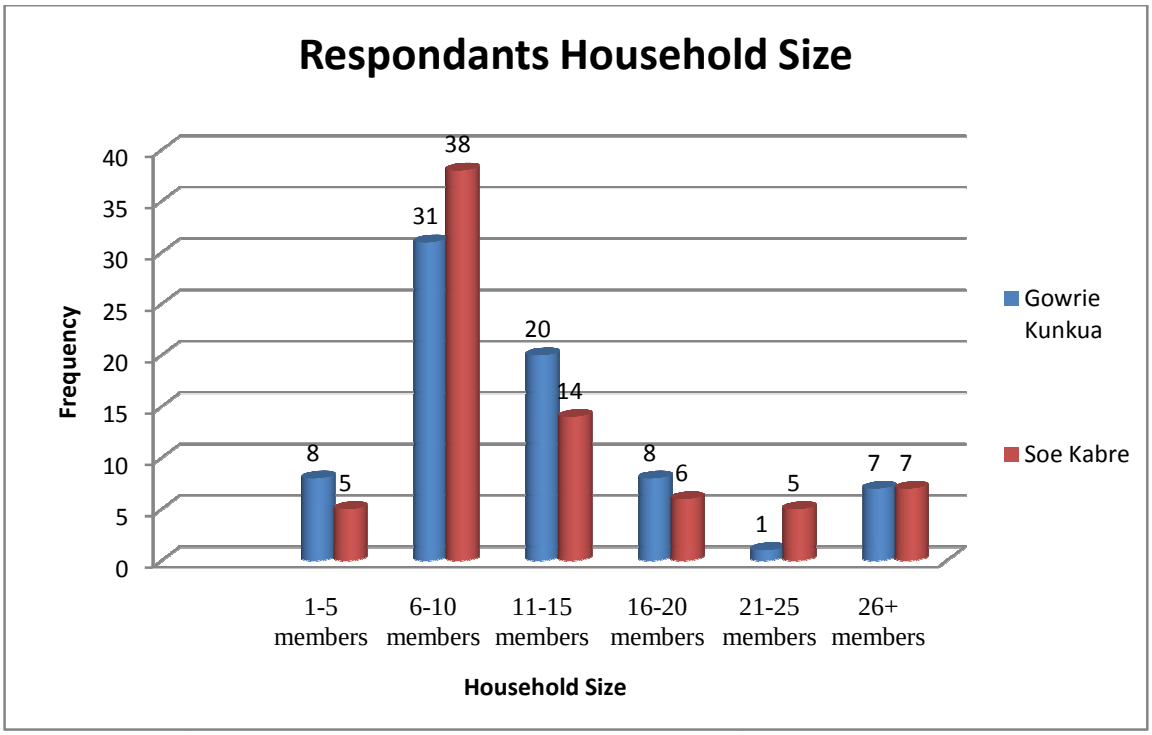
As depicted in Figure 4.3, in the Gowrie Kunkua community (vulnerable community), 36 (or 48%) of households had no formal education, whiles in the resilient community (Soe Kabre), 62 (or 82.7%) of households had no formal education. Considering the fact that, the majority of the households had no formal education or little education, there is strong indication that the domineering perceptions and worldviews from the standpoint of specific households are less prone to be poisoned by Eurocentric values ensuing from formal education and training. This assertion is in tandem with the findings of Yelfaanibe, (2011; 48),

which indicated that, individuals who had no or little education views were not influenced by Western values in natural resource management issues in his study. On adaptation decision and education, 62.2% of educated households across the two communities adopted/implemented some form of adaptation strategies to improve their livelihoods and offset the negative effects of climate variability. The binary logistic regression results showed that education was an important determinant of the adaptive capacity of households in implementing adaptation strategies such as livelihood diversification, temporary migration, indigenous knowledge, planting drought-tolerant varieties and reducing food consumption statistically significant (at $p< 0.05$). The findings are consistent with the observation of Antwi-Agyei, (2012; 167) that, the level of education of the household head (or the most educated members of the household) significantly affects adaptation strategies. On gender and education, 72.9% of female respondents/households had no formal education compared to 58.8% of male respondents/households. A Pearson correlation showed a negative correlation (-0.169) between male and female education statistically significant (at $p < 0.05$). This implies as male education increases, female education decreases (inverse relationship). More women, however, were covered at the secondary level. This explains that fewer women from the study communities are unable to go beyond the secondary levels compared to their men counterparts since the study communities are male dominated. Women‘s access to resources such as land and farm inputs were very minimal.

4.1.4 HOUSEHOLD SIZE OF RESPONDENTS

As presented in (Figure 4.4), 8 households in Gowrie Kunkua had a household size of 1-5 people and 7 households had household size of 26+ people.

FIGURE 4.4 DISTRIBUTION OF RESPONDENTS BY HOUSEHOLDSIZE



Source: Field Survey, July 2015.

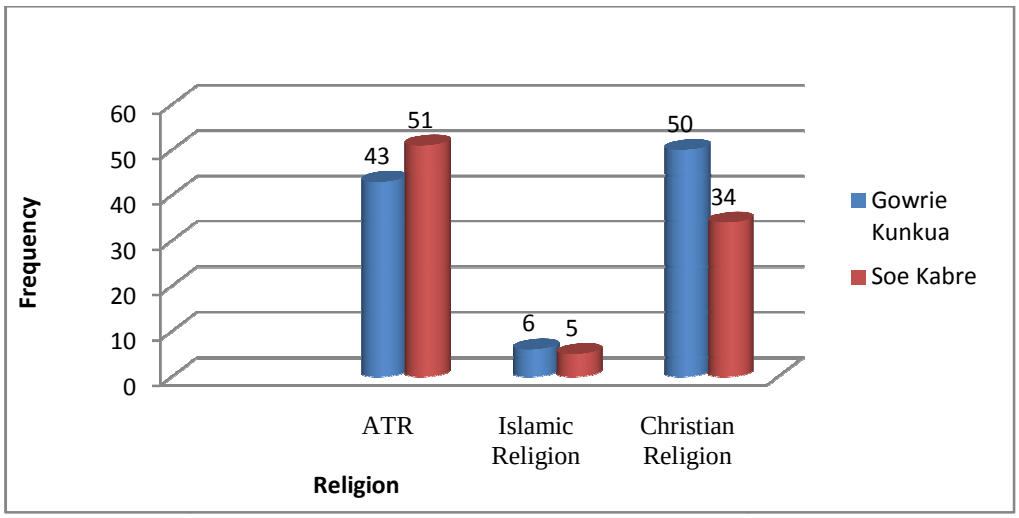
The resilient community (Soe Kabre) on the other hand 5 sampled households had a household size of 1-5and 7 had household size of 26+. The distribution of the household size is typical of a rural area and the highest frequency is found in between 6-10 household size categories. By educational status of households, the educated households had an average household size of 6.2 and the non-educated households had an average household size of 8.3. This is attributable to the fact that, the educated household members are either in schools or working in the cities and towns.

One-way ANOVA was conducted to test the statistical significance between education and household size, the results showed that there is a statistical significant difference between household size and educational status (at $p < 0.001$). This implies that, educated households have small household size whiles un-educated households have large household size. Female-headed households also had lower average household size of 5.3 as compared to 9.6 for male headed households. This is attributed the fact that, Men are polygamous and usually marry more than one wife. This research findings agree with the findings of Mossa (2012), which opined that, female-headed households are more likely to be a smaller family size (mean = 3.83), and male-headed households are likely to be larger households (mean = 6.59) than the average (mean = 4.6 members).A binomial logistic regression showed that household size was not statistically significant with the household decision to implement adaptation strategies (at $p < 0.05$). The influence of household size in the adaptation decision of a household depends on some factors such as educational level, farming experience, land size, belief system and training. Studies conducted in other parts of the world, (Dolisca et al., 2006; Birungi, 2007), contended that, households with large size usually implement labor-intensive adaptation strategies to secure their livelihoods which is contrary to this study. The result of this study (paired T-test) conversely showed that the differences were not statistically significant (at $p < 0.001$). The study revealed that household size decreases as the ages of the households becomes older and older and the age group of (51-70), referred as Middle Age had large household size, 10.1% for 26+ of household size.

4.1.5 RELIGIOUS DISTRIBUTION OF RESPONDENTS

Three main religions, namely, Christianity, Islam and Traditional African religion (ATR) co-exist in the study communities.

FIGURE 4.5: RELIGIOUS AFFILIATION OF HOUSEHOLDS



Source: Field Survey, July 2015.

Each of these religions has a tendency to shape the activities of its devotees hence the perceptions of these adherents and their resultant reactions and response towards climate extremes and its associated risk vary significantly. The distribution of the respondents according to the three main religious denominations is presented in figure 4.5. As shown in figure 4.5, the Gowrie Kunkua community had 43.4% of households belonging to the ATR whereas the Soe Kabre community had 56.7% of the sampled households being ATR. It was also commonly observed in the study communities that, members of a particular household could belong to more than one religion, for example, 20% of households had their household members belonged to Christianity and ATR, 1.3% of households had their household members being ATR and Islam, 0.7% of

households practiced Islam and Christianity and 1.3% of households practiced all three (3) (ATR, Christianity and Islam). It was a common phenomenon that, a man could be practicing ATR whiles the wife and/or children will be Christians or Muslims.

In total, 49.7% of households were ATR, 44.4% were Christians and 5.8% were Muslims. This is an indication that, the ATR is still dominant in the study communities and hence the households' indigenous knowledge and value systems tending to be existing which has reflected in their adaptation strategies. This revelation is in contrast with what Haverkort (2003) contended, that most African value systems and belief system have long been perceived from a Eurocentric lens largely because of the claim that they lack Cartesian rationality and therefore they become branded as a fetish and/or devilish. This notion is not much inherent in converted Christians and Muslims in the study communities since most of them, although they worship ATR no more, they still observe the indigenous knowledge and belief system in their adaptation to climate variability. Hence the value system has not been eroded or devalued with regards to adaptation strategies and coping measures to climate variability. For the study, 40.8% of Christian's households, 52% of ATR households and 37% of Muslims households implemented some form of indigenous adaptation and coping strategies. A bivariate correlation (Pearson correlation = 0.000) statistically significant (at $p < 0.001$) revealed that there is no correlation between one's religion and the decision to adopt/implement adaptation strategies.

There are however new forms of life by the orthodox religions (Christianity and Islam) that has diluted and lessen the efficacy of ATR to instill discipline, but this has mainly to do with the management of common pool resources (environmental resources as the case with tree cutting for charcoal production in the Shoe Kabre community) as there are increased reported cases of bushing burning, deforestation and charcoal processing. This, the community people believe is the cause of the disrespect of the belief system and life forces (shrines, groves, ancestors) perpetuated by the orthodox religions.

4.2 SMALLHOLDER HOUSEHOLDS' PERCEPTION ABOUT CLIMATE CHANGE

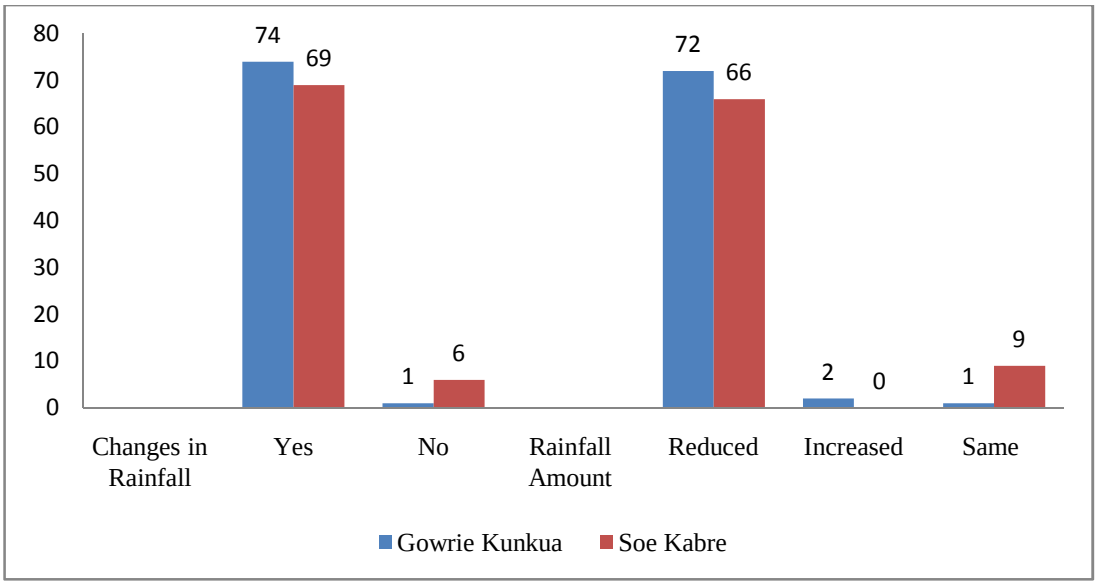
4.2.0 INTRODUCTION

This section of the thesis assessed households' perceptions of climate change at the community level corroborated by meteorological data. To explain and validate farmers' perceptions about climate change, the study looked at how climate data recorded at the Ghana Meteorological Stations (GMA) evolved (trends and variability) and how farmers perceived these changes. Tests were undertaken for linear trend in maximum and minimum annual temperature and total annual rainfall for the Bongo district using records from the Vea weather station. Descriptive statistics based on summary counts of the questionnaire structure were used to provide insights into farmers' perceptions of climate change.

4.2.1 HOUSEHOLD PERCEPTION ABOUT CHANGES IN RAINFALL PATTERN

When asked "have rainfall pattern changed in your lifetime", 98.7% (or 74) of respondents said yes they have observed changes in the rainfall pattern in the Gowrie Kunkua community whiles 92% (or 69) of respondents in the Soe Kabre community said they observed changes in the rainfall pattern.

FIGURE 4.2.1 HOUSEHOLD PERCEPTION ABOUT CHANGES IN RAINFALL PATTERN ANDAMOUNT



Source: Field Survey, July 2015.

Pearson correlation (0.158) showed a weak positive correlation between observed changes in the Gowrie Kunkua and Soe Kabre communities statistically significant (at $p < 0.053$). Among households or respondents who observed changes is the rainfall pattern, 96% (or 72) respondents perceived a decrease or reduction in rainfall amount in the Gowrie Kunkua community whiles 88% (or 66) respondents in the Soe Kabre community perceived a decrease or reduction in rainfall amounts over their lifetime. 2.7% detected/perceived an increase and

1.3% perceived rainfall to be the same in the vulnerable community. While none perceived an increase and 12% perceived the rainfall pattern to be the same in the resilient community as shown in Figure 4.2.1. A study conducted by Mtambanengwe et al. (2012), observed that, 95% of farmers in that study indicated that they have observed changing trends in weather patterns and singled out increasingly unpredictable trends in rainfall distribution as the major change they have witnessed during their lifetime.

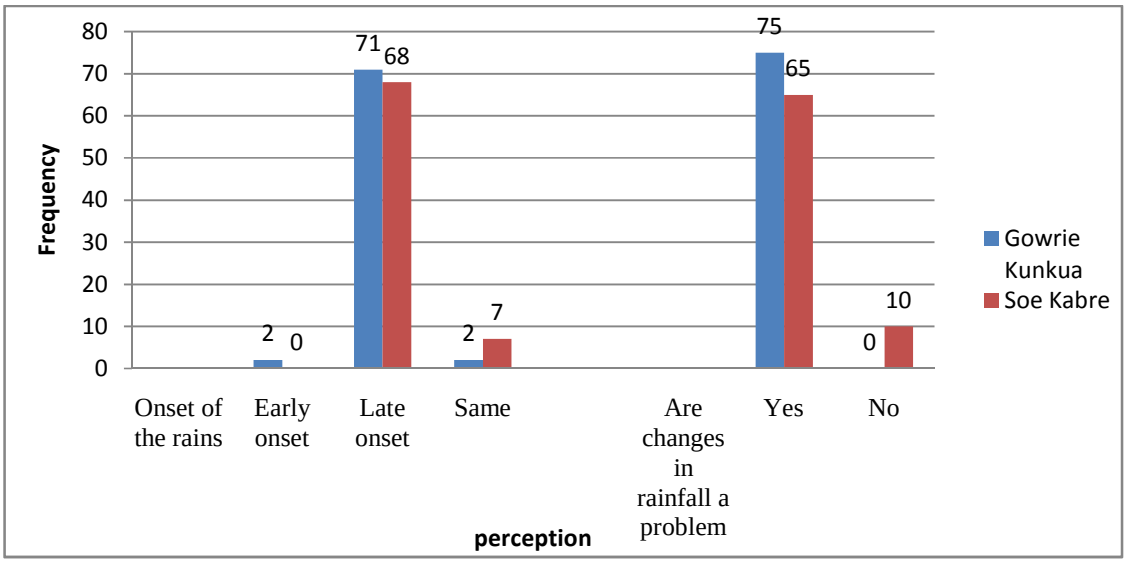
This observation by Mtambanengwe et al. (2012), Menapace et al. (2014) is in tandem with this present study. The key indicators of a varying climate, according to a focus group discussion were related to their farming activities. Drought, floods, reduction in rainfall amount, delay and erratic rainfall regime, hot temperature and availability of pest and diseases are the major indicators of climate change perceived by farmers. Amongst indicators identified, household survey respondents and Key informants both labeled drought and erratic rainfall as the major indicators of climate change in the district. Discussant at a FGD held that rainfall was the most unreliable and tremendously uneven and hence exceedingly unsatisfactory among the indicators. Similar studies in other parts of the world showed that 99% of respondents indicated they witnessed the irregularity of rainfall amount and distribution during the main rainy season (Nigussie and Girmay, 2010).

4.2.2 HOUSEHOLD PERCEPTION ABOUT THE ONSET OF THE RAINS AND ITS EFFECTS

In all the two communities studied, 92.7% (or 139) of households perceived a shorter rainy season with late onset whiles 1.3% (or 2) of respondents or

households perceived the contrary (early onset) and 6% (or 9) of respondents perceived the onset of the rains to be the same (neither increased nor decreased) as shown in Figure 4.2.2.

FIGURE 4.2.2 HOUSEHOLD PERCEPTION ABOUT ONSET OF RAINFALL AND ITS EFFECTS



Source: Field Survey, July 2015.

With regards to the problems of a varying climate on farming activities, 93.3% (or 140) of respondents in the two communities studied perceived the changes in rainfall as a problem for farming whiles the remaining 6.7% (or 10) perceived the changes in rainfall not to have any problem for farming activities.

Households noticed that the erratic rainfall pattern which starts late June or early July and stops early, late September or early October posses serious constraints for their farming activities (including post harvest losses). In a FGDs held across the two communities, discussant solidly all together indicated that "for the past two to three decades, planting time/month has shifted to late May or early June and more recently (2014/2015) to middle or late June". These findings are

consistent with many other previous researches (Antwi-Agyei, 2012; Berlie, 2013; Kassa et al., 2012) which tinted that the onset of the rainfall has shifted from May to June resulting in a change in the planting season, increased risk of crop failure, stunted growth and drying of crops.

4.2.4 CORROBORATING THE EXTENT OF CLIMATE CHANGE IN THE STUDY DISTRICT

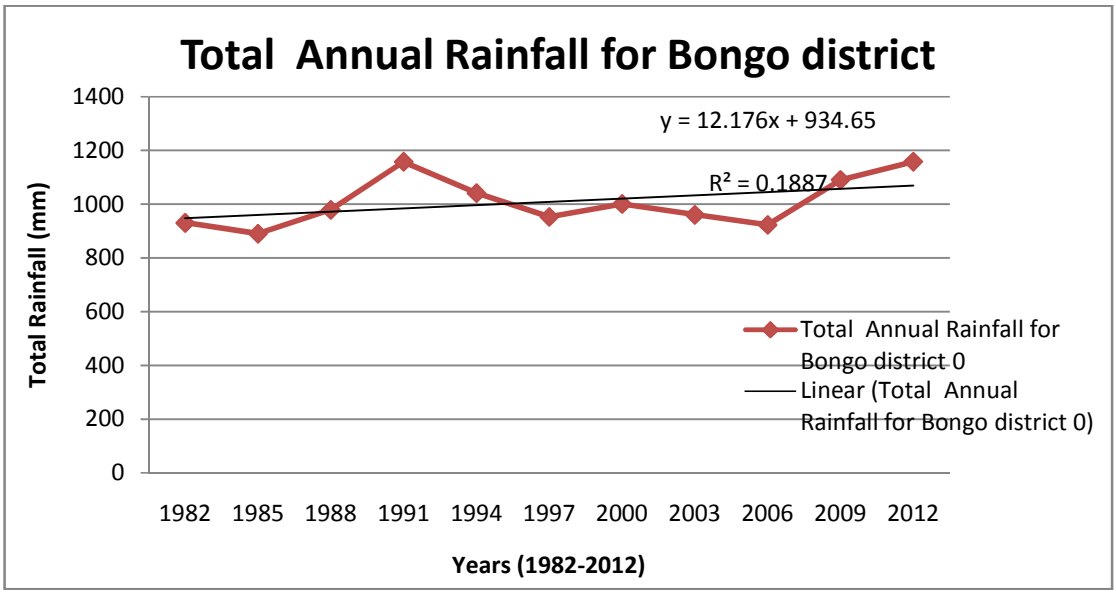
To assess the extent of climate change in the study district, a time series analysis of climate (rainfall and temperature) data obtained from the Ghana Meteorological Agency (GMA) was conducted.

4.2.5 CORROBORATION OF RAINFALL VARIABILITY IN THE STUDY DISTRICT WITH GMA RECORDS

Evidence of rainfall variability in the Bongo district is provided by climatic records from 1982–2012 obtained from the GMA, the records as shown in (figure 4.2.3) indicate that, there have been some hydro-climatological changes within the study district and region at large. The climate time span was restricted to 30 years (from 1982–2012), due to limitations on the availability of climate records at the GMA (Vea Weather station). Notwithstanding, this time frame interval is arguably sufficient to permit the establishment of the degree and magnitude of the dynamics between the livelihood context and climate change in the Bongo district. Figure 4.2.3 shows that rainfall variability has been detected in the Bongo district. For instance, the district recorded the lowest rainfall amount of 890.4 mm in 1985, followed by a succession of erratic rainfall patterns until 1991 and 2012 when the district recorded its highest rainfall amount of 1158.1 mm (Figure 4.2.3). According to officials of MoFA both at the district and regional offices in

the Bongo district and Bolgatanga municipal respectively, the area requires at least 950 mm of rainfall for crop production (Assan et al., 2009; Antwi-Agyei, 2012). Therefore, considering 950 mm as the baseline, there has been 13 years (of agricultural drought) over a period of 30 years that could be considered risky for crop production.

FIGURE 4.2.3 TOTAL ANNUAL RAINFALL



Source: GMA, 2015.

Data from the GMA suggest that within the Upper East region there have been major drought seasons in 1982, 1983, 1984, 1985, 1986, 1987, 1990, 1995, 2002, 2004, 2005, 2006 and 2007.Confirming this study results,1983, 1984, were also identified by Antwi-Agyei (2012) as years with drought seasons. This reduction in rainfall (GMA records) confirms the field observations of households/ respondents' perception that the rainfall regime has become highly variable and erratic. The World Bank Group (2011) and Stanturf et al. (2011) indicated that, mean annual temperature has increased and annual rainfall has reduced and highly variable in Ghana which confirms this study's findings. The research findings of

a reduced and highly erratic and short rainy season associates reasonable credibility to other researches which suggest significant decreases in rainfall amount in Sub-Saharan Africa, including Ghana (Boko et al., 2007; Antwi-Agjei, 2012).

The mean annual rainfall in the Bongo district for the 30 years was 915 mm. This mean annual rainfall (915) is not sufficient for crop production; also, the amount of rainfall is not fairly distributed in the growing months. The long-term mean rainfall showed that between 60%-75% of the total amount of rainfall in a year is concentrated into two wettest months (July and August) worsening and intensifying soil erosion, floods and destruction of properties, collapse of buildings among others (see chapter 2). These findings are in tandem with the (World Bank Group, 2011) which indicated that rainfall in Ghana has decreased to low levels in the late 1970's and early 1980's, resulting in an overall decreasing trend between the period 1960 to 2006, with an average precipitation of 2.3 mm per month (2.4%) per decade (The World Bank Group, 2011). This research disagrees with Van der Geest (2004) who suggests that, the mean seasonal concentration of rainfall does not present difficulties to farmers. Van der Geest (2004) contended that, the difficulty rests in the fact that the distribution of rainfall fluctuates from year to year. The rainfall pattern of the studied district is therefore classified as an intra-annual variability or seasonal concentration since the distribution/variation of rainfall is within a particular year and generates seasonality in the agricultural cycle, labor demands, food availability, food prices,

the prices of consumer goods and labor, health, births, deaths and migration patterns (Van der Geest, 2004).

4.2.6 HOUSEHOLDS PERCEPTION ABOUT CHANGES IN TEMPERATURE

TABLE 4.2.1 HOUSEHOLD PERCEPTIONS OF CHANGES IN TEMPERATURE PATTERN

	Gowrie Kunkua			Soe Kabre				
Options	Responses			Responses				
	Yes	NO		Yes	No		Pearson, R	P-value
Are there Changes in the temperature pattern in your lifetime	96%	4%		90.7%	9.3%		0.107	0.193
	Hotter	Cooler	Same	Hotter	Cooler	Same		
Has temperature pattern become hotter or cooler in your life time	78.7%	14.7%	6.7%	74.7%	17.3%	8%	0.044	0.589
	Yes	No		Yes	No			
Are changes in temperature a problem for farming activities	98.7%	1.3%		80%	20%		0.302	0.000

Source: Field Survey, July 2015.

As shown in table 4.2.2, 96% of respondents in the vulnerable community perceived changes in temperature during the growing season in their life time whiles 4% perceived no changes in temperature pattern. In the resilient community, 90.7% of respondents' perceived changes in temperature pattern whiles 9.3% observed no changes in temperature. Among the believers of temperature changes, 78.7% in the vulnerable community perceived the temperature to be increasing (hotter), 14.7% observed cooler temperature whiles

6.7% observed the temperature pattern to be the same. In the resilient community, 74.7%, 17.3% and 8% perceived the temperature in the growing season to be hotter(increasing), cooler (decreasing) and same (no change) respectively. 98.7% and 80% of households in the vulnerable and resilient communities respectively perceived the changes in the temperature pattern to be a problem for farming activities. A Pearson correlation (R=0.302) statistically significant (at $p < 0.001$) shows a weak positive correlation between the resilient and vulnerable community's household perception about changes in temperature pattern.

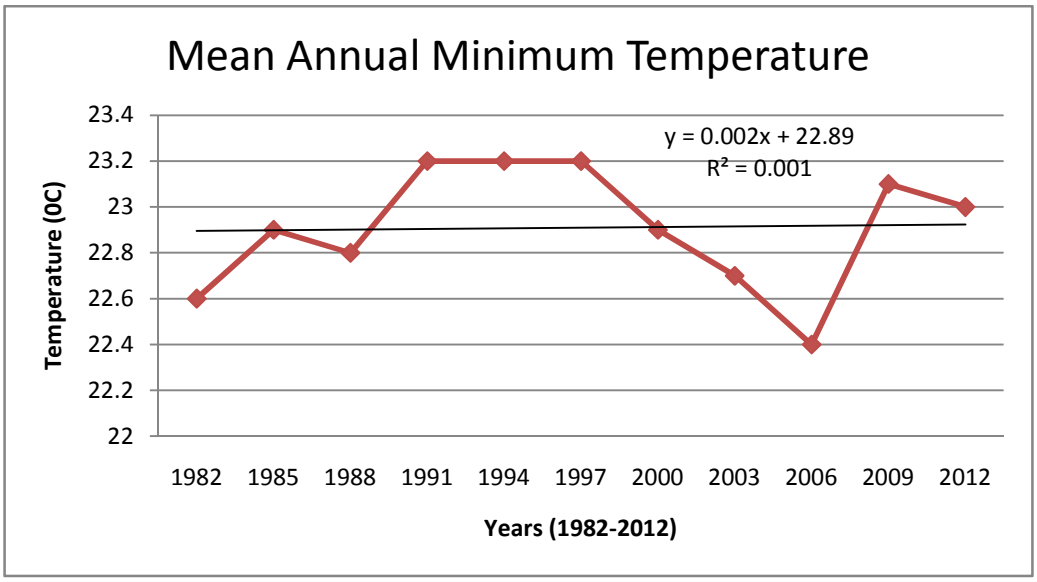
Perceived changes in temperature were reiterated by four (4) FGDs in both resilient and vulnerable communities which ascertained the increment of temperature in their localities. Key informant interviews gathered that, because of increasing temperature during the *Dawooliga* months (March, April and May), crops usually do not germinate well and there is always high prevalence of diseases in both humans and animals (for example anthrax, measles). Furthermore, streams, ponds and dugouts and rivers tremendously declined or dried up during the dry season because of high evapo-transpiration and low underground water table.

Apparently, the key indicators of rainfall and temperature variability are the high rate of diseases and pest, poor germination, withering of crops, change in the planting time/months for the major crops and the disappearance of some fauna and flora (IPCC, 2014).

4.2.7 CORROBORATION OF TEMPERATURE CHANGES IN THE STUDY DISTRICT WITH GMA RECORDS

Temperature is another vital component of agricultural production in the studied district. A time series analysis of maximum and minimum annual temperatures in the Bongo district obtained from the GMA reveals significant variations in annual temperatures for the three decades (1982-2012). The Bongo district recorded an increase of 0.6 ^{0}C for the minimum temperature over the period 1982 - 2012. Figure 4.2.6 reveals an average minimum temperature of 22.6^{0}C in 1982 and 23.0^{0}C in 2012, which denotes an upsurge of 0.6^{0}C.

FIGURE 4.2.4 MEAN ANNUAL MINIMUM TEMPERATURE FOR THE BONGO DISTRICT.



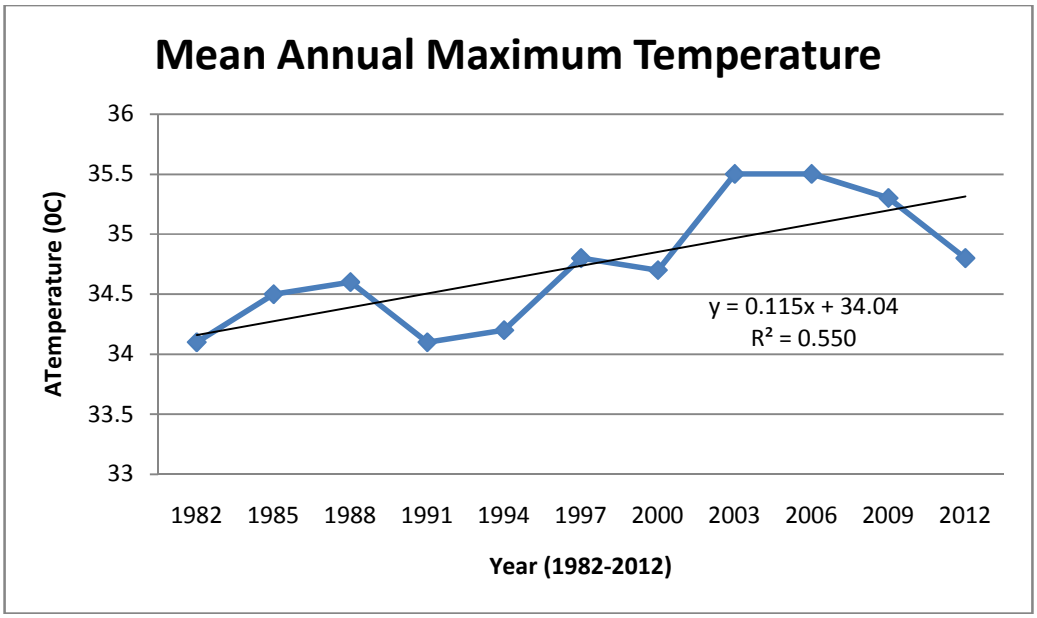
Source: GMA, July 2015.

Comparable trend is detected for the maximum annual temperature in the district (figure 4.2.5) which indicates that maximum annual temperature have been fluctuating with 34.1^{0}C in 1982 to 34.8^{0}C in 2012. This denotes a rise of 1.4^{0}C. Undoubtedly, numerous researches have corroborated the upsurge in the temperature movement in most parts of Africa (Boko et al., 2007; Christensen et

al., 2007; Stanturf, et al., 2011; Antwi-Agyei, 2012; the World Bank Group, 2011).

The findings indicate that there was an intense vulnerability of crop production to droughts in the district. Antwi-Agyei (2012), noted that, continuous cropping of farm lands in the Upper East region without the addition of appropriate soil amendments has left the soil with low fertility and in a highly unproductive state.

FIGURE 4.2.5 MEAN ANNUAL MAXIMUM TEMPERATURE FOR THE BONGO DISTRICT



Source: GMA, July 2015.

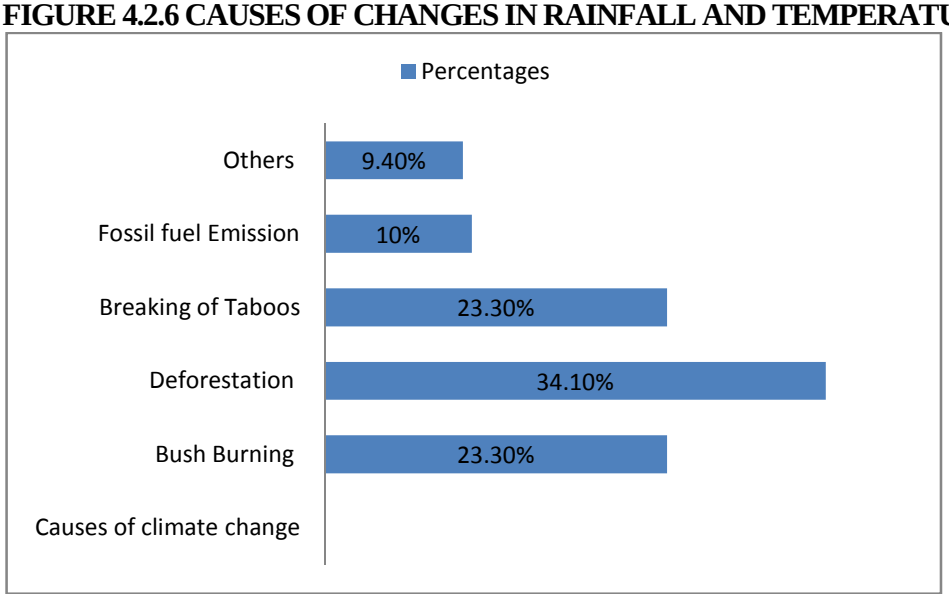
The two communities (all in Bongo district) experience a uni-modal rainfall pattern and are largely characterized by drier conditions and fragile agro-ecosystems. As such, these types of communities are liable to be vulnerable to climate variability. Soils within the Guinea and Sudan savannah agro-ecological zones have poor fertility which in addition with desertification, exacerbates food and livelihood insecurity (EPA, 2003). Declining rainfall in the study district,

connected with imminent predictions of rise in annual temperature (EPA, 2007) poses dangerous challenges to households in the communities since they rely solely on rainfall for crop production and other rural livelihoods. The perceptions of farmers/respondents in the study communities about changes in rainfall and temperature patterns (decrease in rainfall and rise in temperature, late onset and erratic rainfall regimes) were all corroborated and strongly authenticated by rainfall and temperature data obtained from the GMA. This discovery is a clear indication that climate change is occurring and poses negative impacts on the livelihood of smallholder households/farmers in the Bongo district and the Upper East in general.

4.2.8 PERCEIVED CAUSES OF CHANGING RAINFALL AND TEMPERATURE

Although there is a great belief and certainty that climate is changing, there is disparity in opinion of what is responsible for the changing climate.

FIGURE 4.2.6 CAUSES OF CHANGES IN RAINFALL AND TEMPERATURE



Source: Field survey, 2015.

In this study, approximately 23.3% of respondents in both communities associate climate change to bush burning, 34.1% perceived deforestation(indiscriminate felling of trees for various uses) to be the cause of climate change whiles 23.3% perceived breaking of taboos and the disrespect for the beliefs, spirits, gods (life forces) such as shedding innocent blood-killing people, sexual intercourse and abortion among others to be the underlining causes of climate change (Figure 4.2.6).The educated sections of the community mostly aligned climate change to ozone layer depletion caused by emission of fossil fuel (vehicles and industries).The findings of Sakyi and Lassey (2015) indicated that educated households align climate change to depletion of the ozone layer due to excessive fossil fuel emission from industrialization which confirms this study.

The findings are further consistent with the study by Mtambanengwe et al. (2012) who reported that 40% of farmers attributed changes in weather patterns to natural causes viz a viz the will of God, or the result of changing times (unexplained) while some aligned climate change with tradition. This study is also consistent with Arbuckle et al. (2013b) study. A Mann-Whitney U test was conducted statistically significant (at $p < 0.05$) which shows that the distribution of causes of changing rainfall and temperature pattern is the same across the study communities.

4.2.8 CONCLUSIONS

These sections of the thesis explained farmers' perception of climate change and determined the perceived causes of climate change in the study district. In this regard, Rainfall and temperature records from the GMA were used to corroborate

farmers' perceptions about climate change in the study district. Time series analyses were conducted to show the trend of rainfall and temperature patterns spanning the period 1982-2012. The findings reveal that rainfall and temperature pattern have changed with rainfall declining, (highly erratic) and temperature rising. There are strong indications that the varying climate poses serious constraints and risk for the livelihoods of smallholder household in the Upper East Region and the country at large. The findings have set up a next phase of more in-depth research to unravel the degree of personal concern about the potential impact of climate change on farmers' livelihood activities and the perceptions of the magnitude of negative outcomes (concerns) as well as the effect of climate change on the probability of the negative outcomes.

CHAPTER 5

THE EFFECTS OF CLIMATE CHANGE ON LIVELIHOODS

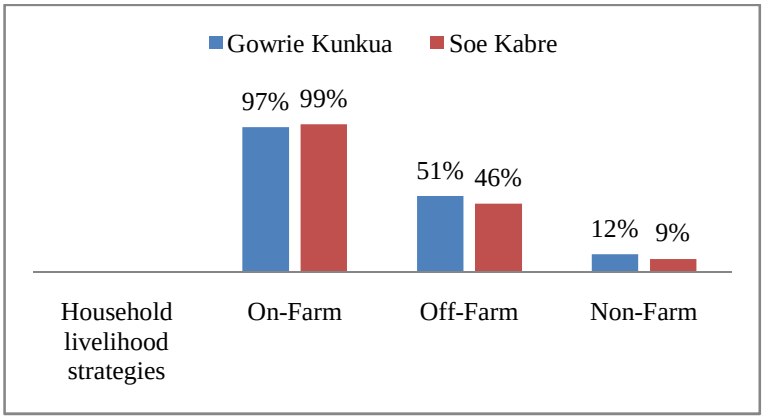
5.0 INTRODUCTION

This chapter investigated livelihood assets and strategies of household and climate change effects on household livelihood activities. A one-way ANOVA was employed to test that climate change presents a severe threat to households and that these negative effects on livelihoods are not due to chance.

5.1 HOUSEHOLD LIVELIHOOD STRATEGIES

As it is shown in (Figure 5.2), 97% of households in the vulnerable community and 99% of households in the resilient community were engaged in on-farm livelihood strategies (crop and livestock production).

FIGURE 5.1 HOUSEHOLD LIVELIHOOD STRATEGIES



Source: Field Survey, July 2015.

51% of the households in Gowrie Kunkua and 46% in Soe Kabre were engaged in off-farm livelihood strategies (petty trading) besides the major livelihood activity (crop farming and livestock production). 12% and 9% of households in Gowrie Kunkua and Soe Kabre communities respectively, were engaged in non-farm

livelihood strategies such as civil service, temporary migration and gifts/remittances.

Burke and Lobell (2010) reported that the inherent seasonality and year-to-year variability of agricultural enforced the rural poor to engage in livelihood diversification which is consistent with this present study. This research is also in tandem with Mahendra-Dev (2011:6) who observed that, rural households obtain livelihoods from agriculture, rural labor market and self employment in rural non-farm economy, and others through migrating to towns, cities and other countries.

5.2 LIVELIHOOD ACTIVITIES OF SMALLHOLDER HOUSEHOLDS

The major livelihood activities across the study communities were crop farming, animal production, pito brewing and malt processing, labor on non-farm jobs (masonry, pottery, pealing of hoes, civil service) as well as shea butter processing. These livelihood activities were being engaged in both studied communities.

Other livelihood activities were peculiar to the locality or community due to differences in the agro-ecology. For instance, smock weaving was not engaged by any household in the Gowrie Kunkua community whiles 2.6% (r = 7) of households in the Soe Kabre community were engaged in smock weaving. Basket and hats weaving was engaged by 14.6% (r = 3) of households in the Gowrie Kunkua community whiles none (0%) of households in the Soe Kabre community was engaged in basket and hats weaving (Table 5.1). Also, fishing was a significant livelihood activity for the Gowrie Kunkua community with 11.5% (r = 5) of households engaged in fishing whiles in the Soe Kabre community; fishing was not a livelihood option.

TABLE 5.1: LIVELIHOOD ACTIVITIES OF HOUSEHOLDS

Livelihood Activities	Gowrie Kunkua				Soe Kabre			
	% within community, n=75	Rank	% within livelihood	% of total	% within community, n=75	Rank	% within livelihood	% of total
Crop Farming	23.4%%	1	50.0%	13.6%	32.3%	1	50.0%	13.6%
Animal Rearing	20.6%	2	49.3%	11.9%	29.3%	2	50.7%	12.3%
Petty Trading	13.7%	4	73.3%	8%	6.9%	5	29.7%	2.9%
Basket weaving	14.6%	3	100.0%	8.5%	0.0%		0.0%	0.0%
Smock weaving	0.0%		0.0%	0.0%	2.6%	7	100%	1.1%
Fishing	11.5%	5	100%	6.7%	0.0%		0.0%	0.0%
Stone Quarrying	0.0%		0.0%	0.0%	8.2%	4	100%	3.4%
Shea nut picking and butter processing	3.1%	8	27%	1.8%	11.6%	3	73%	4.9%
Pito stock processing and brewing	3.7%	7	50%	2.2%	5.2%	6	50%	2.2%
Charcoal production	0.0%		0.0%	0.0%	2.2%	8	100%	0.9%
Others (masonry, pottery, pealing of hoes, civil service	9.3%	6	88.2%	5.4%	1.7%	9	11.8%	0.7%
Totals	100%			58%	100%			42%

Source: Field Survey, July 2015.

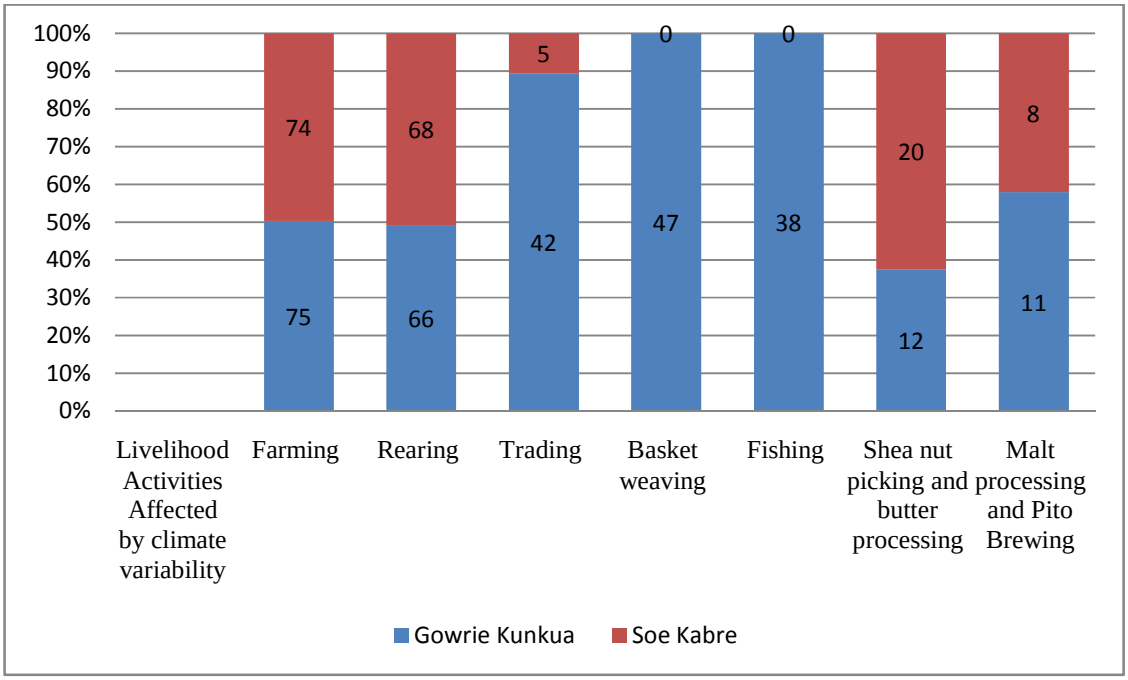
Charcoal production was a livelihood option for Soe Kabre with 2.2% (r = 8) of sampled households engaged in charcoal production whiles Gowrie Kunkua did not have charcoal producers. This is attributed to the fact that, the Gowrie Kunkua community is not close to any forest. Stone quarrying (8.2%) was engaged by households in the Soe Kabre community whiles in the Gowrie

Kunkua community, no household was engaged in stone quarrying. There was, however sand winning in nearby communities (Vea and Bulungu).

5.3 LIVELIHOOD ACTIVITIES NEGATIVELY AFFECTED OR DISRUPTED BY CLIMATE CHANGE

As shown in figure 5.3, all 75 sampled households in the Gowrie Kunkua and 74 out of 75 sampled households in the Soe Kabre community indicated that farming (crop farming) as a livelihood activity was disrupted or severely affected by climate change.

FIGURE 5.2 LIVELIHOOD ACTIVITIES AFFECTED BY CLIMATE CHANGE



Source: Field survey, June 2015

Crop farming through perennial droughts, erratic and delayed rainfall pattern is severely affected and this consequently has led to declining crop production. Discussant mentioned indicated that, once crops yields decline, households are not able to feed laborers' (communal assistance) to plant/sow, weed and harvest crops. This results in continuous decline in food production since the seeding area

is reduced and hence the vicious cycle of poverty. A key formant mentioned poor germination of crops due to high temperature as a problem for crop farming, post harvest losses and disease and pest affect crop production harshly. This findings are in tandem with Campbell et al, (2003; p 6) who observed that rainfall is a primary driver of change, altering crop production from year to year and causing massive longer-term fluctuations in production. Households are unable to raise sufficient grain for their subsistence needs in one out of three years. In particularly bad droughts, or as a result of a sequence of bad years, water reserves are reduced and gardening is affected.

Similarly, 66 (44%) and 68 (45.3%) of sampled households in the Gowrie Kunkua and Soe Kabre community respectively, revealed that livestock production (including poultry) is severely affected by climate change. A study by FAO (2006), indicated that about 83.1% of households noted livestock farming was most often disrupted by climate change which supports the current study. Livestock production is particularly hampered by the unavailability of pasture/grass for animals to graze, inadequate water for animals to drink and more importantly diseases have been killing animals in recent times.

Approximately, 42 and 37 households in the vulnerable and resilient communities respectively, said that, petty trading is disrupted or affected by climate change in the form of high food prices, low demand for food due to the high prices and unstable food supply.

Basket weaving as a key livelihood alternative in the vulnerable community was disrupted by climate change as indicated by 47 and 38 sampled households

respectively. KI noted that, “basket weaving is also hampered since the grass (vertiver grass) which straw is used for the weaving is gradually disappearing”. Basket producers are compelled to buy the straw from markets in the Brong Ahafo and Volta region at a high cost.

Fishing as a livelihood activity is also hampered by climate change as indicated by 38 respondents in the Gowrie Kunkua community. Fish stock, according to a FGD has reduced heavily as compared to the periods before 1980s and this reduction in fish stock is caused by the reduced rains.

The gradual disappearance of sheanut trees and the inability of the existing trees to bear enough fruits due to high temperature, severe wind storms and poor rainfall have hampered the local shea industry. Shea nut picking (or butter processing) is severely disrupted by climate change as indicated by 12 and 26 sampled households in the Gowrie Kunkua and Soe Kabre communities respectively.

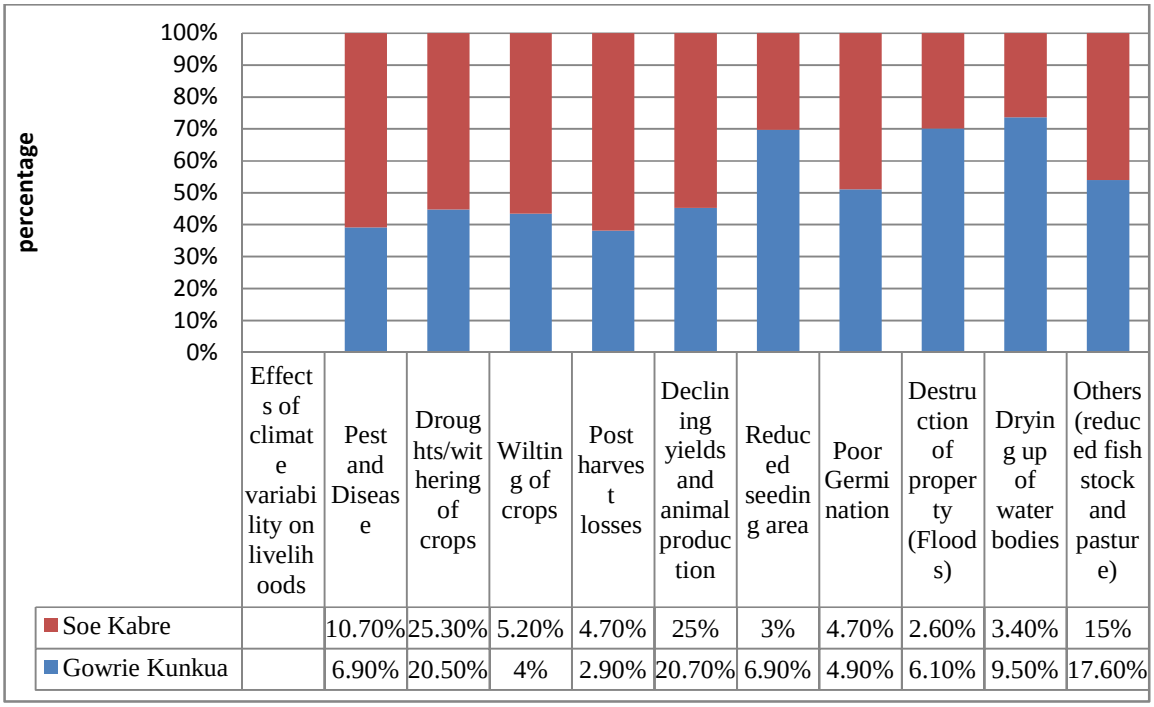
Pito brewing (or malt processing) is also disrupted by climate change as hinted by 11 and 8 sampled households in the Gowrie Kunkua and Soe Kabre communities respectively. Low crop yields, particularly sorghum or Guinea corn is the key factor affecting pito brewing since this culminates in high prices of sorghum. Discussant at a FGD also noted that, due to the high temperature, there is usually poor germination of the pito stock during the malt processing and this consequently leads to bad pito (poor taste and quality). There are also gender considerations, as household members perform activities in accordance with their culturally defined gender roles and ages. Men are mostly involved in agriculture,

while women are involved in household activities. Women are also involved in farming activities, especially farm operations such as weeding, sowing and harvesting.

5. 4 NEGATIVE EFFECTS OF CLIMATE CHANGE ON LIVELIHOODS OF SMALLHOLDER HOUSEHOLDS

As shown in figure 5.4, 20.5% and 25.3% of households in Gowrie Kunkua and Soe Kabre respectively, reported droughts resulting in withering of crops as a major negative effect of climate change on their livelihoods.

FIGURE 5.3 CLIMATE CHANGE EFFECTS ON LIVELIHOODS OF SMALLHOLDER HOUSEHOLDS



	Effects of climate variability on livelihoods	Pest and Disease	Droughts/withering of crops	Wilting of crops	Post harvest losses	Declining yields and animal production	Reduced seeding area	Poor Germination	Destruction of property (Floods)	Drying up of water bodies	Others (reduced fish stock and pasture)
Soe Kabre		10.70%	25.30%	5.20%	4.70%	25%	3%	4.70%	2.60%	3.40%	15%
Gowrie Kunkua		6.90%	20.50%	4%	2.90%	20.70%	6.90%	4.90%	6.10%	9.50%	17.60%

Source: Field Survey, July 2015.

As indicated by Van der Geest (2004) and supported by this study, droughts affect household livelihood more than other circumstances (floods) since wet years are normally good years and hence there are less extreme cases in which excess

rainfall results in yield declines. The particular types of drought reported by sampled household include meteorological, agricultural and socio-economic droughts. Households noted that rainfall was deficient and mostly shortage. The rains fall below the regular or expected amounts in a season. This confirms Mishra and Singh (2010) definition of meteorological droughts as deficient by two times below the standard deviation of the mean. Households also noted that, crops had inadequate water (thus withers) to grow and yield unsatisfactorily which confirms Mishra and Singh (2010) and Van de Geest (2004) illustration of agricultural droughts. Although it is difficult to monitor agricultural droughts since moisture needs of different crops vary considerably, households and KIs noted that, in drought years, there is always inadequate supply of food or farm produce in the markets which results in high prices of food. This assertion in the description of Mishra and Singh (2010) is referred to as socioeconomic droughts. Discussants in FGDs held across the study communities and KIs noted that, when droughts occur, food availability reduces, feed/grass and water for animals reduced and the land degrades. This consequently results in high prices of food which reduces income and hence livelihood insecurity. They also noted that, when grass availability for grazing reduces, households are compelled to sell their livestock at a very low price (supply exceeds demand) and this consequently reduces household livelihood assets. These findings are consistent with Gitz and Meybeck (2012) earlier observation. A key informant also noted that “soil erosion caused by loss of vegetative cover due to overgrazing and over cultivation in the midst of droughts increase the vulnerability of households”. Gitz and Meybeck

(2012) confirmed that, land degradation reduces the value of assets and the productive capital hence livelihood insecurity. Rainfall variability, which has triggered many drought events in the UE/R have led to negative effects on farming activities resulting in decreasing trend for crop and animal production and subsequently food shortfalls hence food and livelihood insecurity, lower incomes and malnutrition. The effects of droughts range from inadequate water for crop and livestock production, which resulted in crop failure and the death of livestock hence severe hunger and malnutrition. Dovie (2010) identified hydrological imbalances, declining crop and animal production, lower germination rates, premature flowering and low quality grain as the problems droughts presents to farmers. Dovie (2010) observation is in tandem with the present study.

Another effect of climate change reported in this study, though not significant is wilting of crops by excessive rainfall. 4% and 5.2% of households in Gowrie Kunkua and Soe Kabre respectively, reported wilting of crops as effects of climate change on their livelihoods. Excess rainfall (as happens in some few months –August) is harmful to crops like millet and sorghum. Discussant noted that, the rains sometimes concentrate and fall heavily on a particular month (August) causing loss of grains stored and unavailability of sunlight to dry the harvested crops at that particular period (millet).

Other devastating effects of climate change include post harvest losses as indicated by 4.7% of households in the Soe Kabre community and 2.9% of household in the Gowrie Kunkua community. About 6.9% of households in

Gowrie Kunkua and 10.7% of households in Soe Kabre communities respectively indicated that, climate change affects their livelihood through pest and disease. This assertion supported by Sietz et al. (2012), that, Climate change and extreme weather conditions are eroding households/farmers livelihoods through decreases in crop yield periodically complicated by the proliferation of insect infection, pathogens, parasitic weeds, diseases, reduced availability of and access medicinal plants and biodiversity loss. Approximately, 3% and 6.9% of households in Soe Kabre and Gowrie Kunkua communities respectively labelled reduced seeding area due to late onset of the rainfall season as an effect of climate change currently hampering their livelihoods and increasing their vulnerability. About 4.7% of households in the Soe Kabre community and 4.9% of households in Gowrie Kunkua mentioned poor germination of crops due to high/hot temperature and less rainfall as an effect of climate variability. The destruction of physical property, loss of life and livestock as a result of floods was indicated by 2.6% and 6.1% of households in Soe Kabre and Gowrie Kunkua community respectively as a critical menace of climate change on their livelihoods. Some households reported having lost their animals to floods, but there was no mention of loss of human life in both studied communities. 3.4% and 9.5% of household stressed on drying up of water bodies as effects climate change presents on their livelihoods. Focus Group discussant noted that, “streams, ponds, lakes, rivers, dams and even ground water are drying up due to droughts (poor rainfall)”. Mishra and Singh (2010) classify this explanation or assertion as hydrological droughts. O’Reilly et al. (2003) suggested that, natural assets such as rivers, lakes and fish stock are

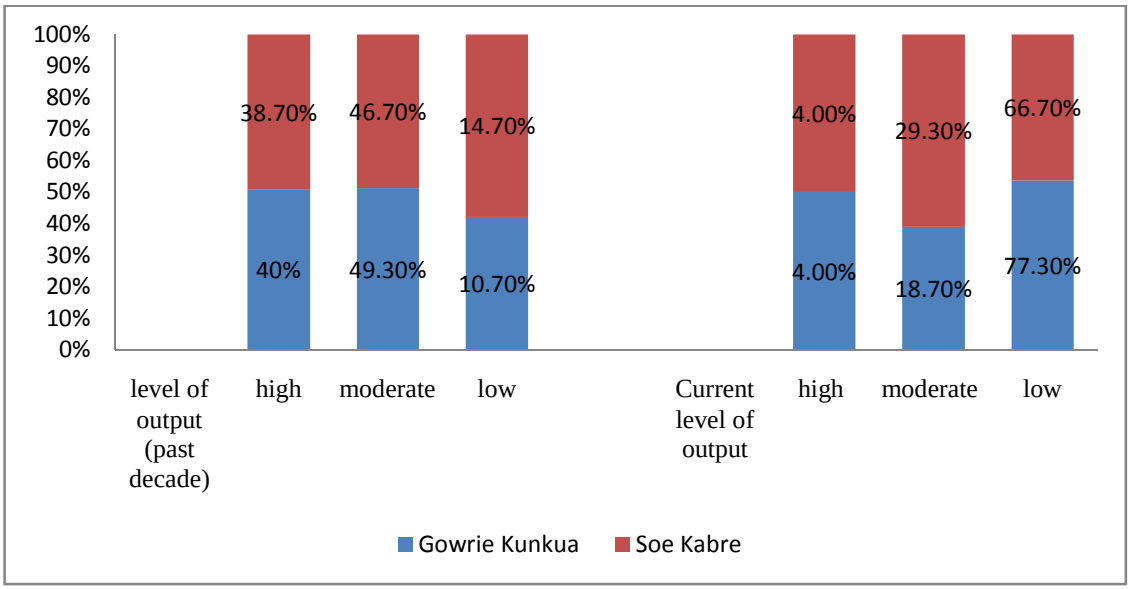
affected by climate change and extreme weather conditions. Around 16% and 17.6% of households in Soe Kabre and Gowrie Kunkua communities respectively mentioned other effects of climate change such as reduced fish stock and pasture, killing of micro-organism in the soil, inadequate termites and erosion cultural and social assets through interruption of familiar social linkages of the poor, women, elderly and women-headed households as negative effects of climate change on household livelihoods. IPCC (2014), projected that the effects of climate change in fishing will exceed that of overfishing by humans and other human impacts. Dovie (2010) confirms these research findings by indicating that, local fish supplies are negatively affected by climate change due to increasing temperature and less rainfall. He further indicated increased contaminants and reduced quality of water, low yields and animal production, reduced liquidity and hunger as the human livelihood effects of climate change (Dovie, 2010).The One-Way ANOVA showed that the effects of climate change (pest and disease, droughts, wilting of crops, post harvest losses, declining yields, reduced seeding area, poor germination, destruction of property by floods, drying up of water bodies and others) presents severe negative effects on livelihoods of households which is statistically significant (at $p < 0.01$). Since the (Fcal) 6.374873 > (F crit) 3.354131, we conclude that, climate change presents severe effects on household livelihoods.

5.4.1 DECLINING CROP YIELDS AND ANIMAL PRODUCTION

As indicated in Figure 5.5 below, 77.3% and 66.7% of households in Gowrie and Soe Kabre communities respectively agreed that level of output has declined.

The analysis further revealed that, whereas 40% and 38.7% of households in Gowrie Kunkua and Soe Kabre believed that crop yields and animal production was high two (2) to three (3) decades ago, 49.3% and 46.7% of households in both vulnerable and resilient community believed yields were moderate.

FIGURE 5.4 LEVEL OF OUTPUT FOR PAST DECADE COMPARED WITH CURRENT LEVEL OF OUTPUT



Source: Field survey, July 2015.

Approximately, 10.7% and 14.7% in the vulnerable and resilient communities respectively indicated that yields (2-3 decades ago) were low, given that, households at that time relied solely on traditional/primitive methods of farming (without the use of tractors and other inputs), households therefore could not cultivate much land. Compare to present day where the use of tractors, plough and other inputs can permit cultivation of large tracks of land. Conversely, 4% of households in the vulnerable community and 4% of households in the resilient community indicated that yields in present time is high whiles 18.8% and 29.3%

of households in both vulnerable and resilient communities respectively indicated yields currently are moderate. These findings are in tandem with FAO (2006), Van der Geest (2004). Decline in crop yields and animal production is a major consequence of climate change on households' livelihoods. All other effects/impacts of climate change and weather extremes have either direct or indirect link with yields. Sampled households mentioned frequent shortage of food resulting in hunger and famine as some of the consequences of erratic rainfall. A key informant noted that, households spend more on food due to high food prices and households that cannot afford this high cost have to decrease their food consumption. Low animal production due to inadequate pasture and more significantly death of animals from disease was also reported during a FGD. Averagely, between 4 - 7 livestock and 12 - 18 poultry die in a year per household. The findings further revealed that, a cultivated one (1) acre of land 2/3 decades ago yielded about fifteen (15) bags of millet/sorghum whereas a cultivated one (1) acre of land currently yields approximately eight (8) bags of millet/sorghum. This suggests that, crop yields (particularly millet and sorghum) have declined by 65% from the past three (3) decades.

5.5 CONCLUSION

This chapter examined major livelihoods strategies and activities as well as climate change effects on these livelihood activities. A detailed assessment of the overall livelihoods activities of household disrupted by climate change and how they are disrupted were assessed. The results showed that households were under considerable stress of livelihood insecurity since key livelihood activities were severely threatened by climate change.

CHAPTER 6

THE DETERMINANTS OF ADAPTIVE CAPACITY FOR COPING AND ADAPTATION TO CLIMATE

6.0 INTRODUCTION

Adaptive capacity to a large extent determines the susceptibility of communities to climate change effects and risk. The severity of climate effects depends on the variations itself and the characteristics of the society exposed to it (Munasinghe, 2000). The characteristics of the society or community in question determine its adaptive capacity and its adaptability. Similarly, precise climate events or hazards can have "extremely diverse consequences for the poor (farmers) they encroach on due to variation in coping ability or adaptive capacity" (Smit and Pilifosova, 2001). This chapter aims to identify and evaluate the main factors that determine the adaptive capacity of households at the local-level, providing a broader understanding of the extent of vulnerability of farming households to climate variability. This will help to provide improved guidance on appropriate interventions to enhance the resilience of agriculture-dependent communities.

6.1 LIVELIHOOD ASSETS OF THE SMALLHOLDER HOUSEHOLDS IN THE BONGO DISTRICT

Household livelihood assets signify the essential foundation upon which households embark on the production, engage in labor markets and participate in mutual trade with other households (Ellis, 2000). These include skills and experiences of household members (human capital), their relations within the wider communities (social capital), their natural environment (natural capital), and physical and financial resources (Gebrehiwot and Fekadu, 2012; Berlie, 2013). The ownership and control of these assets vary among households in the

study communities. This variation indicates the fact that households are confronted with different challenges and engage in different livelihood strategies to achieve livelihood outcomes (Barrett and Webb, 2001).

6.1.1 HUMAN CAPITAL

In this study, the main human resources that can enhance improved livelihoods include technical/vocational training, education, health status, farming experiences and household size. Morse and McNamara (2013) indicated that skills, good health, knowledge and physical capability jointly facilitate households to pursue livelihoods. Skilled labor power is regarded as the most important human resources to generate meaningful development. In this study, the resilient community had about 17.3% of sampled households having access to formal education (primary to tertiary level) whiles the vulnerable community had 52% of the sampled households being educated (primary to tertiary level). This low educational attainment in the resilient community suggests the fact that, the resilient community is endowed with vast agricultural land for crop farming and animal rearing, hence majority of the people are engaged in farming. Highest education level in the vulnerable community explains the fact that, the vulnerable community has inadequate agricultural land and hence the majority of the households are willing to send their children to school as a means of diversifying their livelihoods to non-farms jobs. An evaluation to determine the effect of education on households' vulnerability to livelihood insecurity was conducted. It was also discovered that, some educated households who were not engaged in farming were vulnerable. The explanation by a key informant was that, there are high prices of food due to declining yields and households who do not farm spend

a significant amount of their income to purchase food. On the other hand, some of the illiterate households through the use of indigenous knowledge in adapting to climate change are able to feed their families from their farm produce throughout the year to the next harvest. This supports the fact that, adaptation to climate change can reduce the vulnerability of households. This finding is contrary to Morse and McNamara (2013) and Berlie (2013), who observed that educated households are less vulnerable to climate change than illiterate or uneducated households.

6.1.2 SOCIAL CAPITAL

Social capital, which comprises connections to technical support and social resources such as networks and associations were evaluated by counting the number of associations or groups to which the members of the household belonged to (Vincent, 2007). Local informal institutions/neighborhood associations, religious groups, self-help groups, kinship structures, small credit schemes and cooperatives were found to be important social capital assets in the study area. Social capital consists of both formal and informal associations such as Community Based Organizations (CBOs), Farmer Based Organizations (FBOs) and Faith-Based Associations (FBAs) (Scoones, 1998). Other associations found in the study area were communal labor groups and tomatoes farmers association. The communal labor groups comprises groups of individuals who come together to form an association for the purpose of sowing, weeding and harvesting for each member. The study revealed that, 78% of households farming activities (such as sowing, weeding and harvesting) were carried out by communal assistance from family, groups and friends. It was anticipated that households that are affiliated

with more social groups and associations are better prepared to cope with the negative effects of climate change on their livelihoods activities since this embody social safety nets and a form of informal grassroots insurance available to the household during climate-related crisis (Fraser, 2007). Belonging to such networks, reflects the economic well-being of the household as it was discovered during FGDs that, members of the existing groups are required to pay dues. These associations' present means for the members to assist each other in times of need, ensures unity and mitigate adverse effects of immediate social problems. In this study, 40% and 36% of households in Gowrie Kunkua and Soe Kabre communities respectively belonged to associations such as FBO, CBO, communal labor groups and *Susu* groups (loans and saving group).

6.1.3 PHYSICAL CAPITAL

In FGDs and Key informant interviews held through the communities, discussants identified roads, markets, schools, health centers, shelter, access to information, water harvesting and soil conservation structures as critical physical assets. The existence of irrigation facilities and ownership of radios, donkey cart, television or mobile phones by a household were also identified as key physical assets for strengthening household resilience. Irrigation facilities are vital for rain-fed agriculture-dependent communities, as these facilities help farmers to engage in dry season farming. The Gowrie Kunkua community (vulnerable community) had an irrigation facility via the Vea irrigation dam. However, it was discovered that, the canals where water passes through the farms were badly damaged, hence farmers are not able to farm in the dry season for the past three years. However, animals get water to drink from the dam and household get water from the dam

for household consumption (building and construction). On the other, the Soe Kabre community (the resilient community) did not have a dam. Discussants at a FGD lamented that, their animals do not get water to drink in the dry season. Households cannot also farm in the dry season. It is hypothesized that households with irrigation facilities will be less vulnerable to changing rainfall patterns (Antwi-Agyei, 2012). Contrary to this assertion, the Gowrie Kunkua community is still vulnerable despites the presence of an irrigation facility in the community. The presence of radios, television or mobile phone in a rural household can be an effective tool for communication and accessing information on changing weather patterns (Naab and Koranteng, 2012). The presence of radio is particularly an effective tool for farmers to learn new farming methods and improve their adaptation practices from the Radio Gurune program Farm Radio hosted every Saturday 7:00 pm. Physical assets in the form of road network and the availability of markets and health facilities can improve the adaptive capacity of a household (Zhang et al., 2007). The Gowrie Kunkua community has a road linking to the district capital (Bongo - 8 KM) and Bolgatanga (the regional capital - 15 KM) though not in good shape. The Soe Kabre community did not have a road from the community to the main town but the main town has a road linking to Burkina Faso market (9 KM) and Bongo market or district (10 KM). Other studies have tinted that, the development of rural infrastructure could encourage the development of non-farm enterprises (Gbetibouo et al., 2010) and that good road networks will mean that farm produce are transported to the market in good time and sold in order to obtain financial resources that can be used to purchase food

items to reduce the vulnerability of households to drought-related food insecurity (Zhang et al., 2007). These assets were not included in the computation of the determinants of adaptive capacity because they did not significantly vary among various households either in the resilient or vulnerable communities.

6.1.4 NATURAL CAPITAL

Natural capital assets comprise of natural flow and stocks, land, and biological resources such as trees and biodiversity (Scoones, 1998). In the study area, the rural households considered farmland as the most important natural capital. Households also indicated that, availability of water, grazing land, soil conditions and fuel wood are important natural assets. In general, land holdings were small and varied between households and communities in this study. The first was the size of the farm holding under cultivation, which was estimated as the average area of cultivated land. The study revealed that (as shown in figure 5.1), 56% of households in the vulnerable community (Gowrie Kunkua) cultivates between 1-5 acres of land whiles 14.7% of households in the resilient community (Soe Kabre) cultivates between 1-5 acres. It further revealed that, 44% of households in the vulnerable community cultivates between 6-20 acres whiles 85.3% of households in the resilient community cultivates between 6-30 acres. The One-Way ANOVA confirmed that these differences are statistically significant (at $p < 0.001$). This perhaps explains the vulnerability of the Gowrie Kunkua community, despite the presence of a dam and an irrigation facility (not functional any more). It is assumed that the larger the farm holding, the greater the opportunity for the household to have more crops and yields, and hence the lower the vulnerability to climate variability. On the contrary, it is worth stressing that a household with a

larger farm holding may be more dependent on agriculture and therefore more vulnerable than someone with a small area of land under cultivation, but who works as a teacher or mason/carpenter (Antwi-Agyei, 2012). The resilient community due to its closeness to the forest belt between Ghana and Burkina Faso, is endowed with a vast pasture or grazing land for animal production. The vulnerable community on the other hand lacks adequate land for farming and no land is left for animals to graze. The resilient community is also endowed with a lot of economic and fruit trees such as shea, dawadawa among others whiles the vulnerable community has very little economic and fruits trees.

The second indicator of natural capital was the type of land ownership system under which the household is operating. The type of land ownership and level of security it provides may have serious implications for the management of agricultural soils, and could indirectly affect crop productivity and environmental sustainability, consequently influencing household vulnerability (Deininger and Jin, 2006). Three different ownership types were identified in the study communities. These were “land inherited”, “land purchased” and “land rented” by the households. The study discovered that, 5.3% of households in the vulnerable community purchased land, 90.7% inherited the land from their ancestors and 1.3% of households rented the lands. In the resilient community, 1.3% of households purchased land for their farming activities, 98.7% of the households inherited the land from their ancestors and 0% (no household) rented land in the resilient community. This indicates an abundance of land in the resilient community than the vulnerable community.

6.1.5 FINANCIAL CAPITAL

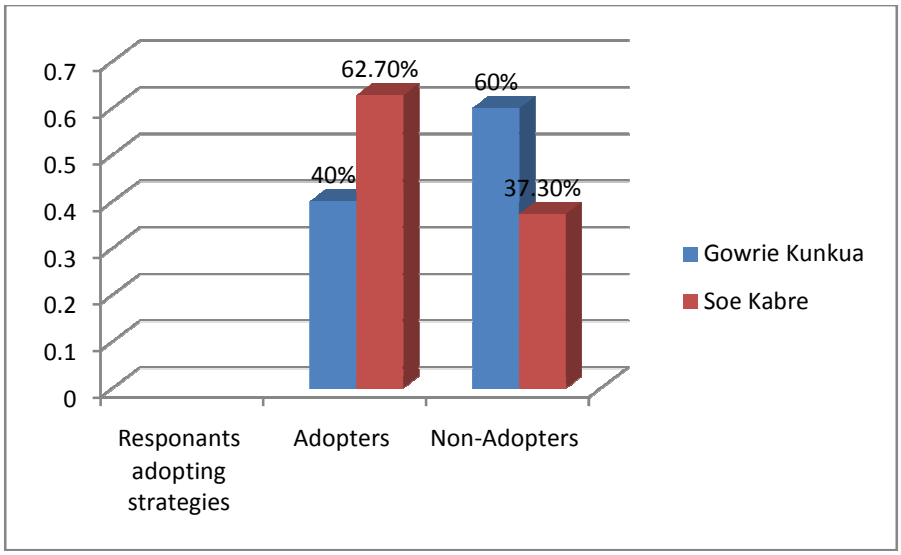
Hesselberg and Yaro (2006) are of the view that, financial capital assets via cash, savings and availability of credit, wages, liquid assets (livestock, poultry and jewelry), pension and remittances play an essential responsibility in cushioning households against drought-related livelihood insecurity. Livestock was considered to offer readily available cash in times of crop failure due to erratic rainfall patterns in the study communities. In this study, 89.3% of household in the vulnerable community owned livestock and poultry whiles 94.7% of households in the resilient community owned livestock and poultry (plate 5.3a and b). The major sources of finance include agricultural products (crop and livestock production, economic trees), engages in food-for-work/cash-for-work activities, remittances and non-farm and off-farm activities. Livestock, as a financial asset, contributes to household livelihoods in many ways in the study area. It begets income through sale of animals and/or animal products, which enables households to purchase food and agricultural inputs. Berlie (2013) noted that livestock can be considered as a liquid asset that can be turned into other forms of financial capital relatively quickly. This means agricultural products are considered the leading source of income in the study communities and grain production is the major activity of the sample households.

6.2 DECISION ON ADAPTATION STRATEGIES

In the Bongo district, every household employs a reactive mechanism when confronted with climate problems (e.g. food shortfall). However, not every household employs anticipatory or planned adaptations. In this study, households reported a diversity of adaptation strategies that included both modern and

traditional methods. Those who responded they implement planned adaptation strategies to climate change indicated different adaptation strategies. It was found (Figure 6.1) that, 40 % of sampled households in Gowrie Kunkua and 62.7% of households in Soe Kabre had implemented planned adaptation strategies to reduce the negative effects of climate change on their livelihoods whiles 60% in Gowrie Kunkua and 37.3% in Soe Kabre did not implement plan adaptation strategies.

FIGURE 6.1 RESPONDENTS ADOPTING ADAPTATION STRATEGIES ACROSS THE STUDY COMMUNITIES IN THE BONGO DISTRICT



Source: Field Survey, July 2015.

6.3 DETERMINANTS OF HOUSEHOLD ADAPTIVE CAPACITY

This study has identified the main possible features of smallholder households that seem to determine their adaptive capacity: age, sex, education, family size, farming experience, climate information, land size, credit, belief system, membership of organization and training. The binary logistic regression model was selected because it can be used with continuous, discrete and dichotomous variables mixed together (Alemu, 2007). Eleven (11) predictor variables were

selected to explain the dependent variable (adaptive capacity). Out of the total predictor variables of 11, five (5) variables were significant at 1%, 5% and 10% probability levels (Table 6.1). The omnibus test of the model coefficients has a Chi-square value of 100.312 on 11 degrees of freedom, which is strongly significant (at $p < 0.001$) indicating that the predictor variables selected had a high joint effect in predicting the status of household adaptive capacity. The predictive efficiency of the model showed that out of the 150 sampled households included in the model, 88.3% were correctly predicted. The sensitivity (correctly predicted adaptive capacity) and specificity (correctly predicted adaptive capacity) were found to be 86.3% and 87.3% respectively. The explained variation in the dependent variable based on the model ranges from 48.8% to 65.0%. The model explained 65% (Nagelkerke R^2) of the variations in adaptive capacity and correctly classified 87.3% of cases. The binary logistic regression results showed that education, belief system, land size, farming experience and training were important determinants of household adaptive capacity.

Training was very important such that the more training a farmer receives, the more likely the household will adapt to climate change. As training increases by one unit, the odds of adapting increase by a factor of 2.482 which is significant (at $p < 0.05$). The regression result in this study also shows a strong relationship between training and household adaptive capacity significant (at $p < 0.001$). Other variables being constant an increase in the education of the household by one unit, households‟ adaptive capacity increases by the odds ratio of 1.528. Farming experience of the household was found to be an important factor in households'

adaptive capacity. As farming experience increases by one unit, the odds of a household adapting increased by a factor of 2.160 statistically significant (at $p < 0.05$). The result is consistent with previous studies which have reported similar results that education, farming experience, land size, cultural factors and training has positively influenced the household adaptive capacity (Antwi-Agyei, 2012; Dhakal et al, 2013).With respect to land size and belonging to membership of an organization (CBO), it was found that land size and belonging to a member of farmer organization increased the odds of adaptive capacity by factors of 1.519 and 0.097 respectively, which is consistent with findings by (Dhakal et al, 2013). The belief system of the community or household significantly determined the adaptive capacity (at $p < 0.05$).

TABLE 6.1: DETERMINANTS OF ADAPTIVE CAPACITY

Predictor variable	Coeff (B)	S.E.	Wald	Sig	Odds ration
Agehh	-0.299	0.390	0.586	0.444	0.742
Sexhh	0.385	0.566	0.462	0.496	1.471
educationhh	0.424	0.168	6,398	0.011***	1.528
Belief systemhh	-0.472	0.238	3.940	0.024***	1.751
Farming experiencehh	0.770	0.413	3.473	0.022**	2.160
Climate infohh	1.361	2.165	0.395	0.530	3.900
Land sizehh (resources)	0.418	0.305	1.886	0.010***	1.519
credithh	-0.194	0.894	0.047	0.828	0.824
Family sizehh	0.111	0.194	0.327	0.568	1.117
Member of orghh	-2.336	1.605	2.116	0.146	0.097
Training	0.909	0.151	36.127	0.000***	2.482
Constant	-1.147	3.445	0.111	0.739	

Source: Field survey, July 2015

Climate information used as a variable in the determination of adaptive capacity of household in a study conducted by Dhakal et al., (2013) had significantly and positively determined the adaptive capacity of farmers, whereas family size (at $P < 0.05$) was negative and significant factor. However, in this study, the regression results showed otherwise, Family size ($p = 0.568$), credit ($p = 0.828$), climate information ($p = 0.530$), sex ($p = -0.496$) and lastly age ($p = - 0.444$) did not significantly influenced the adaptive capacity of the household. Forward stepwise (likelihood ratio) showed that membership of organization and access to credit had explained 44% of the total variation in household adaptive capacity and climate information explained 55% and the five most important variables training, education, belief system, farming experience and land size had explained 61% of the total variation in household adaptive capacity. The results which revealed that factors such as gender, age, education, family size, training, farming experience, land size, member of an organization and climate information of the household's determines to some extent (although the degree to which each predictor determines the adaptive capacity varies) the choice of a particular climate adaptation strategy by a household (planned or autonomous) is in tandem with previous studies(e.g. Smit and Pilifosova, 2001; Deressa et al., 2009; Antwi-Agyei, 2012) that suggest that socioeconomic factors such as education and training, farming experience, land size, resources, technology, infrastructure and skills could significantly influence a household's adaptive capacity. Second, contrary to these studies, the results suggest that factors such as belief system were statistically significant in influencing the adaptive capacity. The following

section of the thesis investigates why the predictors or factors such as education, belief system, training and skills, land size (resource) and farming experience were significant in influencing household's adaptive capacity.

6.3.1 THE EDUCATION OF THE HOUSEHOLD

The findings revealed that, education significantly determined adaptation strategies such as diversification of livelihoods, appropriate agronomic practices, indigenous knowledge, planting drought-tolerant varieties and planting various crops at different times ($p < 0.05$). Conversely, education did not significantly influence adaptive strategies such as changing planting time, reducing food consumption, governmental support and receiving assistance from family and friends. Smallholder households with relatively better formal education (i.e. Secondary education and above) has a tendency to diversify their livelihood sources more than smallholder households without any formal education. In this study, 78% of educated households implemented planned adaptations whiles 60% of uneducated households implemented planned adaptation strategies. Pearson, R correlation shows a moderate correlation (coefficient of 0.523) between level of education and the decision to implement adaptation strategies statistically significant at ($p < 0.001$). These findings are consistent with the findings of Antwi-Agyei, 2012).

6.3.2 FARM SIZE OF HOUSEHOLD

The land holding of a household (farm size) determines the adaptive capacity of a particular household via the choice of agro-forestry as an adaptation strategy ($p < 0.05$). The land size of a household influences significantly the decision to implement planned adaptation strategies such as planting different crops, AAP,

indigenous knowledge, planting drought tolerant crops, tree planting and agro-forestry. On the contrary, the land size of a household did not influence significantly the decision of households in implementing adaptation strategies such as irrigation, reduction in food consumption, planting early maturing crop varieties and temporary migration. Responses from survey questionnaire and FGDs suggest that households with a large amount / size of farm lands are more likely to implement strategies such as soil conservation practices, terracing, contour bonds, stone/grass/mud bonds, fodder production whilst households who have a smaller size of farm lands are likely to implement coping strategies such as applying fertilizer or manure when lands become infertile. For instance, the survey discovered that, 65% of households that have farm size above 15 acres implemented planned adaptation strategies whiles 35% of household with farm holdings of less than 10 acres implemented planned adaptation. This finding supports studies suggesting that insecure land tenure systems and small land holding may hinder farmers from implementing long-term adaptation strategies, e.g. soil conservation techniques (Damnyag et al., 2012; Adjei-Nsiah et al., 2006). During FGDs and KIs, discussant confirmed that, households that had a small farm holding (lands) claimed that the cost of implementing some adaptation measure was high and hence not profitable to incur huge cost implementing such strategies on a small piece of land. Farmers therefore choose to implement adaptation measures on a particular piece of land when the land size is large. It was noted for instance, that, constructing contour bonds and stone/grass bond demands a lot of resources (including donkey cart). This finding is similar to the

findings of Antwi-Agyei, (2012) who indicated that insecure land holding inhibits the implementation of adaptation strategies.

6.3.3 TRAINING AND SKILLS OF THE HOUSEHOLD

Households that successfully adapt to climate change recognize the need to adapt, have the requisite knowledge and skills about existing opportunities, the ability to evaluate the opportunities and the capacity to execute the apt opportunities. In the perspective of climate change, as training is offered to farmers/households about climate extremes and possible solutions, the weather hazards and extremes are better understood, hence households are in a better position to scrutinize, deliberate and execute adaptation measures hence increase their adaptive capacity. This study highlights that, fostering adaptive capacity entail a robust technical understanding of the problems, community involvement and development of solutions using both local and scientific knowledge and all these are attainable through training and capacity building of smallholder households. This finding is consistent with Holmes, (1996 in Smit and Pilifosova, 2001) who indicated that building adaptive capacity requires a strong unifying vision; scientific understanding of the problems, an openness to face challenges; pragmatism in developing solutions; community involvement; and commitment at the highest political level. A key informant and an expert interview and confirmed by Scheraga and Grambsch, (1998 in Smit and Pilifosova, 2001) suggested that lack of training and skill limits a community's or society's ability to implement adaptation options. Throughout the interviews and FGDs, it was asserted that, at large, communities or households with higher levels of training, exposure and human technical knowledge, perhaps possess a greater adaptive capacity than

households or communities with lower amounts of training and technical knowledge. Lack of training on new improved farming methods, perhaps, is the result of the low adaptive capacity in the Gowrie Kunkua community. A KI suggested that, it is essential to ensure that communities and households have access to the dissemination of climate change and adaptation information forums which exist for discussion, innovation and the sharing of adaptation strategies at various levels. In this regard, the field study revealed that, in the Gowrie Kunkua community, an NGO (SUFAEP) has established a Farmer Field School (model farm) for the training of farmers on AAP, improved indigenous farming methods (soil conservation and management, contour bonding and terracing, fodder production, alley cropping etc.). According to a KI, farmers from other nearby communities' visit the Farmer Filed School for trainings and this has helped improve their yields. Pearson, R correlation shows a strong positive correlation (coefficient of 0.723) between training and the household adaptive capacity statistically significant at ($p < 0.001$).

Lack of training implies lack of improved/new technology and this has the potential to seriously impede a community's potential to implement adaptation options by limiting the range of possible responses. Adaptive capacity is likely to vary, depending on availability and access to training (new technology) at various levels. Many of the adaptation strategies identified as viable in the management of climate change directly or indirectly involve technology (e.g., contour identification and stone/grass bonding, animal treatment, grain storage and preservation, composting, fodder production, crop residue management, dry

season gardening). Therefore, a community's or household's access to training reflected in the level of learning technology and its ability to innovate technologies are significant determinants of adaptive capacity. In line with this assertion, Smit and Pilifosova, (2001) confirms this study by asserting that, openness to the development and utilization of new technologies is key to strengthening adaptive capacity.

6.3.4 FARMING EXPERIENCE OF THE HOUSEHOLD

This study measured farming experience by the age of the household head and the number of years the household head has been engaged in farming. There is an indication that, there are more experienced farm households in the resilient community than the vulnerable community. As hypothesized (logistic regression), farming experience of the household was found to be an important determinant of household adaptive capacity statistically significant (at $p < 0.05$). This discovery is in tandem with previous studies which have reported similar findings that farming experience (as per the number of years a household has engaged in farming) positively influenced the adaptive capacity of households (Dhakal et al., 2013).The minimum age of the sampled households was 34 and the maximum was 116. The study affirmed that, the higher the age of a household, the better the chances of reducing vulnerability hence becoming non-poor. This is attributed to the fact that, such households have gained considerable farming experience. The research findings further revealed a positive relationship (at $p < 0.001$) with a Bivariate correlation between age, number of years engaged in farming (farming experience) of the household and adaptive capacity of the household. Young and female headed households were more exposed to vulnerability and livelihood

insecurity since such households lack adequate farming experience. The farming experience of the household's head was significant in determining the choice of adaptation strategies such as using indigenous knowledge, AAP and planting drought resistant crops statistically significant (at $p < 0.05$). The results reveal that more households that were headed by relatively younger farmers (i.e. 34 - 50 years) reported using chemical fertilizers to increase yields whiles households above 60 years extensively used indigenous agronomic practices. This could be attributed to the fact that older farmers (i.e. Above 60 years) were more inclined to use the traditional methods and crop varieties handed to them by their ancestors, which they are used to, compared with improved varieties that may have been modified even if they are high yielding and drought-tolerant.

6.3.5 BELIEF SYSTEM OF THE HOUSEHOLD

Equally significant is the fact that adaptive capacity of households or communities was significantly influenced by their belief system (belief about climate variability). For instance, the belief system of a particular household influences their adaptation strategies such as planting drought resistant crop varieties, use of indigenous knowledge, livelihood diversification and general appropriate agronomic practices statistically significant (at $p < 0.05$). Contrary, the belief system of a particular household or community did not significantly determine adaptation strategies such as reducing food consumption, buying food, migration to work elsewhere, receiving assistance from family and friends, and governmental and NGO support statistically significant (at $p < 0.05$). The findings revealed that households who belief (perceives) climate change as being caused by human/anthropogenic factors such as bush burning and deforestation usually

implement planned adaptation strategies to strengthen their resilience. The results further illustrate those households that believe in climate change are more likely to diversify their livelihoods, plant trees and employ improved agronomic practices contrary to households that do not believe in climate variability. It must however be noted that, factors such as accessibility of alternative livelihood options, access to education and training of the household justifies for the disparities in adaptive capacity between climate believers and non-believers since these factors play a critical role in shaping the belief system. Menapace et al. (2014) observed a significant correlation between farmers' belief about the reality of climate change and their willingness to adapt or to carry an adaptation / mitigation course of action. In this study, 51.7% of farmers/households that perceived changes in rainfall pattern implemented adaptation/coping strategies.

The conceptual framework argues that, farmers' belief system (perception of climate variability) determines their adaptive capacity. The framework has conceived that, farmers' belief system about climate change is a key and significant determinant of adaptive capacity or adaptation strategies of households. 29.6% of households who associate climate change to cultural factors (spiritual) such as the will of the gods (unexplained), shedding innocent blood (killing people), sexual intercourse and abortion, disrespect for life forces (sacred groves, shrines, the earth priest, ancestors etc.) did not adopt or implement adaptation strategies. The majority of those who adopted/implemented adaptation measures (62.7%) associated climate change to anthropogenic factors such as bush burning, deforestation and emission of fossil fuel. This is consistent with

Arbuckle et al. (2013b) study, where 58.02% of climate change believers that asserted that climate change is as a result of anthropogenic reasons adopted to it.

In addition to the belief system of a particular household, which is statistically significant in determining households' adaptive capacity, the studied discovered mediating /intervening factors such as resources, technology, government policies, social networks and institutional support e.g. NGOs. These intervening factors also influence to a large extent the adaptation or mal-adaptation of households to climate variability. Previous studies failed to recognize the belief system of a household/community as a determinant of adaptation to climate variability. This study or conceptual framework has conceived/theorize that, the belief system of a particular household/community is a significant determinant of their adaptive capacity. The study, therefore concludes that, farmers who view climate change as caused by the 'gods' or 'spirits' will not implement planned adaptation strategies (low adaptive capacity) but farmers/households that view climate change as caused by anthropogenic factors will implement planned adaptation strategies to reduce their vulnerability and risks hence a higher adaptive capacity.

6.4 CONCLUSION

In this chapter, households' capital assets were assessed; the major factors that determine the adaptive capacity of the household were examined. An in-depth analysis of the factors that are statistically significant in influencing household adaptive capacity, such as training, education, farm size, belief system and farming experience were assessed. The conceptual framework concluded that, the belief system of the household (i.e. Climate change is caused by anthropogenic or

spiritual factors-perceptions) is significant in influencing household adaptive capacity. This was corroborated by previous studies that socioeconomic factors influence farmers' adaptation strategies to climate variability. The conclusion can be drawn that, in attempts to support household adaptation strategies to climate change, considerable attention must be paid to understanding socio-economic factors, including the belief system in order to develop sustainable strategies that will be culturally accepted by the communities.

6. 5 COPING AND ADAPTATION STRATEGIES

6.5.0 INTRODUCTION

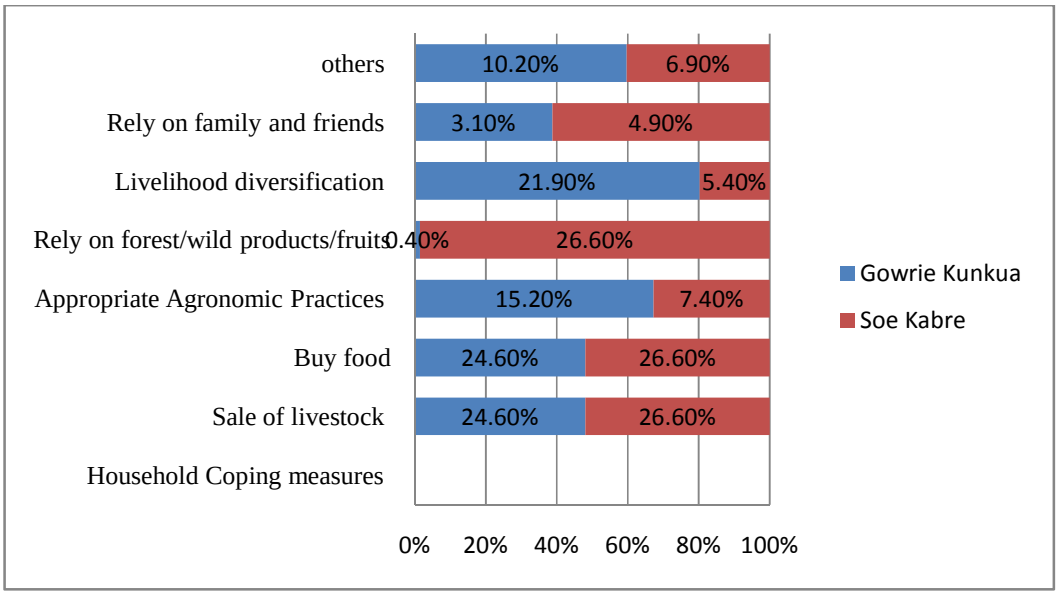
The former UN Secretary General Ban Ki-moon, in November 17, 2007 emphasized the need for climate adaptation, "*Let us recognize that the effects of climate change affect us all. And that they have become so severe and so sweeping that only urgent, global action will do*." As already emphasized, contemporary global attempts in seeking answers to climate change by the IPCC, UNFCCC and the Kyoto Protocol have acknowledged the vital role of adaptation as the course of action required to ameliorate the negative effects of climate change and its risk to most especially vulnerable people (Ford, 2007; Pielke et al., 2007). Notwithstanding the vital consideration and calls for adaptation as a policy option, fewer studies have attempted to explore smallholder households' adaptations in Sub-Saharan Africa, particularly Ghana (Tachie-Obeng et al., 2012; Antwi-Agyei, 2012; Bryan et al., 2013). Exploring household adaptations are particularly vital because, a good understanding of smallholder households' adaptation to climate change is relevant in supporting policy that will strengthen and upscale household resilience. Premised on this contention, this section of the

thesis investigated smallholder households coping (reactive) and adaptation (anticipatory) strategies used to manage the negative effects of climate change on their livelihoods. Smallholder households in the Bongo district employed both coping and adaptation strategies in the face of a wide variety of risks through their own labor, capability and resources to relieve the challenges. Thus, the succeeding discussions focus on the coping and adaptation strategies employed by smallholder households during food crises and climate change scenarios.

6.5.1 HOUSEHOLD COPING MEASURES

Coping measures are usually temporary measures adopted by households when they are faced with a threat. These measures are reactive and are usually discarded when the threat is over.

FIGURE 6.2 HOUSEHOLD COPING MEASURES



Source: Field Survey, July 2015.

The survey results showed that, 24.6% and 26.6% of households in the Gowrie Kunkua and Soe Kabre communities respectively sold their livestock and/or poultry to cope with food shortfalls, another 24.6% and 26.6% in the Gowrie

Kunkua and Soe Kabre communities respectively reported buying food from the market when they experienced food shortfalls. Households in the study area sell their key productive assets, which they usually fail to rebuild (restock) after the disasters had stopped its catastrophes.

AAP, such as depending on wells and dugouts for animals to drink and also for cultivating vegetables, harvesting immature food crops and performing traditional sacrifices were reported by 15.2% of households in the Gowrie Kunkua community and 7.4% of households in the Soe Kabre community. About 0.4% and 26.6% of households in the Gowrie Kunkua and Soe Kabre communities respectively, reported relying on forestry products, wild fruits and wildlife as coping measures. The great disparity between Gowrie Kunkua and Soe Kabre reliance on wild/forestry products is due to the fact that, the Soe Kabre community is located very close to a forest, hence they have access to a whole range of forest products/wild fruits compare to the Gowrie Kunkua community which is in the middle of Bongo township and Bolgatanga township hence more of peri-urban.

Approximately 21.9% and 5.4% of households in the Gowrie Kunkua and Soe Kabre communities respectively, reported diversifying their livelihoods into craftsmanship viz a viz weaving baskets/hats, smocks and paid non-farm jobs viz tailoring, masonry, etc. Another 3.1% and 4.9% of households in the Gowrie Kunkua and Soe Kabre communities respectively reported depending on support from family and friends. 10.2% of households in the Gowrie Kunkua community and 6.9% of households in the Soe Kabre community reported using other coping

strategies such as receiving remittance from institutions through the GSOP, LEAP programs, migration (inter and intra village migration, rural- rural, rural-urban and regional migration), engaging in off-farm jobs (fishing) among others were the main coping strategies employed by smallholder households in the study communities.

Damaging coping strategies such as out-migration of the entire households were practiced especially when elementary coping strategies are exhausted. Previous study (Dovie, 2010; Antwi-Agyei, 2012) in conformity with this present study identified migration, relying on family and friends, remittances, livelihood diversification, eating wild fruits, planting early and using drought tolerant crops and reviving old traditions as the main coping strategies of rural farmers. Continuous selling of productive assets such as livestock, poultry and land is a source of dwindling tangible assets and endangers households to chronic livelihood and food insecurity.

Berlie (2013) suggested that the continuous failure of rainfall has exhausted the coping strategies of vulnerable households, making them fall back on the consumption of seed and sale of farm implements for their survival. These events have significantly reduced the coping ability (or adaptive capacity) of households and endangered future food production and availability hence majority of smallholder households (92%) believe that severe food and livelihood insecurity will result from depletion of assets through continuous use of coping strategies.

From the discussions, it can be concluded that the human, natural and physical assets endowment, production levels, capacity to diversify income sources are the major determinants of smallholder households coping strategies.

6.6.0 SMALLHOLDER HOUSEHOLD ADAPTATION STRATEGIES IN BONGO DISTRICT

Household adaptation strategies used to manage with droughts (the major climate problem in the district) are categorized generally into on-farm adaptation strategies and off-farm adaptation strategies. On-farm adaptation strategies comprise a chain of practices or strategies carried out by agricultural dependent households on their farm intended to offset the negative effects of climate variability. Off-farm adaptation strategies comprise strategies or actions that households carry which are outside the farm intended to moderate their vulnerability to negative effects of climate variability.

TABLE 6.2 ADAPTATION STRATEGIES OF SMALLHOLDER HOUSEHOLDS IN BONGO DISTRICT

Adaptation strategies	Gowrie Kunkua		Soe Kabre	
On-farm	Percentage	Rank	Percentage	Rank
Planting late or early to avoid drought	93.3%	1	69.3%	2
Planting drought tolerant/resistant crops	76%	3	49.3%	4
Planting various crops at different times	89.3%	2	90.6%	1
Use of indigenous knowledge/strategies	78.7%	4	56%	3
Off-farm				
Rely on family and friends	21%	8	9.3%	8
Receive assistance from government	22.7%	7	12%	7
Income from off-farm jobs-livelihood	56%	5	34.7%	6

diversification				
Temporary migration	50.7%	6	40%	5

Source: Field survey, July 2015

The study (through FGDs, key informant interviews, observation and questionnaire surveys (see Chapter 3) obtained wide inventory of on-farm and off-farm adaptation strategies in the Bongo district. Table 6.2 reveals the various and broad strategies (on-farm and off-farm adaptation strategies) that households in the study communities used to manage the negative effects of climate change and these strategies can be exported and applied elsewhere by households in Ghana and SSA through Endogenous Development Approach. The capacity of smallholder households to survive climate effects and associated risks is perceived to be the vital adaptation strategy to strengthen household resilience. It must however be noted that, adaptation strategies are implemented at different times.

6.6.1 PLANTING LATE OR EARLY TO AVOID DROUGHT

The study revealed that an overwhelming majority of households reported altering their planting schedule in reaction to the late start of precipitation for the past three (3) decades. The survey revealed that, 93.3% (rank = 1) and 69.3% (rank = 2) of households in the Gowrie Kunkua and Soe Kabre communities respectively, reported altering their sowing period as a strategy to manage the late arrival of the rains. Discussants at a FGD noted that, three decades ago and beyond, the planting season used to start in March/April, but now farmers have to postpone planting until May/June since the rainfall pattern has become highly variable. The rainy season has become short (starts late and stop early). This is an indication

that the onset of the rains, which decides or regulates the beginning of the farming season has changed. The growing season, which used to begin in March/April in the 1940s through to the 1970s has changed since 1980s/ 1990s to late May and early June and more recently (2014/2015) from late June to early July. Farmers due to uncertainties' now plant their crops late to avoid droughts which wither crops and high temperature which kills seedlings.

6.6.2 PLANTING DROUGHT RESISTANT CROPS AND EARLY MATURING CROPS

Households have resorted to the use of drought tolerant or resistant crop varieties as one of the chief adaptation strategies to ameliorate the negative effects of climate change particular droughts on their livelihoods (food shortfalls). The study revealed that 76% (rank = 3) and 59.3% (rank = 4) of households in the vulnerable and resilient communities respectively indicated using crop varieties that can resist droughts and matures early. Examples of some of these crop varieties in the study district include maize, groundnut, and cowpea. Key informant asserted that these crops require less number of moisture days (65-90) to mature, measured against indigenous crop varieties such as guinea corn, late millet which require between 125-145 moisture days to mature. The use of drought tolerant crops has been indicated as one of the main recommended adaptation strategies in food systems (Campbell et al., 2011). The crops that mature early are also drought resistant because during their flowering which requires adequate moisture comes early enough such that by the time droughts set in the crops would have matured fully. This is very significant in decreasing climate change risks. The crops that mature early are also vital in supporting or

augmenting household food shortfalls especially during the stress periods. This corroborates Antwi-Agyei (2012) who suggested that households respond to climatic and non-climatic drivers through the adoption of crop varieties that matures early and requires less moisture.

6.6.3 PLANTING VARIOUS CROPS AT DIFFERENT TIMES

The study discovered that, farmers or households in the Bongo district are progressively employing or planting various crops at different times as an adaptation strategy to climate change so as to increase their yields and minimize the risk of total crop failure. The survey disclosed that, 89.3% (rank = 2) and 90.6% (rank = 1) of households in Gowrie Kunkua and Soe Kabre communities respectively testified employing crop diversification as an adaptation strategy to reduce the negative effects of climate variability. Experts at MOFA office noted that, diverse crops have distinct biological dynamics and therefore their susceptibility to erratic rainfall and high temperature vary considerably. Key informants explained that, as a way of distributing risks in times of uncertainties, farmers or household plant different crops at different times. A FGD participant noted “If a particular crop fails, the household will be compensated by the yield from other crops and hence avoids total crop failure”. Planting more than one crop on the same parcel of land grants some form of insurance for the household against crop failure. Bryan et al. (2013) discovery confirms this study which suggests that households are constantly employing crop diversification as an adaptation strategy to climate change.

6.6.4 USING INDIGENOUS KNOWLEDGE AND APPROPRIATE AGRONOMIC PRACTICES

One of the key adaptation strategies employed by households which have been passed on from the ancestors (old generation) and is now being modified was the use of appropriate indigenous agronomic practices and knowledge. 78.7% (rank = 3) and 56% (rank = 4) of households in the resilient and vulnerable communities respectively adopted a range of appropriate indigenous agronomic practice which have been developed by local knowledge. The appropriate agronomic practices used by households include:

1. **Manuring**: composting, organic manure application, crop residue management, the use of animal droppings

Plate 6.1a compost with millet straw, Plate 6.1b compost with shea-butter residue

Source: Field Survey, July 2015

2. Soil conservation and erosion control: terracing, construction of contour lines/bonds, mud bonds, stone bonds, grass bonds, alley cropping, and contour ploughing.

Plate 6.2a stone bonds along contour lines **Plate 6.2b stone bonds**

Source: Field Survey, July 2015

Plate 6.3a stone bond with grass re-enforcement, plate 6.3b gully erosion control

Source: Field Survey, July 2015

3. Animal rearing: fodder production, silage and hey, the use of *dabokoka* for the treatment of animal wounds and castration.

Plate 6.4a farmer using luceana to feed animals Plate 6.4b stored fodder

Source: Filed Survey, July 2015

4. Post harvest loss: the use of *dabokoka* in the storage and preservation of grains, the use of groundnut shell to control striger and other hygienic practices to prevent animal diseases.

And others, such as the use of shea-butter residue (molded and dried) as fuel for cooking and also for plastering walls to prevent cracks (buildings from collapsing) and reptiles from entering the premises of the house. Households also reported using pito residue for fishing and feeding animals such as pigs.

6.6.5 PLANTING TREES AND ALLEY CROPPING

Tree planting and agro-forestry is widely recognized as one of the adaptation strategies that can potentially mitigate climate change in the long-term. Respondents indicated that, tree planting has the ability to help reduce high temperature, increase rainfall amounts, provides households with animal feed and improve micro organism on the farm. About 29% and 24% of households in the vulnerable and resilient community indicated they have planted trees on their farms in the past and this assisted them to get fruits to eat, fuel wood and feed for their animals. These findings confirm previous studies by Jama et al.(2006),

Kebebew and Urgessa (2011) and Antwi-Agyei (2012) that suggest tree planting provides opportunity for low-income farmers to enhance their livelihoods activities by selling the wood products as small timbers, medicines and food. The capacity of households to plant trees as strategies to mitigate or adapt to climate change depends to a large extent on the farm holding (size of land) of the household.

Plate 6.5a: trees planted on farms. Plate 6.5b: alley cropping (contour lines)

Source: Field Survey, July 2015

6.6.6 DRY SEASON GARDENING AND IRRIGATION

Rain water harvesting techniques (ponds and dugouts) and large-scale irrigation services are progressively being used by households as a long-term planned adaptation strategy to climate change and related risks. Many households are gradually engaged in dry season vegetable cultivation (particularly tomatoes and other vegetables) during the off-season. Approximately 42% and 6% of households in the vulnerable and resilient communities respectively reported practicing dry season farming. The vulnerable community located close to the Vea irrigation dam, households mentioned that, they (72% of sampled household) have been allocated land at the irrigation site for farming by ICOUR. Although it has been widely agreed that the use of irrigation facilities can significantly reduce food and livelihood insecurity caused by crop failure (as a result of droughts), a

key informant indicated that, the Vea irrigation facility has become obsolete or unused in recent times. He indicated that, the canals feeding water to the irrigated farms are currently damaged, hence water cannot pass through to the farms. FG discussant noted that the inability of ICOUR (government) to repair the Vea irrigation facility has hindered their ability to cultivate vegetables in the dry season hence their current vulnerability to climate variability. As a result of this current challenge, farmers/household in the Gowrie Kunkua community with assistance from NGOs (e.g. Sustainable Family Agricultural and Education Support Program-SUFAEP) have supported farmers with inputs and training (water harvesting techniques, etc.) to cultivate vegetables in the dry season.

According to FG discussant, using irrigation as a way of managing with drought (food shortfalls) yielded significant benefits from the 1960s-early 2000 when the dam was effectively operational, since without the irrigation facilities, farming is limited to only one rainy season June–October in recent years. The vital importance of dry season farming as a planned adaptation strategy was reiterated by a key informant that, “cultivating vegetables such as tomatoes, onions, and other leafy vegetables in the dry season is very critical since there are no rains in the dry season, and the income I earn from the sale of produce is used to support my children health and education, buy food and it also prevents any member of my household to travel to Southern part of the country for work”. As shown by the picture/plates below, dry season farming is a vital adaptation strategy to climate variability. This assertion is supported by Antwi-Agyei (2012) that

households rely greatly on irrigation to cope with climate change, especially during the dry season when there are no farming activities.

Plate 6.6a and b.: tomatoes' farmers pumping water/watering their farms


Plate 6.7a and b.: Rain water harvested to irrigate farms; water in small scale dams used through gravity flow to irrigate farm


Source: Field Survey, July 2015

6.7.0 OFF-FARM ADAPTATION STRATEGIES

Income from off-farm jobs (Livelihood diversification), relying on family and friends, government assistance and migration were reported by households as off-farm adaptation strategies in the study communities. These strategies are elaborated more on in the following sections.

6.7.1 DIVERSIFICATION OF LIVELIHOOD ACTIVITIES

The results show that 56% (rank = 5) and 34.7% (rank = 6) of households in the Gowrie Kunkua and Soe Kabre communities respectively undertake several non-

arable farming livelihood activities in reaction or anticipation to rainfall variability (particularly droughts). A key informant asserted that, livelihood diversification is practiced more at the moment than three (3) decades ago, which enables us to buy food for our families during the dry season. A further scrutiny of livelihood diversification revealed that, off-farm livelihood activities such as petty trade, shea nut picking and butter processing, pito brewing and malt processing and basket and hat weaving are mainly female livelihood activities. Male non-farm livelihood activities were selling livestock and poultry, stone quarrying, sand mining, fishing, masonry, carpentry, motor/bicycle fitting/repairs among others. Livelihood activities such as weaving, charcoal production and petty trade were practiced by both men and women. These findings are in tandem with Berlie, (2013).

6.7.2 RECEIVING SUPPORT FROM FRIENDS AND FAMILY

Approximately, 21% (rank = 8) and 9.3% (rank = 8) of households in the vulnerable and resilient communities indicated they have sought assistance or depended on their family and/or friends for the past five (5) years (2011 to 2015) as an adaptation strategy to climate change and its negative effects on their livelihood activities. Households depend on social capital (alliances and networking) including CBOs, *Susu* /savings association, religious associations etc that offer support to its members in the form of labor on farms, food, credits and animals. More households (40%) in the Gowrie Kunkua belonged to social networks than the Soe Kabre community (36%).

6.7.3 MIGRATION

Approximately 50.7% and 40% of households in the Gowrie Kunkua and Soe Kabre communities respectively indicated that they migrated at least once in the last five (5) years as a strategy to reduce the effects of climate change on their livelihoods. Discussant at a FGD held that, during the dry season especially, people migrate temporarily to Southern Ghana to work in the cocoa growing areas, chop bars and drinking spots and head portage in order to meet their basic needs and remit back home. More recently, some people also migrate to Northern region to work on farms to earn income, accumulate food and harvest vertiver grass straw for weaving of baskets and hats. Awumbila and Ardayfio-Schandorf (2008) findings confirms this study. This study revealed that, some of the migrants in addition to working on people's farm, harvest vertiver grass straw for weaving their baskets since the vertiver grass are depleting in the UE/R. It is important to add that these activities that migrant farmers engage in, are low income paid jobs and others pay with food produce not in cash. Households indicated that, the major trigger of their migration is the recurrent droughts coupled with inherent poor soil fertility in the Bongo district, which have contributed significantly to reductions in agricultural productivity over the years. This finding is in tandem with Rademacher-Schulz and Mahama (2012) and Van der Geest (2011).For instance, data from MoFA suggest that average yields for millet and sorghum were 1.4 mt/ha and 1.2 mt/ha respectively, for 2010, compared with 0.8 mt/ha and 1.0 mt/ha for the same crops in 2012 and a further decline of 0.6 mt/ha and 0.9 mt/ha for 2014. Soils in the Bongo district are

deficient in nitrogen, phosphorus and sulphur (Antwi-Agyei, 2012). As indicated by households', the soil quality for crop production is very poor. The farmers are also challenged with social, economic, political and cultural barriers that, in part, induce their choice to migrate (Yaro, 2006). Other studies by (McLeman and Smit, 2006; Myers, 2002; Gemenne, 2011) also confirm that people migrate in response to harsh climate conditions as a coping mechanism. Discussant at a FGD said "We migrate to the southern Ghana so that we can work and earn money to enable us to buy food, pay our school fees and national health insurance since we have a long dry season in which we sit and do nothing. These assertions all indicate that, households migrate in anticipation of droughts and poor soil quality to secure a sustainable livelihood for themselves and their families.

6.7.4 ASSISTANCE FROM GOVERNMENTAL AND NON-GOVERNMENTAL ORGANIZATIONS

Approximately 22.7% and 12% of households in the Gowrie Kunkua and Soe Kabre communities respectively, reported that they have received assistance from government and NGOs at least once in the last five (5) years (2010-2015). Government assistance such as the Ghana Social Opportunity Project (GSOP) and the Livelihood Empowerment against Poverty (LEAP) and support from NGOS such as SUFAEP, CECIK, NABOCADO, CID, and ACDEP etc. The kind of assistance for the households includes Agric inputs support, trainings, seed support, food items and credit support.

6.8 CONCLUSION

This section examined the capitals assets of households, determinants of household coping and adaptive capacities as well as the main autonomous/coping

measure and planned adaptation strategies employed by smallholder households to ameliorate the negative effects of climate change on their livelihoods in the Bongo district. The findings revealed that households adopt a range of coping measures as well as on-farm and off-farm adaptation strategies to deal with climate change. The key coping measure identified included the sale of livestock, buy food, rely on forest products or wild fruits, family and friends, AAP, such as harvesting premature crops and relying on ponds and dugouts for animals to drink. On-farm adaptation strategies comprised planting late or early, crop diversification, planting drought tolerant crops and early maturing crops, use of appropriate indigenous agronomic practices or strategies, dry season farming, tree planting/agro-forestry and alley cropping. Off-farm adaptation strategies identified were livelihood diversification, migration, assistance from government and NGOs and depending on family and friends and social networks.

CHAPTER 7

CONCLUSIONS AND RECOMMENDATIONS

7.0 INTRODUCTION

The goal of this thesis was to examine the effects of climate change on livelihoods and the determinants of adaptive capacities among smallholder households in the Bongo district of the UE/R of Ghana. The study adopted a mixed method and multi-scale approach to gather suitable data at the household, community, district, regional and institutional levels.

7.1 SUMMARY

The study district is located in a semi-arid drought -prone area characterized by erratic rainfall, reduced rainfall, late onset, short duration and high temperature which have resulted in significant crop failure. These perceptions by households were confirmed by meteorological records of rainfall and temperature from the GMA at the Vea weather station. The study found out that the mean annual temperature had increased by 0.6^0C for the last three decades. The frequency and severity of droughts have increased considerably through time. The study further revealed that crop-growing months dramatically decreased from April/May to June/July.

This objective investigated livelihood strategies of household and climate change effects on the livelihood strategies. The study revealed that livelihood activities such as crop farming, animal rearing, fishing, shea butter processing, malt processing and pito brewing as well as trading were severely disrupted or affected by climate change through droughts (withering of crops), floods (destruction of property, wilting of crops), pest, disease, and poor germination of crops, post

harvest losses, drying up of water bodies and low water table as well as reduced pasture and fish stock. It was revealed that droughts are the most significant cause of declining yields and livelihood insecurity among all the factors mentioned since a minor alteration in rainfall can result in a significant loss in production. The results showed that households were under considerable stress of livelihood insecurity since key livelihood activities were severely threatened by climate change.

This study identified and evaluated the main factors that determine the adaptive capacity of households at the local-level, which have provided a broader understanding of the extent of vulnerability of households to climate change. The analysis further revealed that critical factors such as training, education, farm holding/land size, belief system and farming experience are statistically significant in influencing household adaptive capacity. The conceptual framework concluded that, the belief system of the household (i.e. whether climate change is anthropogenic or spiritual factors) is significant in influencing household adaptive capacity.

Empirical data revealed that households in the study communities employed a range of coping measures as well as on-farm and off-farm adaptation strategies to mitigate the negative effects of climate change (particularly droughts and floods) on their livelihoods. The study indicated that, households employed coping measures such as sale of livestock, buying of food, reliance on forest/wild products, fruits and game, relying on family and friends and diversification of livelihoods. It was further revealed that households employed on-farm adaptation

strategies such as changing the timing of planting, planting drought-tolerant crops and early maturing varieties, diversifying their crops, use of indigenous knowledge in agronomic practices, alley cropping and dry season gardening. Off-farm adaptation strategies included, livelihood diversification, support from friends and family, migration, assistance from government and NGOs and social capital/networks. One of the more significant results that emerged is that most households were using indigenous appropriate agronomic practices such as stone/mud/grass bonding, contour ploughing and terracing, fodder production, composting and organic manuring and the use of *dabokoka* for animal treatment and food preservation and storage in an attempt to avoid destitution due crop failure linked to climate change.

This study explored possible strategies that can build the resilience of households towards climate change. The key strategies that were identified at the household and community levels (through interviews, FGDs and survey questionnaire) were integrating indigenous practice and knowledge with scientific knowledge, provision of credit facilities and subsidies on agricultural inputs, support households to diversify livelihood activities, accurate weather forecasting, construction of mini dams, ponds and dugouts for dry season vegetable cultivation and provision of training and education on new improved methods of farming.

7. 2 RECOMMENDATIONS

Research is expected to offer suggestions for studies, contribute to knowledge, policy and practice. On the bases of this assertion, this study makes the following recommendations in order to address the pertinent issues that have emerged from the findings.

INTEGRATING INDIGENOUS PRACTICE AND KNOWLEDGE WITH SCIENTIFIC KNOWLEDGE

Local indigenous knowledge on climate adaptations should be blended with scientific knowledge in developing appropriate agronomic practice. Rural households in the study communities have used their local knowledge to develop coping and adaptation strategies to ameliorate the negative effects of climate change on their livelihoods since earlier times.

PROVISION OF CREDIT FACILITIES AND SUBSIDIES ON AGRICULTURAL INPUTS

Smallholder farmers lack financial resources to purchase agricultural inputs, have little access to credit to purchase seeds for sowing. Therefore there is the need for households to be provided with adequate credit facilities to enhance their ability to cope with weather extremes.

SUPPORT HOUSEHOLDS TO DIVERSIFY LIVELIHOOD ACTIVITIES

Efforts should be geared towards the development of local know-how to increase production of livestock in these communities through trainings on treatment of diseases of livestock and general production.

ACCURATE WEATHER FORECASTING

The availability of accurate climate information and early warning systems has been tainted as a major strategy that can boost household adaptation strategies. Farmers find it difficult to predict exactly when the rains will start, best time for planting, weeding and harvesting. GMA through AEA should assist farmers with access to information on the distribution of rainfall during the farming season. AEA can possibly use the mobile phone to send early warning messages and other climate information to farmers on time.

CONSTRUCTION OF MINI DAMS, PONDS AND DUG-OUTS FOR DRY SEASON VEGETABLE CULTIVATION

Efforts should be made towards the development of irrigation facilities through the construction of mini dams, ponds and dugouts (and development of water harvesting techniques) around these farming communities to enable farmers engage in dry season vegetable farming.

PROVISION OF TRAINING AND EDUCATION ON NEW IMPROVED METHODS OF FARMING

Households need to be educated on environmental issues, including degradation; desertification, erosion and climate change patterns, etc. and the need to take or adopt measures to safeguard the environment and improve their yields for sustainable development. There is also the need for trainings on new sustainable and improved methods of farming that integrate scientific knowledge with indigenous appropriate agronomic practices.

7.3 PRECEDENCES FOR FUTURE RESEARCH

The study recommends a more in-depth research to unravel the degree of personal concern about the potential impact of climate change on farmers' livelihood activities and the perception of the magnitude of negative outcomes (concerns) as well as the effects of climate change on the probability of the negative outcomes. Secondly, further research is needed to improve the estimation of adaptive capacity by using more proxy indicators such as irrigation potential of the various communities; soil degradation index, farm assets and farm income should be included in the determination of household adaptive capacity. The consideration of such indicators would provide a better understanding of the extent of livelihood vulnerability to climate change in the UE/R and Ghana as a whole.

7.4 CONCLUSION

Climate change presents negative effects on livelihoods of smallholder households. The theoretical frameworks succeeded in highlighting the reasons that account for vulnerability but failed to highlight the extent of smallholder households' vulnerability of livelihoods to climate change. This study has fulfilled this knowledge gap by providing a proper understanding of the determinants of coping and adaptive capacity of households to climate change.

Smallholder households perceptions about climate change corroborated by records from GMA indicated that rainfall and temperature pattern have changed with rainfall declining (highly erratic) and temperature rising. There are strong indications that the varying climate poses serious constraints and risk for the livelihoods of smallholder household in the Upper East Region and the country at large.

Smallholder households' livelihood activities were under considerable stress of livelihood insecurity and were severely threatened by climate change. Households' resource base such as farmland, grazing land and forests has reached their critical stage of degradation, and that is the main causes for the decline of the agricultural production and productivity.

Smallholder households adopt a range of coping measures as well as planned adaptation strategies to deal with climate change. Households are confronted with a number of constraints in implementing planned adaptation strategies. Therefore, households should be educated, trained and supported to diversify livelihood activities.

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9.0 APPENDIX

HOUSEHOLD SURVEY QUESTIONNAIRE

CONSENT FORM

This is an academic research and we are inviting you to take part in the research because you are a member of this household/community. The purpose of this research is to find out the impacts of climate variability on your livelihoods and the adaptation strategies you have been implementing. The study will use questionnaire and you are not obliged to answer every question. The study will also need to audio-record your responses. There will be no financial benefit for you for taking part in this research. The research team will keep your participation in this research confidential. Participating in this research is voluntary. Will you take part in this study? Yes…….No ……

SECTION A

DEMOGRAPHIC CHARACTERISTICS

1. Age …….. ..
2. Gender: (a) Male (b) Female
3. Highest educational level (a) No formal education (b) Primary school (c) Junior secondary school (Middle School) (d) Senior secondary school (e) Tertiary education (University, Polytechnic, Professional Colleges)
4. Indicate household size.

5. What religion do you belong to? (a) Islamic (b) Christianity (c) African Traditional Religion (d) others (specify)……..

Section B. Household Understanding/Perception of Climate Variability

9. Have rainfall patterns changed in your life time? Yes /no

If yes, briefly explain changes you have observed
……

If no, why? .....

10. Is there more or less rain today than in your childhood?

Compared to my childhood, rainfall has (a) increased (b) reduced (c) same

11. Do the rains fall earlier or late this time compared to your childhood?
Compared with my childhood, the rains come (a) earlier (b) late (c) same

12. When did you last have a 'good rainfall' year? (State year or number of years) ……..

13. Have temperature patterns changed during the growing season in your life time? Yes/no.

14. As compared to my childhood, temperature in the growing season has become (a) Hotter (b) Cooler (c)same

15. Do you consider the changes in Rainfall as a problem for your farming activities? Yes/no. Why and how?

……

16. Do you consider the changes in Temperature as a problem for your farming activities? Yes/no. Explain?

……

17. What do you think has been the causes(s) of this changing rainfall patterns?

(a) Bush burning, (b) deforestation (c) Breaking of taboos, (d) emission of fossil fuel (e) Others specify ……..

18. What do you think has been the causes(s) of this changing temperature?

……

……

Section C. The Livelihood Systems of Household

18. By what means does this household earn a living? (a) Farming (b) trading (a) civil/public service (d) remittance from family and friends (e) others (specify)……

19. By what arrangement does this household have access to your land for farming activities? (a) land purchased (b) land inherited (c) land rented (d) others ……..

20. By what arrangements does this household get labour for your farming activities?
(a) Family labour (b) Hired labour (c) communal labour/Assistance from friends

21. What is the size of this household farm holding (average cultivated land for the past 5 years in hectares or acres)? ……..

22. Does this household have access to credit for your agricultural activities? Yes/no.

23. If yes, indicate where you get credit. (a) government (b) NGOs (c) microfinance and banks (d) family and friends (e) others specify ……

24. If yes, when do you get this credit? (a) at beginning of farming season (b) middle of farming season (c) after the farming season.

25. Does this household have livestock or poultry? Yes/no.

26. If yes, list the types and numbers of livestock or poultry

……
……

28. What is your level of output (crops or livestock) currently? (a) High (b) moderate (c) low

29. Do you receive remittances from family or friends? Yes/no.

30. If yes, how often do you receive such remittances? (a) Very often (b) not often (c) sometimes

31. Do you have access to ready markets for your agricultural produce? Yes/no.

If yes, where and how long do you have to travel?.....

Section D. Livelihood activities of households

32. What are main livelihood activities of this household? (Rank with 1 being the most important)
33. Which of these livelihood activities are affected by climate variability?
……
……
34. How are these livelihood activities affected by climate variability?
……

35. What do you do to overcome negative impacts when they occur on the activities you have just mentioned above?

……

Section E Agro-ecosystems assessment

36. Please list the various crops you grow on your farm.

36. How would you describe the quality of soil for crop production in your farm? (a) Very good (b) good (c) poor (d) very poor

37. Do you rely on food from your own farm for the household? Yes/no.

38. If no, where and how do you supplement this? Briefly explain.

……

Do you participate in various community labor organizations? 1. Yes 2. No

If yes, which of the following organizations do you take part? / Multiple responses are possible/

Section F. Impacts of climate variability (past 5 years)

39. Please identify the major climate problems experienced in the last 5 years

SECTION G. Household Adaptation Strategies to Climate Variability

41. What strategies does this household adopt in bad years/years you experience food shortfalls

42. How did this household overcome challenges when face with food shortfalls

43. What are some of the ways you have used to cope with the changes in the climate in the past five years?

(a) Planting late or early to avoid the drought. Why or why not?

……

(b) Planting drought tolerant or resistant crops. State these crops.

.....

(c) Planting of various crops at different times

……

(d) The use of local indigenous knowledge/strategies. Please describe?

(e) Rely on friends/family/neighbours. In what form?

……..

(f) Receive assistance from the government. In what form?

……..

(g) Income from off- farm jobs (livelihood diversification). Briefly explain.

……..

(h) Sell non-farm assets to cope with the changes in the climate.

(i) Temporary migration to work elsewhere. Where and doing what?
……..
(ii) Would you migrate again as a strategy to cope with the changes in the climate? Yes/no. Briefly explain.
……
(j) Buy food or change diet. Please explain.

……

(k) Reducing food consumption

(l) Others (please specify)

44. Please rank the top three adaptation strategies you have used in the past. (1 being the most important and 3 being the least important).

(a) Changing timing of planting to avoid drought

(b) Planting drought tolerant/resistant varieties.

(c) Planting of various crops at different times (insurance against crop failure).

(d) The use of local indigenous knowledge.

(e) Rely on friends/family/neighbours.

(f) Receive assistance from the government.

(g) Rely on income from off- farm jobs.

(h) Sell non-farm assets to cope with the changes in the climate.

(i) Temporary migration to work elsewhere

(j) Buy food or change diet

(k) Others (please describe)

SECTION H: Considerations for Household Choice of Adaptation strategy

45. Please list (and describe) the five most important things that you think could help this household to reduce your vulnerability to climate variability (please list these in order of importance).

……

CHECKLIST FOR FGDS

PART I: Farmers' understanding of climate variability

1. What is the community view/understanding of climate variability?
2. What do you think are the causes of climate variability?
3. List all the livelihood systems in this community
4. List all the livelihood activities in this community

PART II: Effects of climate variability on livelihoods of smallholder households

5. Highlight the livelihood activities that are affected by climate variability

6. Highlight the main climate events that have taken place in this community since the 1980s.

7. How have these events affected your farming activities and other livelihoods?

8. How are these livelihood systems (and livelihood activities) vulnerable to changes in weather pattern?

9. What are the overall effects of climate variability on your livelihoods?

PART III: Adaptation Strategies of smallholder households to manage climate variability.

10. What are the factors that influence your adaptation to climate variability?

11. Are there any beliefs or social norms that prevent the community from taking certain decisions to respond to changes in the weather?

12. How do the community adapt to these changes in the weather pattern?

PART IV: Improving Resilience of households to impacts of climate variability

13. What strategies will strengthen the community's resilience?

Access to natural capital

1. Land holding size and number of plots
2. Ways of getting access to land
3. The trend of land holding size (decrease or increase or no change)
4. The general conditions of the available land (fertility, land fragmentation, topography, etc)
5. Main problems of farmland (land degradation, protection and grazing, complaints on land closures, etc)
6. Land management practices
7. Problems in relation to exploitation of natural vegetation and interest in planting trees
8. Perception towards drought and erratic rainfall and temperature change
9. How is the availability of rainfall in the area? 10. How is the trend of rainfall in the area?

3. Financial capital

Trends in production (decrease, increase or no change)
2. Perennial crops grown for cash crops (eucalyptus, papaya, apple, orange, etc)
3. How is the purchasing power of the household during food shortage?
4. How do they get the cash to buy food?
5. Livestock owned and constraints faced
7. Main expenditure
8. Housing situations (utensils and assets of the household, type of houses, etc.)
9. Availability, constraints and use of credit

4. physical capital

1. Health services 2. Schooling
3. Access to water for human and livestock 4. Agricultural extension services
5. Roads 6. Telecommunication
7. Electricity

5. Social Capital

1. Participation in informal institutions (etc.)
2. Participation in labor organization (etc.)
3. Labor support from neighbors

6. Government intervention

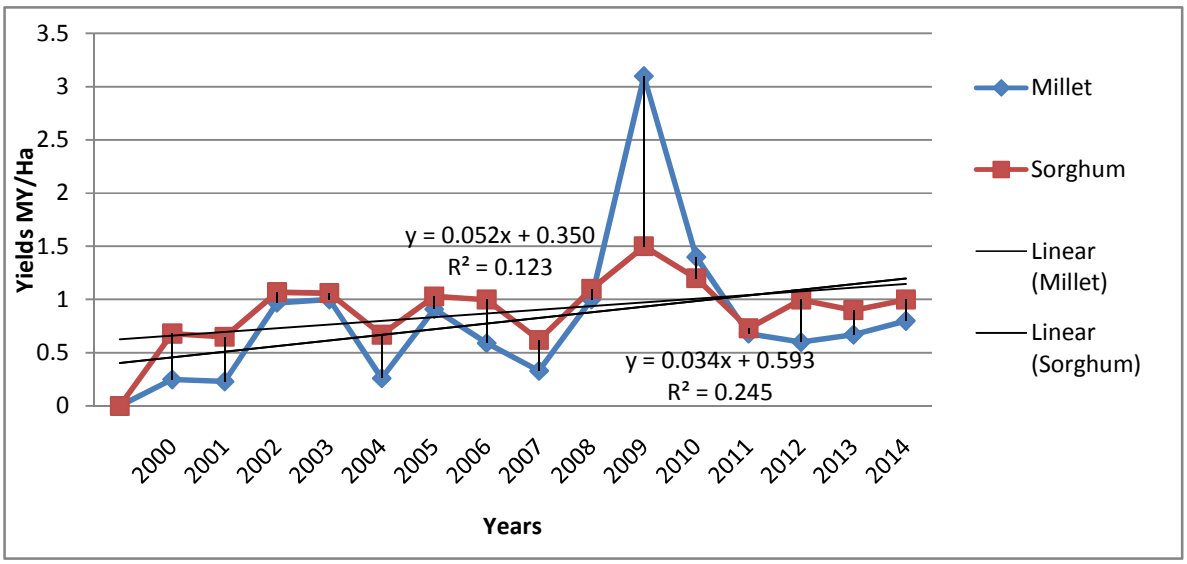
1. GSOP
2. LEAP

TABLE 9.1 HOUSEHOLD LEVELS OF OUTPUT CROPS AND ANIMALS

Components	Soe Kabre		Gowrie Kunkua	
Animals	Total number for sampled household	Average per household	Total number for sampled household	Average per household
Goats	595	8	426	7
Sheep	431	6	262	4
Cattle	425	6	209	3
Donkeys	81	1.1	11	0.2
Pigs	86	1.1	92	1
Guinea fowls	479	7	92	1.2
Chicken(fowls)	1491	20	1061	14
crops	Bags	MA/HA		MA/HA
Millet	601	0.75	463	0.58
Sorghum/guinea corn	649	0.81	477	0.81
Late millet	158	0.19	163	0.20
Beans	203	0.25	92	0.11
Groundnuts	461	0.57	346	0.43
Bambara beans	95	0.12	87	0.11
Rice	31	0.03	206	0.26
Soya beans	69	0.08	87	0.11
Maize	571	0.71	320	0.40
Sweet potato	35 tons		80 tons	

Source: Filed Survey, July 2015.

FIGURE 9.1 PRODUCTION IN MT/HA OF MILLET AND SORGHUM



Source: MOFA, 2015.