INDIGENOUS KNOWLEDGE AND ADAPTATIONS TO CLIMATE CHANGE: A CASE STUDY OF AGRICULTURE IN SELECTED COMMUNITIES IN THE BOSOMTWE DISTRICT

BY

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DECLARATION

I solemnly declare that I have undertaken this thesis submitted herein. It is the outcome of my own research and all other works consulted have been duly acknowledged. This thesis has never been presented anywhere either in part or whole for the award of any degree.

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DEDICATION

This work is dedicated to my family especially my mum, Joyce Asheley Ashitey. I love her deeply.

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ABSTRACT

Climate change impacts are being felt the world over and most vulnerable to these impacts are the indigenous people whose source of livelihood depends solely on natural resources especially farmers and fisher folks. The agricultural sector is highly threatened as the EPA of Ghana predicts that the country would lose about 81.3 square metres of arable land every year and yields of maize and other cereal crops will reduce by 7 percent by 2050 and this could result in unsustainable livelihoods. This creates an urgency to know how the most vulnerable people, on whom the whole country depends for food, adapt to the changes they experience using their local knowledge. The study therefore seeks to investigate and document the knowledge and adaptations of indigenous people to climate change impacts in order to draw support from the Ministry of Food and Agriculture- Bosomtwe and the Bosomtwe District Assembly to their needs and challenges. This will contribute to reducing their vulnerabilities, help build their resilience and help achieve sustainable livelihoods.

Two farming communities; Nyameani and Yaase, and two fishing communities: Abono and Adwafo were purposively selected for the study. Indigenes within these communities were reached through the snowballing sampling technique and they provided the needed primary data through the use of structure interviews and focus group discussions. Staff of MoFA also provided information through a face-to-face interview. Secondary data included meteorological data, literature from books, journals, articles and reports. Quantitative data were analyzed with SPSS-version 16 and Microsoft Excel, and meteorological data was plotted into graphs using Repeated Running Median. Results were presented in tables, graphs and charts. Qualitative data

were however analyzed through a logical reasoning process and results were presented as written descriptions and reports.

The study revealed that knowledge on climate change exhibited by farmers and fisher folks were based mainly on changes in temperature and rainfall patterns within their communities. Though their views were not always in line with meteorological data, these changes impacted negatively on their occupations and worsened their standard of living. As such majority (82 percent) of these respondents were engaged in other sources of livelihood that were not nature-dependent such as trading, hairdressing, driving and tailoring to support their incomes. Nonetheless, these farmers and fisher folks adopted methods such as cultivating different crops, practicing irrigation, using agrochemicals, using more fishing nets and spending more fishing hours as means of adapting to climate change impacts on their respective occupations. Unfortunately their adaptation methods are not sustainable and have minimal support from MoFA as the institution itself is inadequately equipped to support such indigenous adaptation strategies.

In order to improve these adaptation methods and make them sustainable, the study suggests that MoFA researches and documents all methods practiced by these farmers and fisher folks, assess them critically and give advice on the pros and cons related to each and how to get the best out of each method. Also, that central government should strengthen MoFA's capacity to provide the needed support for all indigenous adaptations within the district.

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CHAPTER ONE

INTRODUCTION

1.1 General Introduction

Climate change is a reality (Adger et al., 2005). The earth has warmed significantly and in the coming decades, whatever we do, we are committed to a further rise in temperature of at least 0.6 degrees Celsius (UNEP, 2006). The rise in temperature is attributed to the increasing amount of carbon dioxide and other greenhouse gases that trap heat in the earth's atmosphere (Jenson, 2009). Human activities have caused most of the observed increase in global average temperatures since the mid-20th century (IPCC, 2007 cited in Jenson, 2009).

The impacts of climate change are being felt the world over and these impacts vary across geographical regions. Some anticipated impacts are positive; for instance, water scarce regions such as parts of Southeast Asia may benefit from increased water availability due to changes in temperature, precipitation and snowmelt (IPCC, 2001 cited in UNDP, 2002). Other impacts are negative such as increase in heat waves and drought. A notable example was the European heat waves of 2003, which killed about 50,000 people (Jenson, 2009). The global surface affected by drought has doubled since 1970 and flooding incidences have also increased significantly (UNEP, 2006). Agricultural lands are being lost through flooding, droughts and land degradation. Whiles overall food production may not be threatened, those least able to cope will likely bear additional adverse impacts (WRI, 2005). According to the FAO (2005), 11 percent of

arable land in developing countries could be affected by climate change, including a reduction of cereal production in up to 65 countries. Developing countries are likely to suffer most from these negative impacts (IPCC, 2001 cited in UNDP, 2002).

Most vulnerable to these impacts are poor, natural-resource dependent communities in the developing world (Adger, 2006; IPCC, 2007 cited in Macchi, 2008). In general, the vulnerability will be highest for least developed countries (LDCs) in tropical and subtropical areas. Hence, countries with the fewest resources are likely to bear the greatest burden of climate change in terms of loss of life and relative effect on investment and the economy (IPCC, 2001 cited in UNDP, 2002).

In Africa, agriculture and land use sectors dominate GHG emissions accounting for 57 percent with the energy sector accounting for 32 percent (Nyong et al., 2007). According to the IPCC (2007 cited in Gyampoh et al., 2008), a medium-high emission scenario would see annual mean surface temperatures in Africa increasing by between 3 degrees Celsius and 4 degrees Celsius by 2080. Nevertheless, the continent is already under pressure from climate stresses and is highly vulnerable to the impacts of climate change (UNFCCC, 2007). The climate is predicted to become more variable, and extreme weather events are expected to be more frequent and severe, with increasing risk to health and life. This includes increasing risk of drought and flooding in new areas (Few et al., 2004; Christensen et al., 2007 cited in UNFCCC, 2007). It has been estimated that one third of Africans already live in drought-prone areas and 220 million are exposed to drought each year (UNFCCC, 2007). The continent is likely to suffer from famine and widespread disruption in socio-economic wellbeing as a result of these frequent

occurrences of floods and droughts. In all these vagaries of climate, the impacts on agriculture cannot be overlooked as much agricultural land will be lost, with shorter growing seasons and lower yields which can pose a threat to food security. There will be a general decline in most of the subsistence crops, for example, sorghum in Sudan, Ethiopia, Eritrea and Zambia; maize in Ghana; millet in Sudan; and groundnuts in Gambia (UNFCCC, 2007). Changes in ocean circulation patterns may affect fish populations. Africa may then account for the majority of people at risk of hunger by the 2080s (Fischer et al., 2002). There will also be increasing water scarcity and stress with a subsequent potential increase of water conflicts as almost all of the 50 river basins in Africa are transboundary (Ashton, 2002; De Wit and Jacek, 2006 cited in UNFCCC, 2007). The continent's ability to cope with climate change is proving difficult as a result of factors including poverty, weak institutions, lack of technology and information and low management capabilities (UNDP, 2006).

Over the last forty years, Ghana has recorded temperature rise of about 1 degree Celsius as well as reductions in rainfall and runoff of approximately 20 percent and 30 percent respectively (Gyampoh et al., 2008). Though Ghana's emissions are low compared to other countries (contributing 0.03 percent of global carbon emissions), there is potential for the emissions to grow and peak across sectors considering emerging economic prospects for Ghana under business as usual. Carbon dioxide is the major greenhouse emission in Ghana however; methane is predicted to contribute significantly to the national greenhouse emissions in the coming years as a result of increased activities in the oil and gas industry. The energy sector continues to be the largest source of greenhouse gas emissions as at 2006 and it is predicted to dominate over time. However,

emissions from Land Use, Land Use Change and Forestry (LULUCF) have significant impact on the national emissions especially through forest and grassland conversions (Adu and Benefor, 2010). The impacts of changes in the climate in Ghana are resulting in a rise in drought, flooding from heavy and incessant rains, rise in the sea level and erosion. This has already led to a rise in death and poverty levels in many regions and communities in Ghana, resulting in a great loss of income, lives and property. In 2009, for example, property lost from floods in the southern part of Ghana in June and July alone, was about US$ 5,813,954.7 and the deaths were 23 (EPA, 2010b).

Agriculture is currently the biggest contributor to Ghana's Gross Domestic Product (GDP) but over the last decade, its contribution has declined from 51 percent to 36 percent of GDP. As a result, the rural poor now account for almost three quarters of Ghanaians, who live below the poverty line (ABN, 2010 cited in EPA, 2010a). Increase in temperature, decrease in rainfall, and its unpredictability, are likely to jeopardize the employment of about 60 percent of the active population of Ghana, majority of whom are small scale rural farmers. Agriculture and food security are interrelated and thus climate change induced unsustainable livelihoods will result in negative consequences on food security, poverty, health, education, gender equality and environmental degradation (EPA, 2010a).

Agricultural production's dependence on rainfall is a significant hindrance to the development of the sector in Ghana and this has resulted in the plummeting of agricultural yields. The cereal crop yield alone is predicted to plunge by 7 percent in the next 40 years. By 2009, 5 percent of the Ghanaian population, or 1.2 million people, had

very limited access to sufficient and nutritious food for an active and healthy life (EPA, 2010a). These indicate that Ghana has had its own fair share of climate change impacts. The group that is most vulnerable to the impacts of climate change is the indigenous people whose source of livelihood depends solely on natural resources, thus those involved in primary occupations such as farming, fishing and hunting. If much agricultural lands will be lost with shorter growing seasons and lower yields as a result of changing climate, one may wonder what will happen to our subsistent farmers and other locals whose livelihoods depend on agriculture.

Unfortunately, in Ghana there are low levels of awareness and poor understanding of climate change impacts coupled with significant knowledge gaps about climate change processes (Mensah et al., 2009). These have hindered effective societal decision making of climate change adaptation and mitigation. There is therefore the need to create such awareness and also integrate indigenous climate change adaptation and mitigation planning with sustainable development and poverty reduction goals (Macchi, 2008). It is often believed that financial capital is the most important indicator of adaptive capacity. According to the 1998/1999 World Development Report (cited in Nyong et al., 2007), knowledge, not financial capital, is the key to sustainable social and economic development. Hence building on local knowledge, the basic component of any region's knowledge system, is the first step to mobilize such capital (Phillips and Titilola, 1995 cited in Nyong et al., 2007).

Whiles the importance of indigenous knowledge has been realized in the design and implementation of sustainable development projects, little has been done to incorporate

this into formal climate change mitigation and adaptation strategies. Incorporating indigenous knowledge into climate change policies can lead to the development of effective mitigation and adaptation strategies that are cost-effective, participatory, and sustainable (Robinson and Herbert, 2001 cited in Nyong et al., 2007). Climate change mitigation and adaptation projects can learn from the experiences of other developmental projects by recognizing the value of indigenous knowledge systems. There is therefore the need to integrate indigenous knowledge on climate change into modern scientific knowledge to design projects and national adaptation strategies to fight the climate change impacts (Nyong et al., 2007).

1.2 Problem Statement

According to the Environmental Protection Agency (EPA) of Ghana, the projected annual temperature increase of 2.2-3.5 degrees Celsius in the central belt of the country is significantly higher than the projected average (1.5-3.0 degrees Celsius) for the African continent (EPA, 2010h). Rainfall is also predicted to decrease on average by 2.8 percent, 10.9 percent and 18.6 percent by 2020, 2050 and 2080 respectively in all forest ecological zones (EPA, 2010f) and these will result in floods and droughts. Ghana would be losing about 81.3 square metres of arable land every year and a large part of the country already shows a marked sensitivity to periods of drought (EPA, 2010h). All these are threats to the agricultural sector.

It is forecasted that yields of maize and other cereal crops will reduce by 7 percent by 2050 and could result in unsustainable livelihoods with negative consequences for food

insecurity, poverty, health, education, gender equality and environmental degradation (EPA, 2010a). Those more likely to suffer these impacts and are most vulnerable are the people who depend on natural resources and rain-fed agriculture as their source of livelihood (GebreMichael and Kifle, 2009). This clear scenario portrayed about the country is worrying knowing the fact that the Ghanaian economy is agrarian and depends largely on its indigenous people (usually farmers and fisher folks) to feed the nation. This creates an urgency to know how these most vulnerable people, whom the whole country depends on, adapt to the changes they experience using their local knowledge.

To investigate this, the Bosomtwe district comes up as a good case study. The district falls within the forest belt of the Ashanti region and is within the wet semi-equatorial climate region with a rainfall regime typical of the moist semi-deciduous forest zone of the country. It has two well-defined rainfall seasons; the major season occurring from March to July with a peak fall in June and the minor season starting from September to November with a peak fall in October. Temperature is uniformly high throughout the year with an annual mean of 24 degrees Celsius. The highest mean (27.8 degrees Celcius) occurs just before the major season in February. Agriculture is the backbone of its economy employing 62.6 percent of the labour force. Crop farming employs 57.4 percent and fishing 5.2 percent, however about 41 percent of those engaged in other occupation still take up agriculture as a minor occupation. Farmers are mainly of small scale nature so use low inputs and technology in farming whiles the fisher folks solely depend on the Lake Bosomtwe which is the only natural lake in Ghana for their fishing activities (MoFA, 2011).

According to Gyampoh et al. (2009), indigenous people often observe the activities around them and are the first to identify and adapt to any changes. This gives a reason to also investigate the impacts of changes in climate from these people. Again the Bosomtwe district with most of its people being indigenous to their localities offers a good opportunity to get the necessary data for the study.

1.3 Objectives of the Study

The general objective of the study was to investigate and document the knowledge and adaptations of indigenous people to climate change impacts.

1.3.1 Specific Objectives

1. To assess how indigenous farming and fishing practices contribute to climate change impacts.
2. To examine how changes in rainfall and temperature patterns impact on livelihoods of the people.
3. To discuss indigenous adaptations (local innovations) to climate change.
4. To determine how indigenous knowledge and exposure to climate change has impacted on their level of vulnerability and adaptations.

1.4 Assumptions of the Study

The following assumptions guided to the study:

1. Indigenous knowledge of and exposure to climate change impacts influence their adaptation strategies.

2. The adaptation strategies practiced by indigenous people reduce their vulnerabilities to climate change impacts.
3. Government's support for indigenous adaptation strategies helps build the resilience of indigenous people towards climate change impacts.

1.5 Relevance of the Study

This research will help bridge the knowledge gap in understanding the present and future impacts of climate change on traditional and indigenous people so as to reduce their vulnerability and enhance their resilience and adaptive capacity. It also aims to provide results that will facilitate the integration of indigenous ideas and innovations in programmes and actions to address national climate change impacts.

The research outcome and recommendations will serve as a guide to the Ministry of Food and Agriculture (MoFA)-Bosomtwe and the Bosomtwe District Assembly in drawing out strategies for poverty reduction. This is because as climate change impacts on the livelihoods of the indigenous people are documented, the District Assembly will focus on appropriate strategies that will mitigate such impacts, thereby improving their livelihoods. Also, local communities (especially the study communities) will benefit from the support of NGOs, Government organizations and other related bodies in improving their local innovations to climate change adaptations. The study will also draw the attention of MoFA to the needs and challenges of these indigenous farmers and fisher folks, and the need for support from the ministry to curb their situation. If

adequate support is given, it will help reduce their vulnerabilities, enhance their resilience and help them achieve sustainable livelihoods.

1.6 Fieldwork Limitations and Ethical Considerations

Doing fieldwork and research in Environmental, and Development studies raises important ethical concerns. Ethical guidelines such as informed consent and confidentiality, the latter when requested, were followed throughout the fieldwork. The issue of power differential between the researcher and the researched and how this affects research outcomes from a scientific point of view was also taken into account (Chambers, 1997). Language barrier was not an issue and the use of interpreters not warranted, peeling away another layer of 'remoteness' between the researcher and the respondents who were either fisher folks or farmers.

1.7 Structure of the Study

The study is divided into six chapters. Chapter one dealt with the introduction, statement of the problem, objectives of the study, assumptions of the study, relevance of the study, limitations and the structure of the study.

The second chapter covered the literature review related to the subject matter and the conceptual framework

Chapter three covered the profile of the study area and methodology.

Chapter four covered the analysis of the data collected, presentation as well as discussion of findings related to Indigenous Knowledge and Vulnerability to Climate Change.

Chapter five covered the analysis of the data collected, presentation as well as discussion of findings related to Adaptations and Government's Support for Local Adaptations.

The final chapter (six) dealt with the summary of findings of the study, conclusions and recommendations.

CHAPTER TWO

LITERATURE REVIEW AND CONCEPTUAL FRAMEWORK

2.1 Introduction

This chapter reviews literature on various items related to climate change in relation to the objectives and assumptions of this study. It examines key items-The concept of climate change, Climate change impacts, Understanding the terms; vulnerabilities and resilience to climate change, Indigenous knowledge and climate change, Neglect of indigenous knowledge, and Supporting and integrating indigenous knowledge with science/ western knowledge to climate change adaptations.

2.2. The Concept of Climate Change

2.2.1. Global Changing Climate

Climate change is an environmental, social and economic challenge on a global scale (Scholze et al., 2006). Today, both the scientific and non-scientific communities have come to agree that climate change is already a reality. According to the IPCC (2007 cited in Jenson, 2009), climate change refers to any change in climate over time, whether due to natural variability or as a result of human activity. This definition differs slightly from that of the UNFCCC (1992) to which climate change refers to a change of climate attributed directly or indirectly to human activity that alters the composition of the global atmosphere and that is in addition to natural climate variability observed over comparable time periods. The IPCC revealed the contribution of natural processes like vulcanicity to climate change in addition to human activities whiles the UNFCCC

focused more on the latter. Nevertheless these processes (natural and human) alter the composition of the global atmosphere resulting in the change in climate over time. Moreover, it is widely accepted that human activities contribute immensely to climate change. The accelerated uptake of fossil fuel, the broad scale deforestation, the major technological and socioeconomic shifts with reduced reliance on organic fuel, agricultural activities (such as the application of fertilizer in addition to natural processes) and land use changes continuously emit large quantities of greenhouse gases into the Earth's atmosphere (Millennium Ecosystem Assessment, 2005 cited in Ishaya and Abaje, 2008). These greenhouse gases which include carbon dioxide (CO_2), methane (CH_4) and nitrogen dioxide (N_2O) have the ability to stay in the atmosphere for a long period of time trapping the infrared radiation (sun's energy), which reflects in the form of temperature thus compounding the heat trapping potential and causing global warming. Thus a rise in these gases has caused a rise in the amount of heat from the sun withheld in the Earth's atmosphere, heat that would normally be radiated back into space. This increase in heat has led to the greenhouse effect, resulting in climate change (UNFCCC, 2007).

Climate Change comes with varied characteristics which include increases in average global temperature (global warming); changes in cloud cover and precipitation particularly over land; melting of ice caps and glaciers and reduced snow cover; and increases in ocean temperatures and ocean acidity–due to seawater absorbing heat and carbon dioxide from the atmosphere (UNFCCC, 2007). Continuation and exacerbation of human activities has added to these gases resulting in an increase in the earth's surface temperature, sea level, precipitation, droughts and floods (EPA, 2010). Carbon

dioxide is the major greenhouse gas and its concentration in the atmosphere is measured to determine the rate and extent of global warming which results in climate change. Science has proved that there has been significant rise in global temperatures from the pre-industrial times to present times. According to the IPCC (2001 cited in UNDP, 2002), in the year 2000 the atmospheric concentration of carbon dioxide (CO_2) increased from a pre-industrial value of 278 parts per million (ppm) to about 370 ppm, which represents about a 30 percent increase. In the year 2005, the value shot up to 379 ppm which recorded a rise of 0.74 degrees Celsius in the average global temperature. According to scientists, this is the largest and fastest warming trend that they have been able to discern in the history of the Earth (UNFCCC, 2007). Again the IPCC anticipates that over the next 250 years, the projected global temperature increase, compared to the 1990 global average, is expected to be 1.9 to 5.1 degree Celcius for CO_2 concentration stabilization at 550 ppm, and 2.8 to 7.0 degree Celcius at 750 ppm (IPCC, 2001 cited in UNDP, 2002).

There have been several predictions made over temperature increases in 2100. According to the IPCC (2001 cited in UNDP, 2002) increases are projected to be in the range of 1.4 to 5.8 degrees Celcius by 2100 in comparison to 1990. This slightly differs from the projections made by Desanker (2005) that increases would range between 1.5 degrees Celsius (2.7°F) and 6 degrees Celsius (10.8°F) by 2100 whereas sea levels are projected to rise by 15 to 95 centimeters (6 to 37 inches) by 2100.

Even though predictions by 2100 range from a minimum of 1.4 degrees Celcius to 6 degrees Celcius, the best estimate indicates that the earth could warm by 3 degrees

Celcius by the year 2100 (UNFCCC, 2007). Under a business as usual scenario, greenhouse gas emissions could rise by 25–90 percent by 2030 relative to 2000 and the Earth could warm by 3 degrees Celcius this century (UNFCCC, 2007). These scenarios prove that indeed there has been climate change globally and it is likely to get worse by coming years under current human activities.

2.2.2. Africa's Changing Climate

Climate change scenarios for Africa indicate future warming across the continent ranging from 0.2 degrees Celcius (0.36°F) per decade (low scenario) to more than 0.5 degrees Celcius (0.9°F) per decade (high scenario) with attendant negative effects on livelihoods (Hulme et al., 2001; Desanker and Magadza, 2001 cited in Desanker, 2005). This warming will be greatest over the interior of semiarid margins of the Sahara and central southern Africa. According to the IPCC (2007 cited in UNFCCC, 2007), a medium-high emission scenario would see an increase in annual mean surface air temperatures of between 3 degrees Celsius and 4 degrees Celsius by 2080. Drier subtropical regions may become warmer than the moister tropics (Gyampoh et al., 2009).

The historical climate record for Africa shows warming of approximately 0.7 degrees Celcius over most of the continent during the twentieth century; a decrease in rainfall over large portions of the Sahel (the semi-arid region south of the Sahara); and an increase in rainfall in east central Africa (Desanker, 2005). Much of Mediterranean Africa, the northern Sahara, much of the winter rainfall region and western margins in southern Africa will experience decrease in annual rainfall whiles an increase will be

recorded in East Africa. Though it is anticipated that rainfall will increase in the dry Sahel, this may be counteracted through evaporation (UNFCCC, 2007). Historical facts on rainfall in Africa show that recent rainfall values have dropped compared to decades prior to the 1960s. For instance the years 1984 and 1990 saw rainfall totals drop below 50 percent of those typical of the last decades of the colonial era prior to 1960. During the period 1960-1990 a dramatic decline in average rainfall was recorded in all West African dry lands (Put et al., 2004:27 cited in Kelbessa, 2007). This period led some regions in the northern zone into arid conditions whiles part of the sub-humid zone became semi-arid with drought risks (Kelbessa, 2007). This is a scenario that shows how Africa is experiencing its own share of climate change impacts.

2.2.3. Ghana's Changing Climate

Climate change is real and Ghana has not been left out. The last 40 years of the twentieth century, saw a temperature increase of about 1 degree Celsius (EPA, 2000), meanwhile temperature is projected to accelerate over the next 50 years, resulting in an increase of further 1.5-3 degrees Celsius (EPA, 2010d). There will be further temperature rise of about 0.6 degrees Celcius, 2.0 degrees Celcius and 3.9 degrees Celcius in the years 2020, 2050 and 2080 respectively. Also rainfall is predicted to decrease on average by 2.8 percent, 10.9 percent and 18.6 percent, by 2020, 2050 and 2080 respectively in all forest ecological regions (EPA, 2010f). For instance, a study conducted on the Offin river basin by Gyampoh et. al. (2007), saw a reduction in mean annual rainfall of 22.2 percent and a gradual rise in average maximum temperatures of 1.3 degrees Celcius or 4.3 percent from 1961 to 2006. These government and private

researches help establish the fact that climate change is real in Ghana and its impacts could be severe and damaging.

2.3. Climate Change Impacts

2.3.1. Global Impacts

The consequences of climate change will not be distributed equally and the impacts will be different within any particular society, since rights and resources are unevenly distributed (Duarte et al., 2007; Malone, 2009). The IPCC (2007 cited in Malone, 2009) defines climate change impact as an effect of climate change on the structure or function of a system. Climate change is affecting every corner of the world and its impacts affect the physical, human and ecological systems. As more future impacts are being predicted, most are presently being experienced. There are wide spread consensus on impacts on sea levels, weather systems, ecosystems, public health and economic development (Duarte et al., 2007).

According to Spore (2008 cited in GebreMichael and Kifle, 2009), climate change impacts will lead to a further increase in annual temperature of 0.74 degrees Celcius, the melting of polar icecaps, uncontrolled forest fires and an annual average rise in sea level of 3.1 mm. An example is the melting of the Greenland ice sheet (Gregory et al., 2004 cited in Adger et al., 2005). These impacts could further lead to disasters. For instance, a projected sea level rise could flood the residence of millions of people living in the low lying areas of South, Southeast and East Asia such as in Vietnam, Bangladesh, India and China (Cruz et al., 2007). Regions with increase in precipitation such as the eastern US

will experience increasing snow cover or flooding whiles those with decline in precipitation like the Sahel, the Mediterranean, southern Africa and parts of southern Asia will experience droughts and famine. These cause ecosystem extinction and land degradation which affects food production thus undermining food security. For example, the IPCC (2007 cited in GebreMichael and Kifle, 2009) has estimated that, by 2020, agricultural production would decline by 50 percent in some countries with rain-fed agriculture. Nevertheless, impacts of climate change on food production and security are geographically diverse. Crop productivity is projected to increase slightly at mid-to high latitudes whiles at lower latitudes, especially in seasonally dry and tropical regions, a decrease in crop productivity is projected for even small local temperature increases of between 1-2 degrees Celcius, which would increase the risk of hunger (UN General Assembly, 2008).

Cruz et al. (2007 cited in UNFCCC, 2007), in writing on Impacts of Climate Change on Asia, stated that Asia had many frequent and intensified extreme weather events such as heat waves, tropical cyclones, prolonged dry spells, intense rainfall, tornadoes, snow avalanches, thunderstorms, and severe dust storms. These further lead to hunger, susceptibility to disease, loss of income and livelihoods affecting human survival and well-being. For example the extreme weather events in China during 2006 included major storms and flooding in the east and south, as well as heat and drought in central, western and northeastern regions, killing more than 2700 people and causing USD 20 billion in damages. The loss of plant and animal species, coral reefs and the fast spread of diseases cannot be overlooked. An example is the world's first wildlife refuge in Florida's Pelican Island set aside in 1903, which is now being consumed by rising seas.

The impacts of climate change are numerous and this is just to give an idea of its character and magnitude. Human systems are dependent on their environments, and changes to those environments directly affect human health, society, and prosperity (Jenson, 2009).

2.3.2. Impacts on Africa

The story of Africa is not different from the global situation, yet with Africa being most vulnerable to these impacts, it is wise to highlight the major impacts so one can ascertain the magnitude of our vulnerability having current technology and policies in mind. Africa's share of global carbon dioxide (CO_2) emissions rose from 1.9 percent in 1973 to 3.1 percent in 2002 (IEA, 2004 cited in Manful, 2005:297) with the estimate that Africa produces an average of just over 1 metric ton of carbon dioxide per person yearly (U.S. Department of Energy's International Energy Annual Report, 2002 cited in Fields, 2005). The entire African continent emits less than four percent of the world's total output (Kelbessa, 2007).

The continent will continuously record very warm conditions. For example, East Africa is predicted to warm by about 2-4 degrees Celsius somewhat less than the Mediterranean North-Western Africa and the inner South Africa by 2100 (GebreMichael and Kifle, 2009). Some areas will experience a decrease in rainfall especially in much of Mediterranean Africa, Northern Sahara and in the inner parts of Tanzania where rainfall is predicted to decrease by about 0 – 20 percent. However an increase in rainfall will be recorded around most coastal regions in East Africa where an increase of between 30-50 percent is predicted (Hulme et al., 2001). A rise in sea level and increase in rainfall will

cause flooding which will inundate livestock and agricultural lands worsening food insecurity and increasing the number of hungry Africans, yields from rain-fed crops could be halved by 2020 in some countries (UNFCCC, 2007).

Lack or decrease of rainfall, causing drought, will compound the effects of land degradation and desertification especially in the Sahel and Southern Africa. According to the UNEP (2006) one third of African people already live in drought-prone areas and 220 million are exposed to drought each year whiles 75-220 million people will face more severe water shortages by 2020. The UNEP (2006) again predicted that, by 2025, about 480 million people in Africa could be living in water-stress areas and, by 2085, up to 40 percent of wildlife species habitat in Africa could be lost. Diseases will be rampant on the continent since rising temperatures are changing the geographical distribution of disease vectors which are migrating to new areas and higher altitudes. Boko et al. (2007 cited in UNFCCC, 2007) gives an example to be the migration of the malaria mosquito to higher altitudes which will expose large numbers of previously unexposed people to infection in the densely populated East African highlands. Malaria is predicted to go up by 14 percent by 2030 in Africa (Hay et al., 2006, cited in EPA, 2010g). According to WHO (2004 cited in UNFCCC, 2007) more people will be susceptible to other infectious diseases such as cholera.

2.3.3. Impacts on Ghana

Ghana is no exception to the effects climate change impose on nations. The Environmental Protection Agency's Policy Briefs of 2010 cover issues pertaining to impacts of climate change on health, agriculture, tourism, energy, water resources,

disaster risk reduction, forestry, education, human settlement, coastal zone and resources, and on development planning. This shows that the country feels the impacts in all its sectors of the economy.

Over the last 50 years, recorded data by the Ghana Meteorological Agency clearly shows progressive and discernible rise in temperature and steady decline in rainfall in all agro ecological zones (EPA, 2010g). Temperature has risen by almost a degree over the last century and is projected to accelerate over the next 50 years, resulting in an increase of further 1.5-3 degrees Celcius (EPA, 2010f). Temperatures have been estimated to rise on average by about 0.6 degrees Celcius, 2.0 degrees Celcius and by 3.9 degrees Celcius in the years 2020, 2050 and 2080 respectively in all forest ecological zones (EPA, 2010f). The projected annual temperature increase of 2.2-3.5 degrees Celsius for Ghana in the central belt is significantly higher than the projected average (1.5-3.0 degrees Celcius) for the African continent (EPA, 2010h).

Rainfall is also predicted to decrease on average by 2.8 percent, 10.9 percent and 18.6 percent by 2020, 2050 and 2080 respectively in all forest ecological zones (EPA, 2010f). Changes in the rainfall patterns will result in floods and droughts and a rise in sea level (EPA, 2010d). Scenarios of sea level changes with respect to the 1999 mean, predict an average rise of 5.8 cm, 16.5 cm and 34.5 cm. by 2020, 2050 and 2080 respectively (EPA, 2010f). A sea-level rise of 2.1 mm per year over the last 30 years is currently resulting in estimated erosion of up to 3 metres of coastal land every year. By inference, Ghana would be losing about 81.3 square metres of arable land every year and the coastline would have receded by 465 metres of seaside land to erosion, resulting in a

loss of 1,110 square kilometres land, placing 132,200 people at risk by the year 2020. Unfortunately, high rates of influx of people from the hinterland, population growth and urbanization have put heavy pressure on the coastal zone of Ghana, which flanks a coastline of approximately 550 km (Armah et al., 2005:204 cited in Kelbessa, 2007). The east coast of Ghana is particularly vulnerable to flooding and shoreline recession (EPA, 2010c). A large part of the country shows a marked sensitivity to periods of drought. Overall, Ghana already has one of the lowest conversion factors of precipitation to runoff on the continent, with an average of 15 percent (EPA, 2010h).

In the sector of agriculture, it is forecasted that yields of maize and other cereal crops will reduce by 7 percent by 2050. This could result in unsustainable livelihoods with negative consequences of food insecurity, poverty, health, education, gender equality and environmental degradation (EPA, 2010a).The climatic conditions are gradually bringing a shift in the known timeframe and geographical boundaries of various diseases. Cases of meningitis, diarrhoeal diseases, guinea worm infestation, etc are predicted to increase but cases of malaria and measles will decline because of the climatic conditions and existing case management and preventative measures (EPA, 2010g).

Weather events like droughts, dry spells and unreliable rainfall are strong determinants of the sustainability of water resources and water. Of all the water in Ghana, 97.5 percent is salt water and only 2.5 percent is fresh water. About 69 percent of this amount of freshwater is inaccessible and almost 30 percent is groundwater. This leaves only about 1 percent of all freshwater in freshwater rivers, lakes, wetlands, and soil moisture

(EPA, 2010k). Studies at the Council for Scientific and Industrial Research-Water Research Institute (CSIR-WRI) show that even without climate change considerations, Ghana is predicted to become a water stress country by 2025. The CSIR-WRI 2000 report on Climate Change and Water Resources cited in EPA (2010k) estimates:

- A general reduction in annual river flows in Ghana by 15-20 percent for the year 2020 and 30-40 percent for the year 2050.
- A reduction in groundwater recharge of 5-22 percent for 2020 and 30-40 percent for 2050.
- By the year 2020, all river basins will be vulnerable and the whole country will face acute water shortage.

In an observation made by Gyampoh et al. (2007), flows in the River Offin have decreased from 6.9 m^3 per second in 1957 to 3.8 m^3 per second in 2006 indicating a 45 percent reduction. In the face of increases in the frequency and severity of extreme weather events in the future, climate change will result in flooding and also worsen future water scarcity in many places in the country (EPA, 2010k). In the educational sector, climate change impacts negatively on the delivery of quality education. Increase in the frequency and severity of extreme weather events results in damage to educational infrastructure leading to temporary or more lasting disruption in the provision of educational services and other socio-economic activities. An example was in 2007, when the Northern Region reported of a number of collapsed school buildings due to floods (EPA, 2010d). The extreme climatic conditions associated with climate change such as droughts and floods are potential factors to slow, delay, destroy, and severely impair the

operations of land use activities and the functional qualities of infrastructure developments thereby challenging national developmental agenda (EPA, 2010h). Destruction to roads, bridges and drainage infrastructure affects not only the transport sector but also tourism.

The harnessing of energy resources and use of energy result in the emission of greenhouse gases into the atmosphere. However, energy infrastructure may also suffer significantly from the effects of climate change. Very severe rainstorms may threaten the safety of hydro dams with excessive water inflows that will require frequent spillage. On the other hand iterant droughts may cause the drying out of mini and small hydro facilities as high temperatures will also enhance evaporation of water from the surfaces of large hydro-dam reservoirs. These result in rapid water loss and also threaten the sustainability of hydro facilities. The availability of fuel wood could also be affected by persistent droughts especially in the savannah zones. Again, severe storms and floods may increase the risk of damage to off-shore oil platforms, oil-gas pipelines and national electricity grid systems. It is therefore very necessary that climate change effects and adaptation strategies are factored into the planning, costing, design and management of these facilities (EPA, 2010e). A Change in species composition, an increasing presence of invasive species in forests and farmlands, increased wildfire threats and extension of the forest transition zone further down south are evidence of the impacts of climate change in our forest. As at 2005, the cost of environmental degradation in major natural resource sectors, in terms of the value of natural assets depletion, was estimated at 5 percent of GDP. The forest sector alone accounted for US$ 500 million or 63 percent of this cost (ISSER/World Bank/DFID, 2005 cited in EPA, 2010f).

Projected climate changes would not only have serious environmental, social and economic implications, but also implications for peace and security and migration. Furthermore, climate change will bring increased health, economic and social costs with negative consequences for growth and development (UN General Assembly, 2008).

2.4. Understanding the Terms; Vulnerability and Resilience to Climate Change

Climate-related hazards do not automatically translate into disasters. It is the overall vulnerability and capacity for resilience that will determine if a society can absorb climate impacts and positively respond or is unable to do so and therefore suffers the losses associated with disaster (Duarte et al., 2007).

2.4.1. Climate Change Vulnerability and Resilience Defined

Vulnerability is defined by Malone et al. (2008:4) as the degree to which a system is susceptible to, and unable to cope with, adverse effects of climate change, including climate variability of extremes. It is a function of the character, magnitude, and rate of climate change and variation to which a system is exposed, its sensitivity, and its adaptive capacity. The International Strategy for Disaster Reduction (ISDR) also defines vulnerability as the characteristics and circumstances of a community, system or asset that make it susceptible to the damaging effects of a hazard (UN/ISDR, 2002). These two definitions outlay common ideas. Thus when a system faces undesirable circumstances; its incapability (in terms of limited resources, technology, etc) to adjust itself to such a change makes it more prone to the effects, thus making it vulnerable to those effects.

Resilience on the other hand, is defined as the ability of a system, community or society exposed to hazards to resist, absorb, accommodate to and recover from the effects of a hazard in a timely and efficient manner, including through the preservation and restoration of its essential basic structures and functions (IFRC, 2009). Malone (2009) also defines it as a composite concept, incorporating environmental, social, economic, political, demographic, cultural, gender and psychological factors, in describing the capacity to recover and survive, to change and grow. Thus it emphasizes the degree to which the risks of climate catastrophe can be cushioned or ameliorated by adaptive actions that are or can be brought within the reach of populations at risk. Both definitions share the thought of a system having capabilities to defend itself from being totally damaged by climate change impacts. Both focus on the ability of the system to recover from the undesirable circumstances in time whiles maintaining its basic structures. However, the latter definition lays emphasis on the need for the system to survive after recovering. It also acknowledges a change in the system and the need for the system to grow after such a change occurs. Therefore, the latter definition is fit for the study. According to Malone (2009), earlier researches on climate change emphasized vulnerability but now focus is shifted to resilience as a positive concept that can be more integrated with general development goals.

2.4.2. The Relationship between Vulnerability and Resilience

Understanding the relationship between vulnerability and resilience is very expedient at this juncture. In relation to the definition of resilience, a society should be able to get back to its original state after facing climate change impacts, otherwise it is considered vulnerable to climate change. Knowing this, it is appropriate to say that every

community in the world is vulnerable to climate change since regaining an original state is barely impossible. However, some communities are more vulnerable than others depending not only on the location and timing of occurrence, but also the resources and agility of the communities who experience these impacts (Malone, 2009). This suggests that every community has a level of resilience which determines the level of vulnerability. In other words, a community with more capability is said to be more resilient and less vulnerable and the opposite holds for a community with less capability (less resistant and more vulnerable).

2.4.3. Exploring Vulnerability Concepts

Climate change vulnerabilities cover a myriad of concepts and models. Examples are urban vulnerability which is defined by Satterthwaite et al. (2007) as the potential of people to be killed, injured or otherwise harmed by the direct or indirect impacts of climate change, and natural hazard vulnerability defined by Liverman (1994 cited in Malone et al., 2008) as the characteristics of places or people that are likely to be harmed by meteorological and geophysical events. But for the purpose of this study, concepts like biophysical, social, demographic and indigenous vulnerabilities will be considered. As these concepts are explored, questions like; who are most vulnerable, where are they found and why they are vulnerable (factors influencing vulnerability) will be answered.

Biophysical vulnerability relates to the location of people's residence and the availability of natural resources. According to Brooks (2003), exposure to change impacts depends on where people choose or are forced to live. Indigenous people often live in fragile

environment and highly depend on the natural environment to sustain their livelihoods. They get their food, water, medicine, fuel from and even make spiritual contacts with these natural materials. In the face of climate change, these resources are expected to be altered in availability and distribution. Indigenous people will then be affected as for example a loss of biodiversity will impact on their food sources (Macchi, 2008). According to Duarte et al. (2007), the biophysical perspective on vulnerability in climate change is largely about the degree of human exposure to threats provoked by climate change and is therefore primarily external, comprising the amount of potential damage caused to a system by shocks (such as sudden climatic events like hurricanes) or trends (such as environmental degradation over time). The most vulnerable industries, settlements and societies are generally those in coastal and river flood plains, those whose economies are closely linked with climate-sensitive resources, and those in areas prone to extreme weather events, especially where rapid urbanization is occurring (UN General Assembly, 2008).

Social vulnerability deals with issues such as poverty, marginalization, health and nutrition. Brooks (2003) explains that, social vulnerability exists independently of external hazards, but is governed by internal properties of human societies, for instance poverty, marginalization, literacy, food entitlement and health. Mostly, indigenous people face social and political exclusion with little access to power and decision-making. Thus they are marginalized and as a result, their tenure and access to lands may not be legally recognised. Insufficiency of income, assets or wealth is one of the most important determining factors of socioeconomic vulnerability of indigenous and traditional people. As such, climate change is expected to adversely affect poverty

eradication measures and to jeopardize the Millennium Development Goals (Macchi, 2008). According to the DFID (2004 cited in Macchi, 2008:16), "climate change is expected to impact on the spatial distribution of vector-borne disease, e.g. malaria and dengue fever. Increase in exposure to ultra violet radiation causing damage to skin and eyes will also be experienced in some places. Other predictions include under-nutrition resulting from diminishing crop productivity; deaths caused by heat waves, droughts, floods and storms; and water-borne diseases as a result of poorer water quality causing increased incidence of diarrhoeal and respiratory disease".

According to Duarte et al. (2007), the social dimensions of vulnerability to climate change are predominantly about the internal side-that is, what assets, institutions, and relationships do people have to deal with these external threats, and how in turn will their social organization be affected? Further the team noted that social vulnerability is assessed at the level of individuals, households, or groups, but incorporates factors that exist at local, regional, national, and sometimes global scales. They concluded that the concept therefore relates to the ability of individuals or groups to act within the social, political, and environmental contexts in which they live. Eakin et al. (2007 cited in Malone et al., 2008) looking at social vulnerability of farmers in Mexico realized that, the lack of income diversification and access to financial and material resources increases their sensitivity and lowers their adaptation capacity, since they do not have a buffer against climatic risk.

Altman et al. (2009) attest to the fact that those most vulnerable to climate change are generally those with low incomes, poor access to education and health services and

living in remote areas. Kelbessa (2007) sides with Altman et al. (2009) by iterating that, those who lack the resources to adapt, to find alternative sources of food and healthcare will suffer a lot from climate change, especially the world's poorest countries. It can then be said that the least developed countries (LDCs), developing countries and the small island developing states (SIDS) are highly vulnerable to the impacts of climate change as their capacity to manage disasters is lower, and could impede progress towards achieving the Millennium Development Goals (UN General Assembly, 2008; UNEP, 2006).

Demographic vulnerability assesses the gender and age structure that are most vulnerable to climate change impacts. Although both women and men are vulnerable to climate change, women are most affected and are more vulnerable than their male counterparts (UN Women Watch, 2009). The UN Women Watch (2009) highlights the causes of women's vulnerability as follows-

1. Women are the majority of the world's poor and depend more on natural resources as they are charged with the responsibility to secure water, food and fuel for cooking and heating. Also, they face social, economic and political barriers that limit their coping capacity. Finally, when coupled with unequal access to resources and to decision-making processes, limited mobility places women in rural areas in a position where they are disproportionately affected by climate change. In Nigeria, Ishaya and Abaje (2008), stress that among the most vulnerable are women and children.
2. Indigenous vulnerability focuses on how and why indigenous or local people are exposed to climate change impacts. Since the study's focus is on indigenous

people, this concept will be discussed in much detail under the sub-heading 'Indigenous People's Vulnerability and Adaptations to Climate Change'. These vulnerability concepts can be interrelated as done by some schools of thought. An example is the socio-economic concept which focuses on both the social and economic factors that make people vulnerable to climate change.

In exploring these concepts the causes of vulnerability have been explained. According to Malone (2009) understanding these causes will support analysis of policy options to address its underlying causes rather than just its symptoms. On the other hand, understanding resilience and adaptive capacity will provide guidance on where to direct resources to build on existing strengths or open new areas of support.

2.5. Climate Change Adaptations

The United Nations Framework Convention on Climate Change (UNFCCC) provides that all Parties must formulate and implement national or regional programmes containing measures to facilitate adequate adaptation to climate change (Art. 4.1.b cited in FAO, 2007:1).

Adaptation in climate change is a broad concept with different definitions. Burton (1992 cited in GebreMichael and Kifle, 2009:3) defines adaptation as "the process through which people reduce the adverse effects of climate on their health and well-being, and take advantage of the opportunities that their climatic environment provides". To Stakhiv (1993 cited in GebreMichael and Kifle, 2009), adaptation means any adjustment, whether passive, reactive or anticipatory, that is proposed as a means for

ameliorating the anticipated adverse consequences associated with climate change. These definitions recognize the need for a community to take appropriate measures to face climate change impacts so as to survive. Stakhiv however introduced in his definition, the different forms of adaptation. The IPCC (2001 cited in GebreMichael and Kifle, 2009) outlines these adaptation forms as anticipatory and reactive adaptation, private and public adaptation, and autonomous and planned adaptation. According to Ahmed (2008 quoted by Mukta, 2009), all definitions of 'climate change adaptation' have been developed considering 'climate change' as a 'static event' instead of a 'changing/dynamic process', thus missing out the 'time' dimension completely.

2.5.1. Defining Various Terms in Climate Change Adaptation

In understanding the concept of climate change adaptation, certain terms often used in adaptation literature needs to be understood as well.

- Adaptive capacity is the ability of a 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 (IPCC, 2007 cited in Malone, 2009). According to Malone (2009), this definition applies to both physical and social systems. Actions associated with building adaptive capacity may include communicating climate change information, building awareness of potential impacts, maintaining well-being, protecting property or land, maintaining economic growth, or exploiting new opportunities (Adger et al., 2005).

- Adaptability refers to the degree to which adjustments are possible in practices, processes, or structures of systems to projected or actual change in climate (IPCC, 1996 cited in GebreMichael and Kifle, 2009).
- Adaptation methods are those strategies that enable the individual or the community to cope with or adjust to the impacts of the climate in the local areas. Such strategies include the adoption of efficient environmental resources management practices such as the planting of early maturing crops, adoption of hardy varieties of crops and selective keeping of livestock in areas where rainfall has declined. They also include the use of technological products that enable the individual to function in the new condition (Nyong et al., 2007).
- From various definitions and concepts in adaptation, GebreMichael and Kifle (2009) extracted the following major principles:
- Adaptation is a continuous and learning process.
- Adaptation is a response to actual or expected risks; in other words, adaptation can
- occur before, during or after any external stimulus or threat.
- Adaptation integrates prevention or mitigation in its process.
- Adaptation can be spontaneous and planned.
- Adaptation can be a practice, management practice or process.
- It is worth noting that adaptation decreases a system's vulnerability, or increases its resilience to impacts.

2.5.2. Types of Climate Change Adaptations

- Autonomous adaptation is the reaction of, for example, a farmer to changing precipitation patterns, in that he changes crops or uses different harvest and planting/sowing dates (Easterling, 1996 cited in FAO, 2007).
- Planned adaptation measures 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. For example, deliberate crop selection and distribution strategies across different agroclimatic zones, substitution of new crops for old ones and resource substitution induced by scarcity (Easterling, 1996 cited in FAO, 2007).
- Short-term adjustments are seen as autonomous in the sense that no other sectors (e.g. policy, research etc.) are needed in their development and implementation (FAO, 2007).
- Long-term adaptations are major structural changes to overcome adversity such as changes in land-use to maximize yield under new conditions; application of new technologies; new land management techniques; and water-use efficiency related techniques (FAO, 2007).

Societies, organisations and individuals have adjusted their behaviour in response to past climatic change. Much of this adaptation is reactive, in the sense that it is triggered by past or current events, but it is also anticipatory in the sense that it is based on some assessment of conditions in the future (Adger et al., 2005).

2.5.3. Adaptations Strategies from the World Over

The specific impacts of climate change will depend on the climate variance and change it experiences as well as its geographical, social, cultural, economic and political situations. As a result, countries require a diversity of adaptation measures that reflect their unique circumstances-(UN General Assembly, 2008:1).

Adaptation is made up of actions throughout society, by individuals, groups and governments (Adger et al., 2005). Every society differs from the other and so are their actions (adaptations) towards climate change. Nevertheless, some adaptation strategies from one society can be adopted by another in facing climate change impacts.

For developing countries, despite their strategies and plans to implement adaptation activities, they have limitations in capacity (especially in human capacity and financial resources) making adaptation difficult (UN General Assembly, 2008). All the same, their adaptation strategies cover varied areas where vulnerability is high. Example is the agricultural sector where landless farmers and livestock keepers are very much affected (Barber et al., 2003). In Ethiopia, some strategies adapted by farmers and livestock keepers include a shift in livestock species, where goats and sheep are preferred to the rearing of camel, because they need less pasture. Also there is the diversification of economic activities where for example, people who use to depend solely on fishing, now market the fish and rear small livestock (GebreMichael and Kifle, 2009). In other areas, farmers cultivate different crops or varieties of crops with different susceptibility to drought and floods so as to get good yields at any time of the year (Salick and Byg, 2007).

The most effective adaptation approaches for developing countries are those addressing a range of environmental stresses and factors. These approaches should aim at poverty alleviation, enhancing food security and water availability, combating land degradation and reducing loss of biological diversity and ecosystem services, as well as improving adaptive capacity (UN General Assembly, 2008).

For developed countries, a country like Canada has identified 96 different adaptation measures in their agricultural sector including change in topography of land (11 measures), use of artificial systems to improve water use/availability and protect against soil erosion (29), change in farming systems (21), change in timing of farm operations (2), use of different crop varieties (7), governmental and institutional policies and programmes (16), and research into new technologies (10). Many of these involve improved resource management – an option with benefits that extend beyond adaptation (FAO, 2007).

Adapting to climate change will entail adjustments and changes at every level, that is from community to national and international. Communities must build their resilience, including adopting appropriate technologies whiles making the most of traditional knowledge, and diversifying their livelihoods to cope with current and future climate stress. To enable effective adaptation measures, both governments and non-government organizations, must consider integrating climate change in their planning and budgeting in all levels of decision making (UN General Assembly, 2008).

The focus of this study is on indigenous people's adaptations and this has been discussed under the topic-'Indigenous People's Vulnerability and Adaptations to Climate Change'.

2.6. Integrating Livelihood Security in the Study of Adaptation and Resilience

Livelihood security is defined by Carney (1998 cited in Ashley and Hussein, 2000) as the ability to make a living and withstand shocks. However, a livelihood comprises the capabilities, assets (including both material and social resources), and activities required for a means of living. A livelihood is sustainable when it can cope with and recover from stresses and shocks and maintain or enhance its capabilities and assets both now and in the future, whiles not undermining the natural resource base (Chambers and Conway, 1992 cited in Elasha et al., 2005).

One of the ways to understand livelihood systems is to analyze the coping and adaptive strategies pursued by individuals and communities as a response to external shocks and stresses such as drought, civil strife and policy failures (Elasha et al., 2005). By understanding the dynamics of local people's livelihoods, it is possible to understand how climate change impacts affect them, what will be their response based on the resources they have, and how these conditions can be reflected and built upon for successful adaptation strategies (Razafindrabe, 2007). At this juncture, it is expedient to know what comprises the livelihood resources of the local people. The resources are also referred to as assets or capitals.

Livelihood Assets (resources or capitals)

- Natural capital: Consists of land, water and biological resources such as trees, pasture, and biodiversity. The productivity of these resources may be degraded or improved by human management**.**
- Financial capital: Consists of stocks of money or other savings in liquid form. In this sense it does not include financial assets only but should also include easily disposable assets such as livestock, which in other senses may be considered as natural capital. It includes income levels, variability over time, and distribution within society of financial savings, access to credit, and debt levels.
- Physical capital: Is that created by economic production. It includes infrastructure such as roads, irrigation works, electricity, reticulated equipment and housing.
- Human capital: Is constituted by the quantity and quality of labour available. At the household level, it is determined not only by the household size, but also by education, skills, and health of household members**.**
- Social capital: Any assets such as rights or claims that are derived from membership of a group. This includes the ability to call on friends or kin for help in times of need, support from trade or professional associations (e.g Association of farmers) and political claims on chiefs or politicians to provide assistance (Carney, 1998, cited in Elasha et al., 2005)**.**

It is worth noting that CARE (2002 cited in Razafindrabe, 2007) separated the political capital from the social capital, thus identifying 6 assets. CARE (2002) defined the political capital as consisting of relationships of power and access to and influence on the political system and governmental processes at the local and higher levels. Razafindrabe (2007) suggests important points to be taken into consideration when

addressing these resources: the combinations necessary for sustainable livelihoods, the trade-offs that exist between resources, the sequences that may exist between them, and the long term trends in their use.

These assets form the basis on which a livelihood framework is built. The livelihood framework and its focus on assets can be used to clearly understand the pathways in which climatic stresses affect fisher folk livelihood security. As mentioned before, one of the difficulties encountered in resilience research is to define what to measure and for what (Carpenter et al., 2001). The advantage of the livelihood framework is that for each of the capital/ assets, indicators can be derived and the concept has been vigorously debated in the literature (Campbell et al., 2001) and used by practitioners (Allison and Horemans, 2006). The aim of the indicators is to measure changes (qualitatively and quantitatively) in the distribution and access to assets.

Table 2.1 provides an example of the type of indicators that can be used based on the review of the impact of climatic stresses on capital/ assets. Changes in capital/ assets can be used as surrogates to measure resilience, more specifically changes in absorption, self-organization and adaptive capacity. Indeed once the system has been bounded (scale and unit of analysis) and a reference state defined (for instance temporal scale before a climatic stress), levels of resilience can be evaluated according to shifts of indicators between the reference and the disturbed state. In evaluating the impact of past climatic stresses, it might be difficult to obtain a baseline of livelihood assets and strategies before the events. In this context secondary data to create the baseline as well as open-ended questions to explore changes overtime can be used.

Table 2.1: Capital Assets Change and Climatic Stress: Possible Indicators in the Case of Farming and Fishing

Capital /assets	Criteria-change (Δ) in capital	Potential indicator
Natural	Δ in Harvest	Fish catch/ crop yields.
		Catch/crop structure (size of fish/crop, species composition and numbers)
		Landings by fishing zones.
Physical	Δ in Equipment	Investment in fishing/farming equipment due to loss, re-tooling (negative impact) or increased income (positive impact).
	Δ in Housing infrastructure	Changes in condition of house (flooded, partly destroyed, re-location etc).
	Δ in items owned by the household	Investment in household appliances (due to loss or increased income).
	Δ in Public infrastructure	State of landing sites/ common harvest grounds.
		Access to roads
Financial	Δ in Income of fishermen/farmers	Profitability (Fishing/farming efforts, Landings, Prices, Fuel costs)
		Other activities (services)
		Change in proportion of day spent at sea due to weather (changing daily and seasonal calendar) Change in time periods spent on farm due to weather (changing daily and seasonal calendar).
		Subsidies (access to credit, emergency aid)
Human	Δ in Health of fishermen/farmers and household members	Impoverished/improved diet for family members
		Increased occupational health hazards
		Presence of diseases
	Δ in Fishing/farming skills	Increased "traditional skills" based on past experience and knowledge sharing
		Increased "modern skills" based on formal training
Social	Δ in Social networks	Increased migration (increased number of fishermen or boats) Increased number of people into farming.
		Membership to a fishing/farming association
	Δ in Social mobilization	Increased number of groups to face negative effects of climate stress.
		Increased number of fishermen/farmer associations.

Source: Adopted from Ashley et al. (1999).

2.7. Indigenous Knowledge and Climate Change

2.7.1. What Is Indigenous Knowledge?

Indigenous knowledge (IK) also known as Traditional/ Local knowledge has varied definitions by different authors and institutions. Gyampoh et al. (2009:70) defined it as "the wisdom, knowledge and practices of indigenous people gained over time through experience and orally passed on from generation to generation". Though slightly different in capturing but same concept, the UNEP (2009 cited in Graff et al., n.d) defined 'Indigenous knowledge' as "the knowledge that an indigenous (local) community accumulates over generations of living in a particular environment". According to the UNEP (2009 cited in Graff et al., n.d), this definition encompasses all forms of knowledge – technologies, know-how skills, practices and beliefs – that enable a community to achieve stable livelihoods in their environment.

Indigenous Knowledge often transmits the history, beliefs, aesthetics, ethics, and traditions of a particular community and often has symbolic value for that community (LINK cited in Mukta, 2009:3). IK emanates from the rural societies and (Shaw et al., 2008) has been an essential survival tool for humans since time immemorial but unfortunately, its values have almost been replaced by modern global values and has almost been forgotten (UNEP, 2009 cited in Graff et. al., n.d). Although IK is unique to a given culture or society, there is a misconception that as it passes through generations, there is little or no change in content or structure. However, studies have underlined the dynamic nature of this knowledge. According to LINKS (2007) it is re-appropriated by each generation of knowledge holders, and re-interpreted through their own experiences, practices and interactions. Agrawal quoted by LINK (cited in Mukta, 2009:3) identified

that "because IK changes over time, it is sometimes difficult to decide whether a technology or practice indeed is indigenous, or adopted from outside, or a blend of local and introduced components".

Woodley (1991 cited in Nyong et al., 2007:792) pointed out that, "the knowledge set is influenced by the previous generations' observations and experiment and provides an inherent connection to one's surroundings and environment". He further explains that IK is therefore not transferable but provides relationships that connect people directly to their environments and the changes that occur within it, including climate change.

2.7.2. Who Are the Indigenous People?

Indigenous people are the local people that live close to natural resources and often observe the activities around them and are the first to identify and adapt to any changes (Gyampoh et al., 2009). Macchi (2008) stated that the world has most of its total population being indigenous people. They customarily own, occupy or use 22 percent of the world's land surface, manage 11 percent of the world's forest lands, maintain within their lands and territories 80 percent of the planet's biodiversity and are located in or adjacent to 85 percent of the world's protected areas. He further described them as being amongst the poorest globally and are heavily dependent on lands and resources for basic needs and livelihoods: food, fuel, shelter, clothing, medicine. They live in ecosystems particularly prone to the effects of climate change; polar regions, humid tropics, high mountains, small islands, coastal regions, semi-arid deserts and are becoming the first wave of "climate change refugees".

These people are closely tied to their environment and have interacted with it over generations through observations, interpretations, and skilful adjustments to environmental changes like climate change. Because of this interaction, indigenous people hold a rich body of knowledge, which they use, in decision-making and in setting priorities (Salick and Byg, 2007). This knowledge needs to be incorporated into scientific research to help curb and adjust to climate change impacts. The farmers and fisher folks in the Bosomtwe district (sample frame) share these characteristics and descriptions of indigenous people and are therefore appropriate for the study.

2.7.3. Indigenous People's Perceptions of Climate Change

Indigenous people have their own interpretations to climate change. As they live close to nature and observe all the changes critically, they have their own perceptions towards what they see and experience. Ishaya and Abaje (2008) mentioned that indigenous people's interpretations of climatic and weather phenomena are geared towards spiritual thoughts as signs of something more than mere biophysical processes. Similarly, Gyampoh et al. (2008) observed that some indigenous people attribute the changes around them to factors other climate change such as a sinful generation, wrath of God, and signs of the end time of life. These moral or spiritual explanations of climate change contrast with scientific explanations. However, Ishaya and Abaje (2008) further recognized that other traditional people integrate scientific and local explanations. For example, some people have the view that climate change is caused by people's greed and selfishness in overconsumption that leads to greenhouse gas emissions. Local views of climate change are characteristically interwoven with other environmental and societal problems (Ishaya and Abaje, 2008).

Furthermore, Ishaya and Abaje (2008) argued that whiles many traditional people see climate change as having spiritual and social causes, there are also inverse examples of climate changes being perceived as a threat to local deities and spiritual powers. A typical example they stated is in Tibet, where local deities are physically manifest in snow-capped mountains and some Tibetans worry about the fate and power of these mountain deities melting away with the snow. Therefore, Ishaya and Abaje (2008) recognised that local interpretations of these climatic impacts may vary and although the media's coverage of climate change influence people's perceptions, people's own observations are more local and tangible Communities in different locations were selected for the study to know if their interpretations of the impacts they observe may vary or not. As the study seeks to investigate and document indigenous people's knowledge and adaptations to climate change impacts, it is worth knowing how these locals interpret the impacts, for the reason that their perceptions constitute their knowledge and further influence their adaptations.

2.7.4. Indigenous People's Vulnerability and Adaptations to Climate Change

It is widely recognised that poor, natural-resource dependent communities in the developing world are especially vulnerable to climate change, of which many are indigenous or traditional. Indigenous people's livelihoods depend on natural resources that are directly affected by climate change, and they often inhabit economically and politically marginal areas in diverse, but fragile ecosystems, making them vulnerable to climate change (Rai, 2008). However, they have preserved knowledge about agriculture, hunting, fishing, foraging and the use of medicinal plants. Through past exposure to environmental change, these people have often developed elaborate coping strategies

and can offer valuable knowledge in terms of future adaptation to and mitigation of climate change (Macchi, 2008). As noted by Penehuro (2003), many indigenous communities have used changes in their environments to predict fluctuations in the weather and climate long before the advent of complex numerical climate models.

Salick and Byg (2007:13) stated that "the appearance of certain birds, mating of certain animals and flowering of certain plants are all important signals of changes in time and seasons that are well understood in traditional knowledge systems". Indigenous people have used biodiversity as a buffer against variation, change and catastrophe; in the face of plague, if one crop fails, another will survive. Adaptation has often been based on such indigenous systems of climatic observation and interpretation of migration of animal and bird species (Macchi, 2008).

Indigenous communities with their long experience have developed strategies to face and minimize climate change impacts. Though the impacts of climate change differ among communities, indigenous communities have common reasons that make them vulnerable to climate change. Therefore, most indigenous communities have common ways of adapting to climate change. Since agriculture is the major occupation among indigenous people, their adaptations focus more on crop cultivation practices, storage of fodder, food and water harnessing techniques (Ishaya and Abaje, 2008).

In a study conducted on 'Indigenous Peoples and Climate Change' by Salick and Byg (2007), it was observed that indigenous people exhibited various adaptation strategies to survive the impacts of climate change in their localities. They cultivate

different/varieties of crops with different susceptibility to drought and floods and supplement this with hunting, fishing and gathering wild food plants. An example is the traditional people in the Amazon basin who switched to a reliance on fish during the drought of 2005. Some people restrict themselves to different planting dates by shortening the growing season whiles others adopt water maximization by practicing irrigation farming in combating climate change. In the Kalahari, for example, changes in precipitation encouraged a shift from rain-fed agriculture to manually watered homestead gardening (Salick and Byg, 2007). This same study by Ishaya and Abaje (2008) further revealed that some indigenous people change from farming to non-farming activities when rainfall becomes less. The works of Gyampoh et al. (2009) revealed that in areas with market access, people may supplement their subsistence base by selling surplus crops, handicrafts, wage labour and forest products. Others adapt chemical fertilizer as climate change adaptation strategy, some increase the extent of land put into agriculture and also they mulch the land to reduce the loss of soil moisture for crops like yams and ginger. Significant differences in the extent of adaptation strategies of combating climate change in the study area was realized (Ishaya and Abaje, 2008).

According to Gyampoh et al. (2009), the diversity of crops and food resources is often matched by a similar diversity in location of fields, as a safety measure to ensure that in the face of extreme weather some fields will survive to produce harvestable crops. Some people even move along with their settlement, an example is the Makushi of Guyana who move from their savannah homes to forest areas during droughts and plant cassava,

their main staple crop, on moist floodplains normally too wet for the crop (Salick and Byg, 2007).

Among the pastoralists, some adaptation strategies include the use of emergency fodder in times of droughts, multi-species composition of herds to survive climate extremes, and culling of weak livestock for food during periods of drought. They usually change from cattle to sheep and goat husbandry as the feed requirements of the latter is less than the former (Oba 1997 cited in Nyong et al., 2007). In communities with frequent water shortages, a major adaptation strategy is the reuse of water. For example water from washing clothes or utensils is used to irrigate backyard gardens and nurseries. Rainwater harvesting (a traditional way of collecting and storing rainwater in big barrels placed under the roofs of houses) is also practiced in such communities. However, households ration water by trying to reduce the water use per person per day (Gyampoh et al., 2009). Indigenous people have developed intricate systems of gathering, prediction, interpretation and decision-making in relation to weather. All these and many more adaptation measures adopted by indigenous people help reduce their vulnerabilities to climate change impacts (Nyong et al., 2007). However, reducing vulnerability entails the strengthening of adaptive capacities of vulnerable individuals and groups. Therefore, capacity building should emphasize the need to build on what exists, to utilize and strengthen existing capacities (Nyong et al., 2007).

2.8. Supporting and Integrating Indigenous Knowledge with Scientific/Western Knowledge to Climate Change Adaptations.

As much as indigenous people need the support of their local government in terms of finance or technology to improve on their adaptation strategies, international support is also needed to help continue their role as traditional caretakers of marginal and fragile ecosystems. This is because as projected impacts become severe, traditional coping mechanisms may not in themselves be sufficient to deal with these impacts (Rai, 2008).

It is believed that traditional ecological knowledge (TEK) and western science cannot be integrated and cannot be bridged. Rather a collaborative research and mutual problem solving between these two fundamentally different ways of knowing are crucial in addressing environmental issues. However, the approach to be used is to empower local communities to do their own assessments (Wall, 2009). On the contrary, Nyong et al. (2007), believe that indigenous knowledge can be integrated with western science. In their study on 'the value of indigenous knowledge in climate change mitigation and adaptation strategies in the African Sahel', they identified two major obstacles to integrating indigenous knowledge into formal climate change mitigation and adaptation strategies. These are: recognizing the need to and how to actually integrate indigenous knowledge into formal western science. Further in their study, they outlined the following as the values indigenous knowledge adds to climate change studies:

- Indigenous knowledge systems create a moral economy. It identifies a person within a cultural context, therefore providing decision-making processes or rules of thumb to be followed based on observed indicators or relationships within events (Adugna, 1996;

Woodley, 1991 cited in Nyong et al., 2007). As members of communities act within these rules of thumb, they are provided with a sense of community, belonging and stability.

- Indigenous knowledge is increasingly exhibiting a resemblance with scientific methods as many ideas in indigenous knowledge that were once regarded as primitive and misguided, are now seen as appropriate and sophisticated.
- Indigenous knowledge systems provide mechanisms for participatory approaches. This helps sustain projects as the local people are seen as partners in the project, with joint ownership. This is best achieved when the communities effectively participate in the design and implementation of such projects.
- Indigenous knowledge systems share the same guiding principles with sustainable development framework with 3E concerns—Economy, Equity, and Environment (Davies and Ebbe, 1995 cited in Nyong et al., 2007). The essence of most climate change projects is to reduce poverty and ensure sustainable development. This can be facilitated by the integration of indigenous knowledge into climate change policy.
- Indigenous knowledge systems can facilitate understanding and effective communication and increase the rate of dissemination and utilization of climate change mitigation and adaptation options.

After having an in-depth study on this topic, Nyong et al. (2007) further pointed out major steps to be taken in order to integrate indigenous knowledge into formal climate change mitigation and adaptation studies. The steps are as follows:

- Acknowledge that indigenous knowledge has provided communities with the capability of dealing with past and present vulnerabilities to climatic extremes and other stresses.
- One must adopt the bottom–up participatory approach that encourages the highest level of local participation.
- Local communities should be seen as equal partners in the development process, thus local actors should progressively take the lead whiles external partners back their efforts to assume greater responsibility for their development.
- Indigenous practices in climate change mitigation and adaptation should not be developed as substitutes of modern techniques but rather the two should be seen as complements and learn from each other in order to produce best practices (Adugna, 1996 cited in Nyong et al., 2007). However, indigenous practices need to be scrutinized before their integration since not all may be beneficial to sustainable development.

Mukta (2009:7) sided with Nyong et al. (2007:794) on the participatory approach towards integration. He said '…… an inclusive process does not only mean the incorporation of IK in adaptation planning but also 'direct involvement or participation of 'indigenous people/community' (facing the adverse impact of climate change) from planning/risk assessment to implementation/evaluation process'. It is worth-noting that, the issue of under-representation of indigenous knowledge and perspectives in research on climate change can only be addressed appropriately if the indigenous people are fairly represented in climate change discourse (Wall, 2009).

Almost every community in the world is entrenched with indigenous knowledge, each with their own local environmental, social, cultural, economic and political contexts. Although this knowledge is intrinsically tied to these local conditions, there is potential for specific principles and practices to be transferred between communities in order to further support disaster reduction (Shaw et al., 2008). Local coping strategies and traditional knowledge need to be used in synergy with government and local interventions (UN General Assembly, 2008).

The analysis of this study on 'Indigenous Knowledge and Adaptations to Climate Change' draws inferences from the literature of different authors discussed in this chapter. Likewise ideas for the presentation of results and findings are drawn from the literature. Linkages between concepts like vulnerability and adaptation explained in the literature form the conceptual framework for the study. This is explained in the next section.

2.9. Conceptual Framework

The framework that guides this study is the Sustainable Livelihood Approach (SLA) developed by the DFID. The SLA is a tool to improve understanding of livelihoods, especially of the poor. "A livelihood comprises the capabilities, assets (including both material and social resources), and activities required for a means of living. A livelihood is sustainable when it can cope with and recover from stresses and shocks and maintain or enhance its capabilities and assets both now and in the future, whiles not undermining the natural resource base." (DFID, 1999 cited in Macchi, 2011).

The objective of DFID's SLA is to increase the agency's effectiveness in poverty reduction by seeking to mainstream a set of core principles and a holistic perspective in the programming of support activities to ensure that these correspond to issues or areas of direct relevance for improving poor people's livelihoods (Krantz, 2001). The core principles underpinning the approach which however can be applied to any type of development activity are:

- **People-centered:** Sustainable poverty elimination will be achieved only if external support focuses on what matters to people, understands the difference between groups of people, and works with them in a way that is congruent with their current livelihood strategies, social environment, and ability to adapt.
- **Responsive and participatory:** Poor people themselves must be key actors in identifying and addressing livelihood priorities. Outsiders need processes that enable them to listen and respond to the poor.
- **Multi-level:** Poverty elimination is an enormous challenge that will only be overcome by working at multiple levels, ensuring that micro-level activity informs the development of policy and an effective enabling environment, and that macro-level structures and processes support people to build upon their own strengths.
- **Conducted in partnership:** With both the public and the private sector.
- **Sustainable:** There are four key dimensions to sustainability-economic, institutional, social and environmental sustainability. All are important-a balance must be found between them.

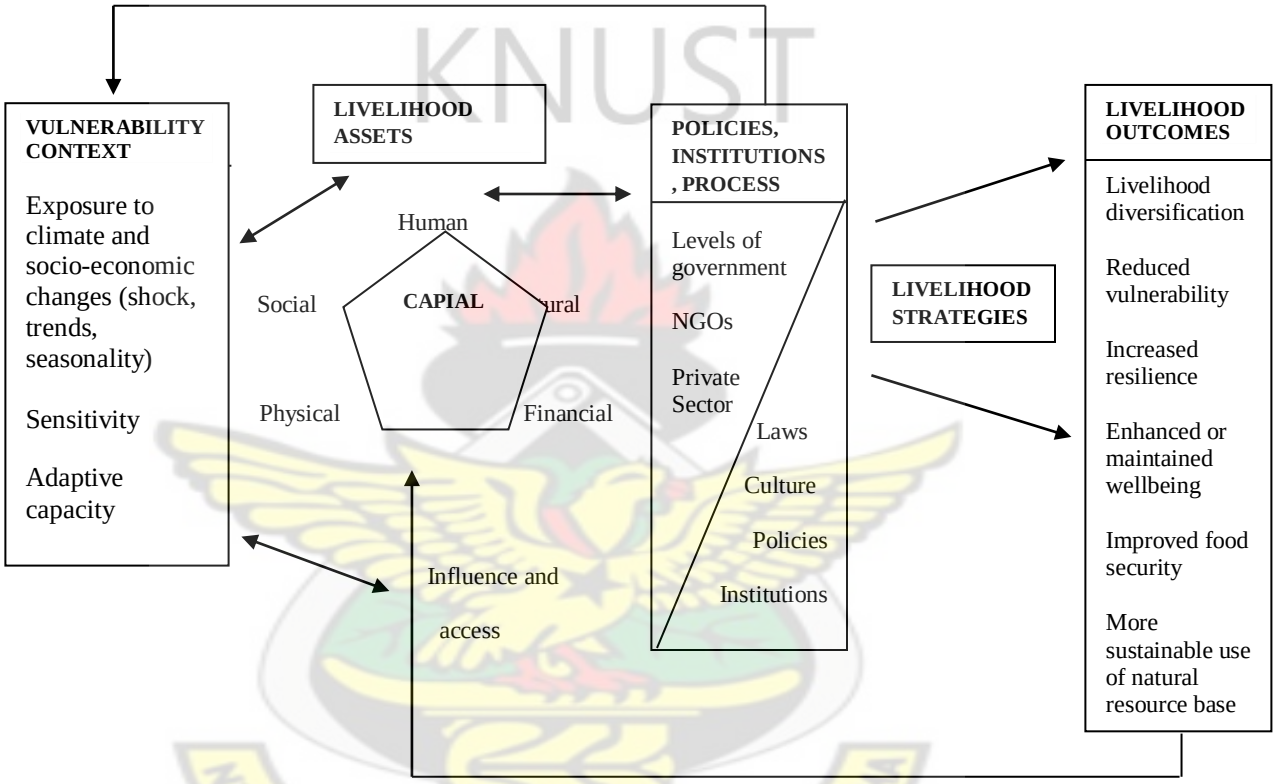
- **Dynamic:** External support must recognize the dynamic nature of livelihood strategies, respond flexibly to changes in people's situation, and develop longer term commitments (Ashley and Carney, 1999 cited in Krantz, 2001).

In using this approach, the implicit principle for the DFID is that activities should be designed to maximize livelihood benefits for the poor (Krantz, 2001). The SLA presents the main factors that affect people's livelihoods and the different assets people have (Macchi, 2011). The SLA framework is built around five principal categories of livelihood assets, graphically depicted as a pentagon to underline their interconnections and the fact that livelihoods depend on a combination of assets of various kinds and not just from one category (Krantz, 2001). These five livelihood assets on which the SLA is built around are:

- **Human capital**: Includes health, nutrition, education, knowledge, and skills.
- **Social capital**: Comprises networks and connections, relationships of trust and mutual support, formal and informal groups, common rules and sanctions, collective representation, mechanisms for participation in decision making, and leadership.
- **Natural capital**: Encompasses access to land and produce, wild foods and fibres, water and aquatic resources, biodiversity, trees and forest products, environmental services, and wildlife
- **Physical capital**: Consists of infrastructure, tools, and technologies

- **Financial capital**: Covers savings, credit, remittances, pensions, and wages (Macchi, 2011). The SLA framework with its components is illustrated in Figure 2.1.

Figure 2.1: Sustainable Livelihood Approach Framework



Source: Adapted from a guidance sheet from the UK Department of International Development (DFID, 1999 cited in Macchi, 2011).

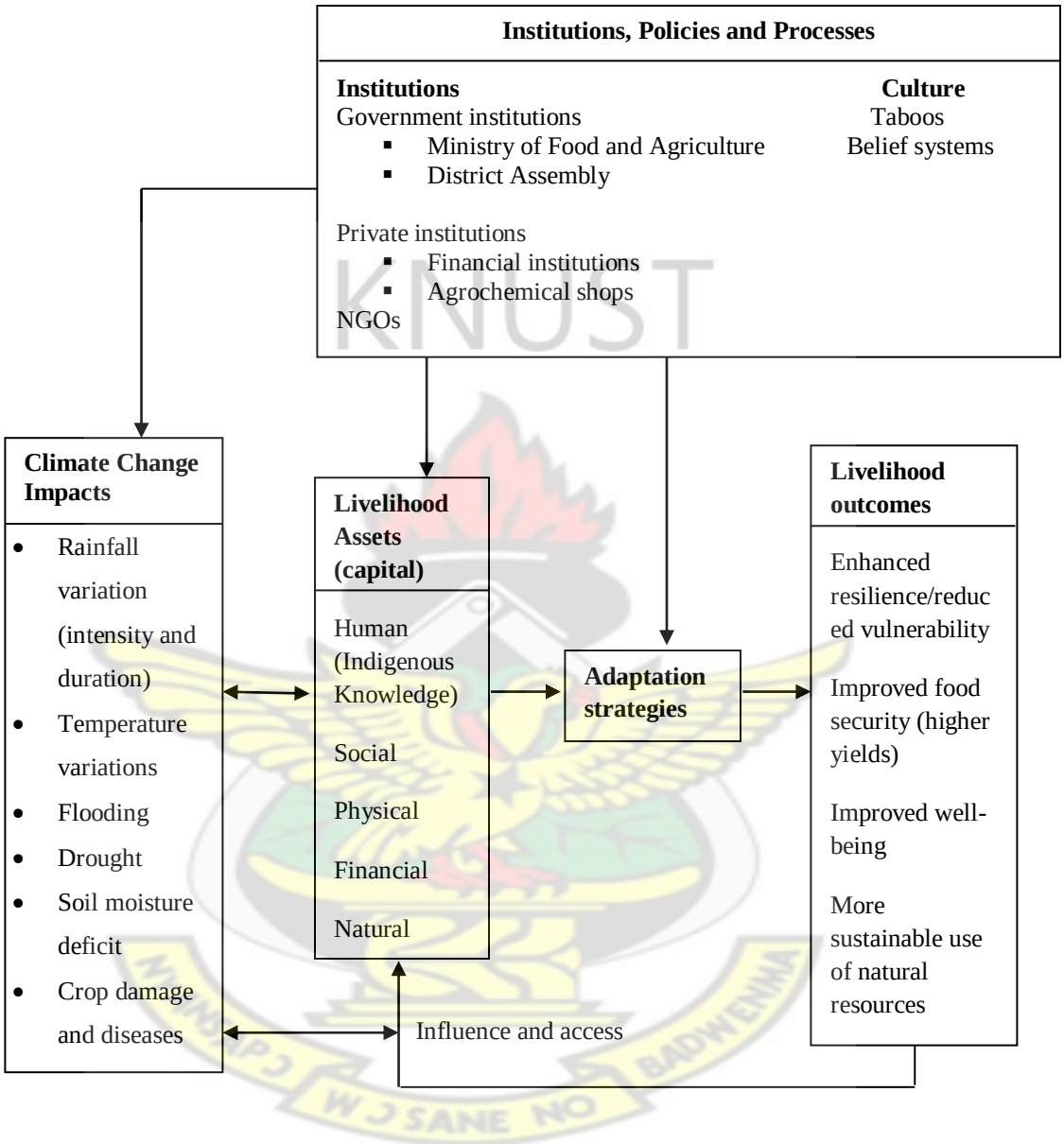
Figure 2.1 shows an analytical structure that facilitates a broad and systematic understanding of the various factors that constrain or enhance livelihood opportunities, and show how they relate to each other (Krantz, 2001). The framework offers a way of assessing how organisations, policies, institutions, cultural norms shape livelihoods, both by determining who gains access to which type of asset, and defining what range of livelihood strategies are open and attractive to people. (Carney, 1998 cited in Krantz,

2001). Also it helps to analyze a community's vulnerability and adaptive capacity, as livelihood assets are important determinants of a community's capacity to adapt to climate and socioeconomic change (Macchi, 2011).

The SLA though serving as a guide for this study on "Indigenous Knowledge and Adaptations to Climate Change" has been modified to suit the purpose for which the study is being undertaken. This modified version is illustrated in Figure 2.2. The key themes of this study are Climate Change, Knowledge (as the principal human asset) and Adaptations. The modified version reflects these themes and linkages among themselves and other relevant components so as to provide in-depth understanding of how indigenous knowledge of climate change affects their adaptation strategies and how these strategies enhance or worsen agricultural output. The original framework focuses on people's access to assets and how these assets can translate into livelihood strategies and reduce vulnerability. However, this study focuses on Knowledge as the key asset and how it informs adaptation strategies in order to build resilience.

The suitability of the SLA to this study is based on the key components inherent in the framework namely the vulnerability context, institutional support, livelihood strategies and livelihood outcomes as illustrated in Figure 2.2. The figure presents the key factors that increase or decrease farmers and fisher folks' susceptibility to the impacts of climate change. These factors include climate change impacts, the resources available to individuals, the strategies adopted to adapt to climate change, the priorities that people define as their desired livelihood outcomes; and institutions and their policy interventions.

Figure 2.2: Conceptual Link between Indigenous People's Vulnerabilities, Knowledge and Adaptations to Climate Change.



Source: Adapted from DFID's Sustainable Livelihood Approach cited in Macchi, 2011.

The study presents climate change as the context within which agricultural activity (fishing/ farming) is organized. The elements which make up climate change impacts include rainfall variability, temperature variability, drought, flooding, among others.

These are the external environment over which people have limited or no control. Climate change impacts are presented as the external environment which poses a serious threat to agriculture and food security particularly to the poor who are least able to cope. These factors directly influence people's access to livelihood assets. For instance, in a situation where farmers depend heavily on rain-fed agriculture, any variation in the amount and timing (delay or early onset of rain) of rainfall will affect agricultural productivity. Farmers therefore become susceptible to droughts and flood. Moreover, excessive rainfall may result in flooding which may destroy crops thereby reducing agricultural output which will in turn put a major constraint on financial capital.

The framework is hinged on five livelihood assets which determine how people especially the poor are able to deal with climate change. These assets are translated into adaptation strategies with the aim of achieving outcomes and reducing vulnerabilities. Adaptation strategies and outcomes reduce the impacts of climate change by increasing the asset base of individuals. To better adapt to the changes, the quality and quantity of assets available to individuals and their ability to put the assets into productive use are very important. For instance, people's knowledge and understanding of climate change inform the choices they make as strategies to adapt to climate change impacts. Therefore people who have knowledge and understand climate change impacts will be able to better adapt to the changes and less vulnerable than those who have no knowledge about climate change. Moreover, farmers who depend on rain-fed agriculture will be more vulnerable to climate change impacts than those who depend on irrigated agriculture. This is because easy access to modern technology such as irrigation system (physical capital) will increase agricultural output thereby reducing climate change impacts. On

the contrary, people's inability to access modern technology such as irrigation will make them vulnerable to low rainfall thereby reducing agricultural output. The modified framework is built on five interrelated livelihood assets namely:

- **Human capital**: Knowledge and skills.
- **Social capital**: Community rules and sanctions, membership to an association and government support.
- **Natural capital**: Access to land, water bodies and other resources.
- **Physical capital**: Infrastructure, tools and technologies.
- **Financial capital**: Profits, savings, access to credit and loans.

It is also important to note that livelihood outcomes will in turn influence a person's asset status. This is because an improved wellbeing for instance would give a better opportunity to build on one's financial assets giving the person an advantage to access other various assets with ease. Furthermore, culture also influences assets and vulnerabilities in that taboos on the use of certain natural resources, like land and water bodies further affect people's ability to adapt.

In as much as adaptation strategies depend on climate change impacts and access to capital assets, institutions also determine or create vulnerability context, assets and outcomes. Institutions act as the external mediating environment that supports people to build their livelihood assets and translate them into adaptation strategies and outcomes thereby enhancing or reducing resilience. For instance, in the Ghanaian context, the Ministry of Food and Agriculture (MoFA) support farmers by implementing policies

that aim at boosting agricultural production. These policies determine the choices available to people to adopt.

The impacts of climate change are more relevant in developing countries; more especially in sub-Saharan African countries where agriculture is the backbone of their economies and majority of the populace depend on rain-fed agriculture. This seems to suggest that these farmers are more exposed and vulnerable to the impacts of climate change. The discussion also revealed that many interrelated factors constrained people's ability to achieve better outcomes. Therefore, looking at the factors that make people vulnerable to climate change, any intervention that seeks to build the asset base of the people must take into consideration all the interrelated components in order to achieve a sustainable livelihood.

CHAPTER THREE

PROFILE OF THE STUDY AREA AND METHODOLOGY OF THE STUDY

3.1 Introduction

Profile of the Bosomtwe district consists of its population structure, relief and drainage, infrastructure, climatic conditions, vegetation, soil types and the economic activities with emphasis on agriculture since it is the focus of this study. In the year 2000, the total population of the district was 62,450 with the dependent population (children and older people) constituting 51.8 percent whiles the active population (working group) constituted the remaining 48.2 percent. Although there was a projected 2010 population total of 83,165 (MoFA, 2011) as at the time of data collection , this could not be relied on because the Ghana Statistical Service (GSS) had no categorization or specific details related to this projection. That is, the 2010 Population and Housing Census report was not available and could not be used in designing the research methods. Therefore in this study, all data related to the district's population with its categorization is based on the 2000 population outcome. However, the current population of the district according to the 2010 Population and Housing Census is 93,910 (GSS, 2014). The district has rich fertile soils, good climatic conditions, reasonably available agricultural land, good infrastructure and close proximity to the Kumasi Metropolis (MoFA, 2011).

Agriculture is the dominant economic activity of the people with about 62.6 percent of the population engaged in the sector. Agricultural activities are much focused on

poultry, piggery, aquaculture and vegetable production. Farmers are mainly of small scale nature so they use low inputs and technology in farming which generally leads to low productivity. The only natural lake in Ghana, Lake Bosomtwe serves as the main tourist attraction in the district (MoFA, 2011).

3.1.2 Location and Size

The Bosomtwe District, formerly Bosomtwe-Atwima-Kwanwoma District is located at the central portion of the Ashanti region and lies within Latitudes 6° 24' South and 6° 43' North and Longitudes 1° 15' East and 1° 46' West. The district is bounded to the North by the Kumasi Metropolitan Assembly, to the South by Bosome-Freho District, to the Northwest by Atwima Kwanwoma District to the Southwest by Amansie East District and Ejisu-Juaben District to the East.

According to the 2000 Population and Housing Census (cited in MoFA, 2011), the population of the district which was 62,450 covered an area of approximately 500 sq. km out of the district's total land area of 1300 sq. km. The district is made up of 3 area councils namely: Kuntanase, Boneso and Jachie. The Lake Bosomtwe covers the south-eastern end of the district (MoFA, 2011).

Figure 3.1 shows a map of the study area (district) in a national context and Figure 3.2 shows the study communities within the district map.

Figure 3.1: The Study Area (Bosomtwe District) in National Context

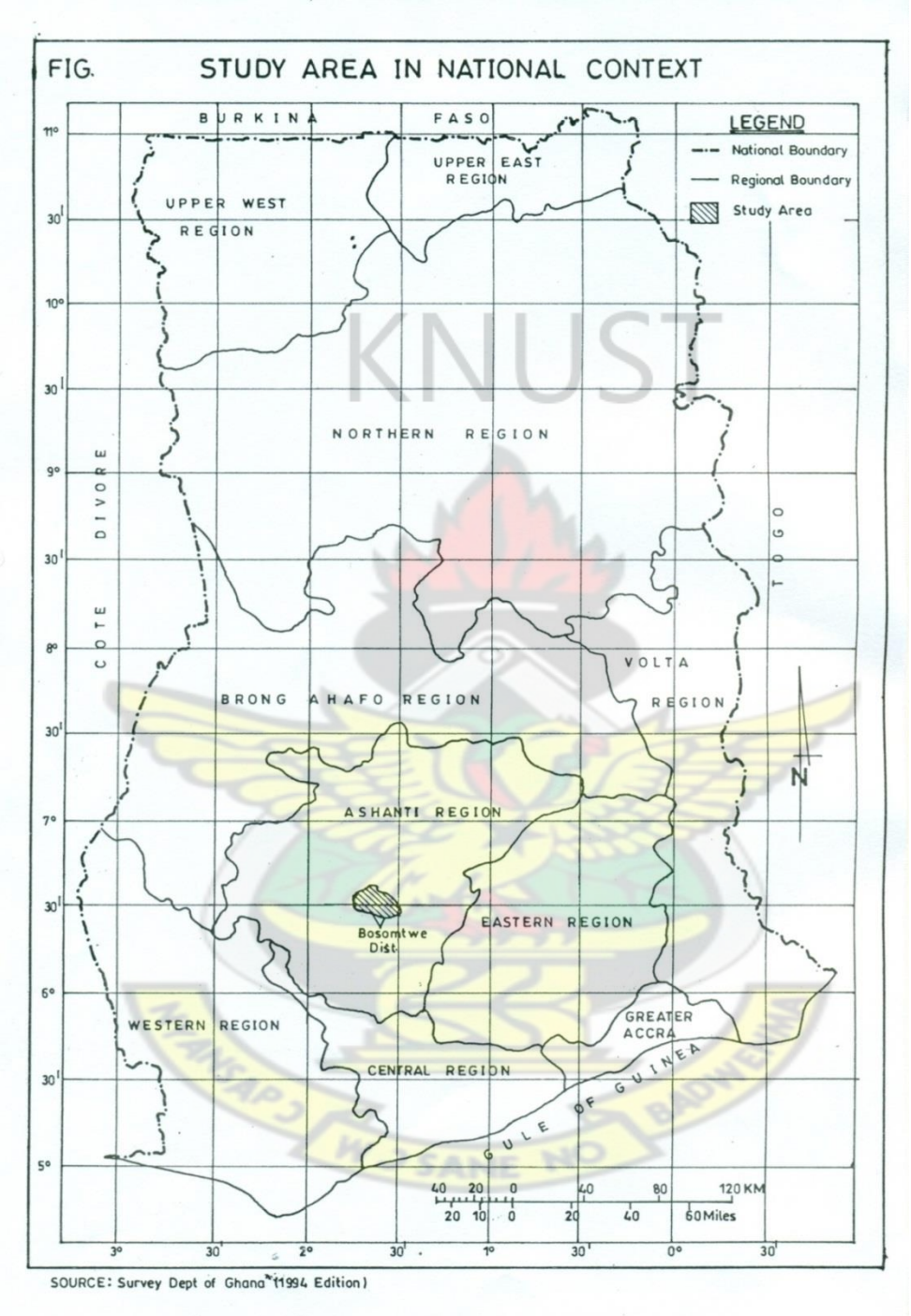
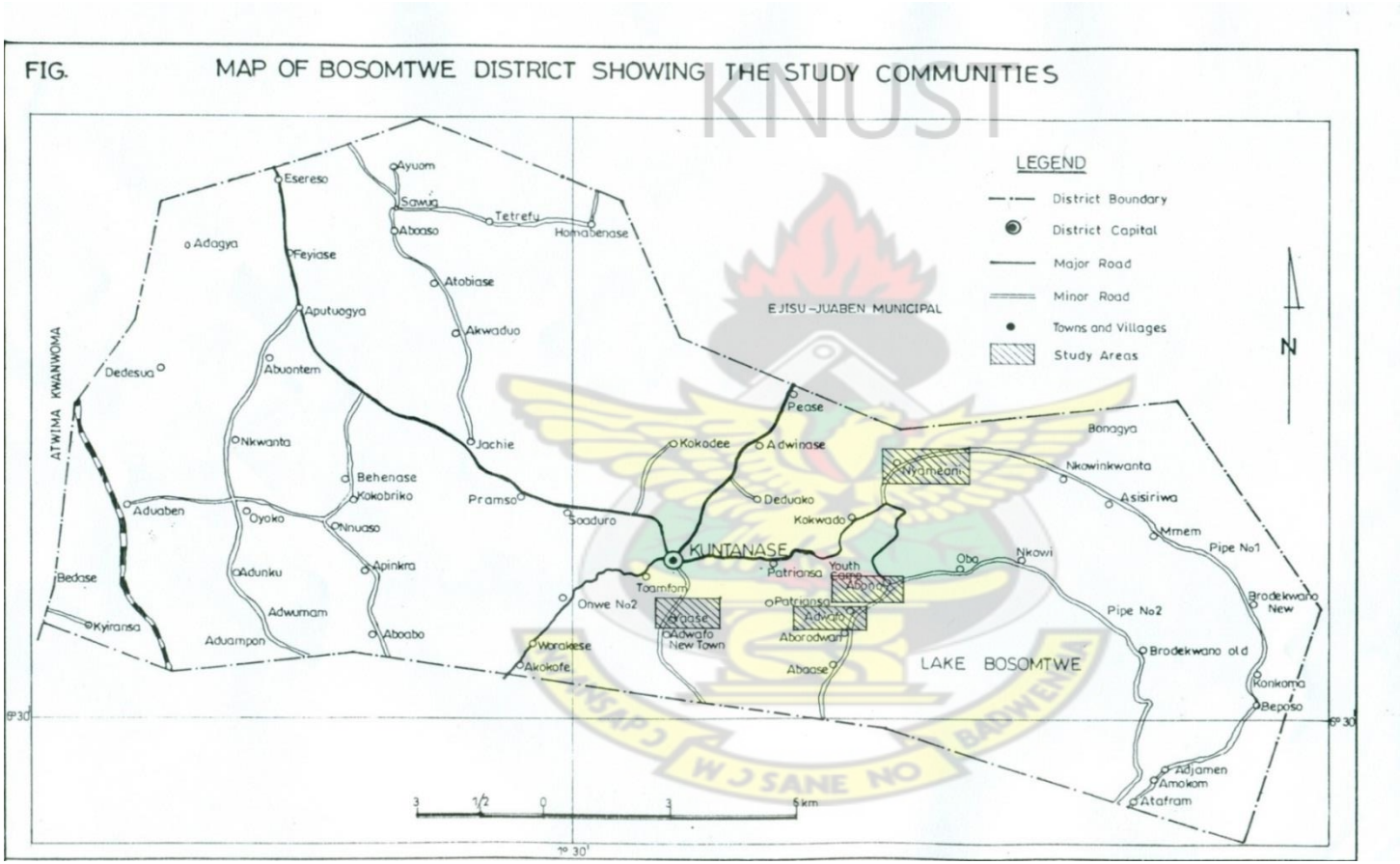


Figure 3.2: The Map of Bosomtwe District Showing the Study Communities



Source: Bosomtwe District Assembly, 2011.

3.1.3 Age and Sex Composition

The year 2000 Population and Housing Census results revealed that there are 51.0 percent of females in the district as against 49.0 percent males as at the time of data collection. This is because men usually migrate in search of jobs leaving the women to take care of the children particularly during the dry season (MoFA, 2011).

Table 3.1 shows the age distribution of the population as at the time of data collection. Table 3.1 reveals that the dependent groups within the ages 0-14 (child dependency) and 65 year and above (older dependency) constitute 27,303 and 4,343 respectively and these are supported by 30,406 of the working population within the ages 15-64.

Table 3.1: Age Distribution of Population

Age Distribution	Population
0-14	27,303
15-64	30,406
65+	4,343

Source: MoFA, 2011.

Table 3.2 shows the percentage distribution by broad age groups and sex. It is seen that except within the child dependency population, women outnumber the men in both the active and older dependency populations. This could be attributed to the fact that most males have migrated to the cities for greener pastures than their female counterparts (MoFA, 2011).

Table 3.2: Percentage Distributions by Broad Age Group and Sex

Age Group	Males (percentage)	Females (percentage	Both sexes (percentage)
0-14	44.4	43.1	43.8
15-64	47.7	48.7	48.2
65+	7.9	8.2	8.0
Total	100	100	100

Source: MoFA, 2011

3.1.4 Occupational Distribution/ District Economy

The structure of the district's economy is made up of agriculture, service and commerce. The major occupation in the district is agriculture and that employs 62.6 percent of the labour force. Of this, the crop farming sector employs 57.4 percent and fishing 5.2 percent. About 41 percent of those engaged in other occupation still take up agriculture as a minor occupation as indicated in Table 3.3. The service sector comprises both government and private employees and other workers. The educated labour force dominate this sector.

Table 3.3: District Occupational Structure

Sector	Percentage
Agriculture	62.6
Industry	19.1
Others	16.7
Service	1.6
Total	**100.0**

Source: MoFA, 2011.

3.1.5 Relief and Drainage

The only unique topographical feature in the district, the Lake Bosomtwe, which is located in the southern end of the district, has an outer ridge that maintains a constant distance of 10 km from the centre of the lake and stands at an elevation of 50m to 80 m. The drainage pattern of the district is dendritic with the rivers flowing in a north-south direction. There is an internal drainage where the streams flow from surrounding highlands into the lake. The rivers are perennial and notable among them are the Oda and Bankro.

3.1.6 Climate and Vegetation

The district falls within the forest belt of the Ashanti region and it is within the wet semi-equatorial climate region with a rainfall regime typical of the moist semi-decidous forest zone of the country. There are two well-defined rainfall seasons; the major season occurs from March to July with a peak fall in June. The minor season starts from September to November with a peak fall in October. August is generally cool and dry. The dry season begins in December and ends in February (MoFA, 2011).

Generally, temperature is uniformly high throughout the year with an annual mean of 24 degrees Celcius. The highest mean (27.8 degrees Celcius) occurs just before the major season in February. Relative Humidity (RH) is generally high throughout the year. The values range between 95 percent and 71.6 percent during the wet season with the lowest value of 42.5 percent in the dry season usually during January (MoFA, 2011).

The natural vegetation of the area falls within the semi-deciduous forest zone of Ghana. Due to extensive farming activities, the original vegetation has been degraded to a mosaic of secondary forest, thicket and forbs re-growth, and various abandoned farms with relics of food crops and vegetation (MoFA, 2011).

There are secondary forests, which are generally over ten years. They are characterized by close upper canopy at heights of about 9m with a number of growing soft wooded trees and few hard woods. It has less open undergrowth of spiny shrubs and climbers. The major tree species are Terminalia spp, Funtumia spp, Ceiba pentandra, Bombax spp, Alchonia spp, Ficus spp, etc.

There are also tickets or forest areas of about five years with relatively impenetrable mass of shrubs, climbers, and young trees. The mass is dominated by Chromolaena odorata (Siamese weed) with few trees above the mass (MoFA, 2011). Forbs re-growth made up of soft stemmed leafy herbs such as the Chromolaena odorata weeds which appear on farms have to be cut down regularly likewise remnants of food crops and coppice shoots re-growth from stumps of felled trees (MoFA, 2011).

3.2 Agriculture

3.2.1 Soils / Agricultural Land Use

The district has six main soil types that are described as follows:-

1. Soil developed over granite and associated rocks. i.e.
    a. Kumasi-Offin Compound Association

b. Bomso-Offin Compound Association

2. Soil developed over the upper and lower Birimian rocks, that is:

a. Bekwai-Oda Compound Association

b. Bekwai-Akomadan-Oda Compound Association

c. Kobeda-Bechem-Webenso-Oda Compound Assocation

d. Atukrom-Asikuma Assocation.

The Kumasi-Offin and Bomso-Offin Compound Associations have similar characteristics. They are well drained and made of quartz gravels and iron-stone nodules in the sub-soil. They are mostly found in the western and middle belt of the district respectively. They support both cash and food crops such as coffee, cocoa, oil palm, citrus, vegetables, maize just to mention a few. The Bekwai-Oda and Kobeda-Bechem-Webenso-Oda Compound Associations also have similar characteristics. These associations are found mostly in the western, north-eastern and eastern parts of the district respectively. These soils are moderately well-drained and support cash crops, legumes and food crops. The Atukrom-Asikuma Association is well drained in some parts. This soil type is mostly found in the eastern part of the Lake Bosomtwe and supports food and tree crops as well as vegetables and sugar-cane production (MoFA, 2011).

The soil types in the district have been found to be ideal for the cultivation of cash crops and indigenous food crops. They are developed over a wide range of highly weathered parent materials including granite, Tarkwaian and Birimian rocks and are more richly supplied with nutrients (MoFA, 2011).

3.2.2 Land Tenure and Agricultural Land Availability

Land ownership is mainly on family bases where the head of family holds title in trust and on behalf of family members. There are some stool lands, which are held and cared for by occupants of the stools, kingmakers and elders of the royal lineage.

Available lands for agricultural purposes are acquired from these two recognised land owners on lease or outright purchase. Individuals who own parcels of land probably through inheritance or care-taker titles also give land out for agricultural activities. The common practices are share-cropping ("Abunu" or "Abusa") and hiring of land (money is paid for the right to use a piece of land for a period of time, usually counted in years). Apart from the few commercial farmers who purchase large tracts of land, the small scale and peasant farmers mostly use family lands by free hold (MoFA, 2011).

The land area available for agricultural activity is nearly 48 percent of the total area of the district (1300 sq. km). This is primarily because of the good soils, vegetation and favourable climatic conditions prevailing in the district. Agriculture involving crops, animals and fish farming employ about 58.55 percent of the active working population. Crop farming alone accounts for 53.41 percent of the active population in the agricultural sector, with the rest in livestock and fishery sectors (MoFA, 2011).

3.2.3 Farming Methods/Systems

The common method of farming in the district is the slash-stump and burn method basically done to prepare lands for cropping. This method adopted is used as result of the location of the district in the forest belt (semi-deciduous forest zone of Ghana) where

methods such as ploughing and other mechanical methods of farming are rarely used. Secondly, the hilly and undulating nature of most portions of the district is a limitation of their use. Two main systems of farming are adopted in the district. These are:

i. **Permanent cultivation:** This is adopted for perennial crops such as cocoa, oil palm, sugar cane, plantain and citrus among others. Under this system, the farmer remains on the piece of land under cultivation for many years growing the same crops. Year to year harvest is derived from ratoon crops, as in sugar cane or yields from the same parent crop.

ii. **Land rotation:** Most of the arable crops are grown under this system, examples are maize and cassava likewise vegetables. They are either grown as a sole crop (monocrop) or mixed-crops where a combination of more than one crop is cultivated on the piece of land for a season and then shifted to another to enable a period of fallow (MoFA, 2011) .

3.2.4 Agricultural Production

Farm holdings in the district are moderately large. Farmers have holdings of more than 3 hectares with an average of 3.5 hectares per farmer put under various crops. Crops of substantial economic significance in the district are cocoa, maize, oil palm, cassava, plantain and cocoyam. The cultivation of these crops is mainly on subsistence basis. On the whole, agricultural production is low but supplement crops come in from Kumasi. Though majority of farmers produce on subsistence basis, areas on mass production of some crops have surpluses for sale or processing. Maize is the predominant food crop cultivated though cassava thrives well in most parts of the district. Vegetable production has a greater potential as it also has ready market in view of the district's proximity to

Kumasi. Some of the rivers namely Oda and Bankoro though perennial promote vegetable production in the dry season. The district's proximity to Kumasi serves as a favourable influence of market prices and attractive market awareness for farmers. Thus prices are very different in most parts of the district compared to the city of Kumasi (MoFA, 2011).

3.2.5 Agricultural Production and Yields

Even though crop production is said to be low in the district due to majority of farmers growing on subsistence basis, Table 3.4 shows consistent increase in some major food crop production each year from the period 2006 to 2009 (MoFA, 2011).

Table 3.4: Agricultural Output/ Production (Metric Ton)

Crop	**2006**	**2007**	**2008**	**2009**
Maize	6,385	6,394	6,415	6,443
Cassava	60,104	60,108	60,116	60,188
Yam	4,375	4,397	4,402	4,408
Plantain	30,456	30,463	30,497	30,584
Cocoyam	6,309	6,328	6,389	6,443
Rice	348	356	367	378

Source: MoFA, 2011.

Table 3.4 shows that cassava is the most cultivated food crop followed by plantain whiles rice is the least cultivated (MoFA, 2011).

3.2.6 Livestock, Poultry and Fishery

The livestock industry is not well established in the district. However some few farmers have small ruminants, pigs and cattle. Poultry production is gaining patronage in the district mainly due to its closeness to the regional capital, Kumasi (MoFA, 2011). There

are few large commercial poultry farms north of the district closer to Kumasi. Table 3.5 gives the production level of poultry and livestock in the district from 2006 to 2009.

Table 3.5: Livestock/ Poultry Census

Livestock/poultry	2006	2007	2008	2009
Sheep	8,427	8,238	8,541	8,056
Goats	5,478	5,647	5,887	6,149
Ducks	3,456	3,812	3,699	4,128
Fowls (local)	8,897	8,495	10,722	10,086

Source: MoFA, 2011

Fishing is done on a smaller scale in the Lake Bosomtwe. Aquaculture is now being practiced in the district with over fifty fishponds found in Kuntanase, Apinkra, Abuontem, Oyoko, Sawuah, Jachie and Esreso.

3.2.7 Agricultural Projects/ Programmes

The District has five projects in the agricultural sector. These are:

i. Cocoa Diseases and Pests Control Programme (CODAPEC)/ Cocoa Mass Spraying Programme
ii. Cocoa Hitech Programme
iii. Expanded Maize Production Programme
iv. Fertilizer Subsidy Programme
v. Livestock Development Project

i. The Cocoa Mass Spraying involves the spraying of cocoa farms against cocoa capsid disease. Various societies are supplied with chemicals to spray their farms. There are presently twenty three societies with twenty-three (23) spraying gangs. A total of 1,900 hectares of farms were sprayed for the year 2009 covering a total of 4,502 farms.

ii. For the Cocoa Hi-tech Programme**,** only sidalco fertilizer (a liquid fertilizer) was supplied by COCOBOD to the district to mix with the capsid chemicals for Mass Cocoa Spraying. The district applied for cocoa-feed fertilizer to sell to farmers in the year, 2011.

iii**.** The Expanded Maize Production Programme involves the giving out of loans to especially groups of farmers to cultivate maize on large scale. The Bosomtwe District Award Winners Association and the Atwima Kwanwoma District Award Winners Association were given some loans to cultivate maize during the minor season. The loan recovery was over 90 percent. This implies that recognised Faith-Based Organisation (FBO) could be supported with credit for farming activities instead of individual farmers.

iv. The Fertilizer Subsidy Programme started in 2008 and involved the issuing of fertilizer coupons to farmers to buy fertilizer at subsidized prices from some identified input dealers. These subsidized fertilizers include NPK 15-15-15, NPK 23-10-5, Sulphate of Ammonia and Urea.

v. The Livestock Development Project begun with the selection of five farmers in the district to start the project in 2010. They were each supplied with 10 sheep (one ram and 9 ewes) for breeding except one farmer who got ten (10) ewes with no ram.

The district also carried out some farmer registration through the Agricultural Extension Agent. A total of 7,070 (3,534 males and 3,536 females) farmers were registered for the year 2009, the exercise is on-going (MoFA, 2011).

3.2.7.1 Agro Processing

There are few agro processing activities in the district. Oil palm processing is carried out in Piase, Worakose and Jachie-Krofrom. Cassava processing and pineapple processing are also carried out in Abuentem and Jachie-Krofrom respectively. The plant at Abuentem currently processes corn dough because of lack of cassava tubers. Other industrial activities include saw milling, making of ornament, gold smithing, akpeteshi distilling, wood carving, textile and dress making (MoFA, 2011).

3.3 Fishing in the Lake Bosomtwe

The Lake Bosomtwe is a relatively small circular (10km diameter, 78m deep) natural crater lake found in the forest zone of Ghana specifically the Bosomtwe district of the Ashanti region. It is the biggest natural lake in the country and a major tourist spot in the Ashanti region. There are two existing theories about the formation of the lake (Dontwi et al., n.d). One established that it was formed from a meteoritic impact and the other by an explosion of volcanic gases and was gradually filled with water (Moon and Mason, 1996, cited in Dontwi et al., n.d). The lake is fed by ground water which drain into it as well as streams and rivers namely river Aberewa and Konkoma. Fish species found in the lake belong mainly to the family Cichlidae. There are 24 towns and villages surrounding the Lake and about 1000 fishermen from all these towns and villages

operate in the lake Bosomtwe. They use 18ft wooden planks as fishing boats and use three types of fishing gears; the wire mesh trap, efficient gillnet 25m x 2-3m and 4cm stretched mesh and a 1-2m radius cast net (Dontwi et al., n.d).

The main species that dominate catches by fishermen are Tilapia busumana, T. discolor, T. zilli, Hemidiromis faciatus and Sarotherodon galilaeus multifaciatus. Clarias species and Hetero bronchus species are rarely found in the lake, however, there are seasonal variations in fishes dominance (Dontwi et al., n.d). Fishing is done throughout the year and usually begins at dawn till dusk. In recent years, individual catches are low, less than 5kg per fisherman per net trap due to both internal and external threat factors (Dontwi et al., n.d). Table 3.6 illustrates the average daily catch per number of gill nets used in the Abono and Adwafo communities which are the 2 fishing communities selected for this study.

Table 3.6: Catch per Unit Effort Using Number of Gill Net

Site	Mesh Size Class (mm)	Number of Nets	Average Daily Catch	CPUE (g/mm)
Abono	35-38	5	100	20
	39-42	5	390	78
	43-46	5	150	30
	47-50	5	300	60
	51-54	5	500	100
		25	1440	288
Adwafo	35-38	5	100	20
	39-42	5	150	30
	43-46	5	100	20
	47-50	5	150	30
		20	500	100

Source: (IRNI, KNUST cited in Dontwi et al., n.d)

From Table 3.6, a total average of 1440 fishes is caught from the lake in Abono whiles a total average of 500 fishes is caught in Adwafo. In Lake Bosomtwe fishery, fishermen count the fish in the catch rather than weigh the catch (Dontwi et al., n.d).

The internal threat factors that lead to low fish catch are:

Over fishing: About 40 to 50 fishermen from each of the 24 villages surrounding the lake undertake their fishing activities in the lake. As such about 960 to 1200 fishermen fish from the lake and most of them fish every day of the week throughout the year. Moreover most of them use unapproved fish gears like wire mesh trap, gillnets (50m x 2m and 4cm length), mosquito net and cast nets in fishing. Gillnets total about 4800–6000 and about 50 percent are permanently set in the water. About 1000 cast nets are daily employed on the lake and these remove a substantial quantity of fish from the lake (Dontwi et al., n.d).

Annual Overturn: Annual overturn results in massive fish kills over the entire lake or in localized areas of the lake and this is what the traditionalists associate with the gods. This is due to stratification involving de-oxygenation below 10m-15m. This lasts for about a month and happens twice annually (Beadle, 1974 cited in Dontwi et al., n.d). It occurs late August and early September (Dontwi et al., n.d). The annual over turn is also due to wind induced overturn resulting from atmospheric instability. During this period the oxygen boundary is lowered to about 50m allowing enough anoxic and H_2S charged water to the surface to kill the fish. The traditional belief is that the gods are angry with the people because the chief has not been performing the customary rites to the gods. The Asamanhene should have sacrificed a dog and a cow with authority from

the Asantehene but to date it has not been done. They call the periodic of overturn "Atuduro" (Dontwi et al., n.d).

Deforestation: Logging, slash and burn practiced in agriculture leads to soil erosion and eventually results in runoffs into the lake. The destruction of vegetation along the shoreline has disturbed the breeding ground of the fishes and also altered the dietary need of the fish species especially those which feed on epiphytic algae and those that feed on seeds or terrestrial insects. The loss of rainfall canopy has resulted in climate change (Dontwi et al., n.d).

Agrochemicals: The accelerated use of agrochemicals by local farmers such as fertilizer and pesticides for the spraying of crops drain into the lake where they accumulate and may lead to eutrophication and the death of fish (Dontwi et al., n.d).

The external factors include:

Physical development: The increase of infrastructural development like hotels along the shore of the lake has been identified as a major tourist attraction. However, the waste water and sewage effluents from these hotels cause pollution and eutrophication problems in the lake (Dontwi et al., n.d).

Socio-economic pressures: There are laws and taboos to protect the lake and fishes. These include; no fishing in the lake on Sundays, the use of the traditional wood plank ("padua") as boat for fishing, no woman in her menstrual period should enter the lake, and sacrifices should be offered to the lake by the Asamanhene of Kokofu Asaman on

behalf of the Asantehene (Dontwi et al., n.d). However, the ever increasing demand for more fishes from the rapidly growing lakeside communities has led to a conflict between the aspirations of the local people and the aim of protecting and conserving the lake as a sustainable resource (Dontwi et al., n.d).

Also the district has several sites of historical, scientific and aesthetic importance serving as tourist attraction spots. These include; the Humakyemase sacred groove along the Kuntanase – Piase road, the waterfall at Piase with special species of fish, River Bobi and Kokom (River Bobi has the history of never having dried up and River Kokom is considered the spiritual base of Kuntanase), the settlement at Feyiase (which is the final battle ground between Denkyiras and Ashantis) and the Okomfo Anokye's Kola tree which still stands in the district (MoFA, 2011).

3.4. Research Methodology

3.4.1 Research Design

A research design is a plan or blueprint which specifies how data relating to a given problem should be collected and analyzed. It provides the procedural outline for the conduct of any given investigation (Nworgu, 2006:50). The cross-section design was employed for the study. This is where a cross-section of the population is contacted once in the time of study for the required information about the problem under investigation. Although this study design cannot measure change in the phenomenon (because the study population is contacted once in time not twice), it still gives the opportunity to

identify the study population and select a sample for the necessary responses. It is extremely simple in design and easy to analyze.

Both quantitative and qualitative methods of data collection were used. Quantitative data are more definite and straight forward. However, on some occasions, qualitative analysis was relevant to show how consistent the outcomes were with the literature. Both quantitative and qualitative data were analysed with the aid of the Statistical Product for Service Solution (SPSS)-version 16 and Microsoft Excel. Within these, descriptive statistical tools were used to give frequency distribution of data for the various communities and results were presented in tables, graphs and charts. Some qualitative data were logically analyzed and results presented in written descriptions.

3.4.2 Sampling Technique and Sample Size

3.4.2.1 Sampling Technique

The purposive sampling technique was used to select 4 communities out of 63 from which various respondents were selected to provide the required information for the study. These constituted two fishing communities; Abono and Adwafo which are very close to the Lake Bosomtwe and two farming communities; Nyameani notable for the production of rice and Yaase known for the cultivation of vegetables especially cabbage. These four communities were selected based on their recognition in fishing and farming activities. Also, the need to find out if communities located close to each other observe similar climate change impacts and those located far apart observe different impacts, further influenced the selected of these communities. In that wise, Abono and Adwafo were selected because they are located close to each other whiles Nyameani and Yaase

were selected because they are far apart. The purposive sampling technique was again used to select key informants from the, District Directorate of the Ministry of Food and Agriculture-Bosomtwe. The key informants were selected based on their close work-relationship with farmers and fisher folks within the communities and their in-depth knowledge on local adaptations.

Although these four communities had recognition in fishing and farming, their inhabitants are not homogenous (based on occupation), besides not all their farmers and fisher folks (sample frame) were experienced to provide the needed information relating to climate change impacts. Therefore, snowball sampling technique was utilized in attaining the sample size as a result of the difficulties encountered in assessing the population size of the group. The snowball sampling is a technique for finding research subject (Atkinson and Flint, 2001:43). In this sampling technique, the first subject (person) gives the researcher the name of another subject, who in turn, provides the name of a third, and so on. This strategy is viewed as a response to overcome the problems associated with concealed or hard-to-reach population. According to Berg (1988:18 cited in Atkinson and Flint 2001:45), "the process is based on the assumption that a 'bond' or 'link' exists between the initial sample and others in the same target population, allowing a series of referrals to be made within a circle of acquaintance". This was implemented by acquiring an initial list of farmers and fisher folks within the classification with their house numbers. Each farmer and fisher folk contacted on the list made referrals to their colleagues who also recommended other contacts until the sample size was attained.

3.4.2.2 Sample Size

The formula n= N/{1+N (a)^2} (Saunders *et al*., 2007:212) was employed in getting the sample size of farmers and fishermen respectively for each community.

Where 'n' is the sample size.

'N' is the total number of farmers/ fishermen in the community

'a' is the margin of error estimated at 5 percent (0.05)

The formula was applied after 10 percent of the population into agriculture of each community was extracted. Therefore 'N' represented 10 percent of the population into agriculture in a community. The details of each community's population who engaged in agriculture was obtained from the Ghana Statistical Service in Kumasi.

Example: In getting the sample size for Nyameani:

Total population into agriculture is 788

N= 0.1× 788

N= 79

Therefore sample size for Nyameani= 79/ {1+79(0.05) ^2}

Sample size for Nyameani= 66.

Table 3.7 shows the derived sample size for each community whiles Table 3.8 shows the sample size of all the specific respondents.

Table 3.7: The Derived Sample Size for Each Community

Community	Total population	Population in Agriculture	10 Percent of population into Agriculture	Sample size (derived from the above formula).
Nyameani	2,011	788	79	66
Yaase	706	389	40	36
Abono	1,154	305	30	29
Adwafo (lakeside)	773	144	14	14
Total	**4,644**	**1,629**	**163**	**145**

Table 3.8: The Sample Size of All Specific Respondents

Respondents	Number of respondents					Total
	Nyameani	Yaase	Abono	Adwafo (lake side)	Staff of MoFA	
Farmers	66	36	-	-	-	102
Fishermen	-	-	29	14	-	43
Extension Officers	1	1	-	-	-	2
Other staff of MoFA	-	-	-	-	3	3
Total	**67**	**37**	**29**	**14**	**3**	**150**

3.4.3 Data Collection Procedure

3.4.3.1 Archival Research

Researchers should make maximum use of historical and secondary data to supplement the primary data collected. Too often, these sources of data are rejected outright as being

unreliable (Smith et al., 1983). The first phase of a research should thus focus on a comprehensive secondary data collection (Smith et al., 1983). Thus information pertaining to climate change and agriculture (farming and fishing) in Ghana and in the study sites was collected at the onset of this study. Books, articles, reports from journals, magazines, internet search and other related literature concerning climate change, indigenous knowledge and agriculture were reviewed.

3.4.3.2 Qualitative Approach

3.4.3.2.1 Focus Groups

Focus Group Discussions (FGDs) were held in each of the four communities. Each community had two FGDs, one for males and one for females making a total of eight FGDs held in all. Each group was made up of between 8 and 12 persons and interview guides were used to collect data during the discussions. All FGDs were conducted in their local dialect 'Twi' and were recorded on a video camera. However, reports were also taken but written in English. Focus groups are somewhere between "a meeting and a conversation" (Agar and MacDonald, 1995 cited in Kidd and Parshall, 2000), where participants relate their experiences and reactions among presumed peers. Homogenous focus groups are an optimal way to obtain in-depth information about certain activities (Mikkelsen, 1995). The objective was to get combined responses (answers, emotions and sentiments) of the group concerning their asset base, constraints and problems each community face due to climate change and observe their level of exposure to climate change effects. Such combined response is more insightful. The meetings provided a learning platform for the researcher and participants to get acquainted with the research and comment on preliminary results.

3.4.3.2.2 Observations and Interviews

Observation is widely used in classical anthropology and is an indirect method of data collection that stresses the importance of dialogue rather than extractive techniques (Mikkelsen, 1995). In this study, non-participant observation was undertaken which included walks in communities and observing how indigenous fishing is done, crop cultivation and harvesting. Structured interview guide for key informants were also used to obtain specific and detailed information related to the subject matter. Key informants according to Mikkelsen (1995:75) are individuals anticipated to have a particular insight or opinions about the topic under study. Key informants in this study were the District Development Officer of Extension, the District Development Officer for Crops and the Agriculture Extension Officers for the farming communities all from the Ministry of Food and Agriculture (MoFA)-Bosomtwe.

3.4.3.3. Quantitative Approach: Structured Interview

In order to collect data to support the role of indigenous knowledge (IK), vulnerabilities, and adaptations to climate change, a structured interview was designed and used. The structured interview had two main components:

1. Basic data on background characteristics of respondents including sex, age, educational level, religion, town of origin and length of occupational practice.
2. The second component consisted of questions which were under the following five divisions:

i. Indigenous perceptions on climate change.

ii. Indigenous occupational activities that compound the impacts of climate change.

iii. Impacts of changes in temperature and rainfall pattern on livelihood and identifying indigenous people's vulnerabilities to climate change.

iv. Indigenous adaptations to climate change.

v. MoFA's support for indigenous adaptations

The first component of the structured interview consisted of only closed-ended questions whiles the second component consisted of both open-ended and close-ended questions.

3.4.3.4 Meteorological Data

For such a study on climate change, meteorological data that shows the climatic variations within the district over a 15 year period was sourced from the Ghana Meteorological Agency-Kumasi. The data spanned a period of 15 years only due to absence of recordings on temperature and rainfall in certain years. Hence, there were several gaps making it impossible to have straight data for 30 years and beyond.

The data collected were the:

i. Mean monthly maximum temperature

ii. Mean monthly minimum temperature

iii. Total Annual rainfall

iv. Potential Evapo-transpiration

These data helped verify responses of the study respondents on changes in the climate.

3.4.4 Methods of Data Analysis and Presentation

The data obtained from closed-ended questions gathered on the field were analyzed using the Statistical Product for Service Solution (SPSS)-version 16 and Microsoft

Excel. The data were coded and fed into the SPSS. The descriptive statistical tool of the SPSS and Microsoft Excel were used to give frequency distributions on the data for the various communities. This helped in making comparison among the different categories of respondents and also among the various communities on a common issue. Results were presented in tables, graphs and charts (bar graphs and pie charts) in order to facilitate easy understanding and interpretation.

The data obtained from key informants interviews, focus group discussions and open-ended questions were analyzed with the aid of an interpretative technique called 'coding'. This is a means of analyzing such qualitative data with quantitative tools after the data has been demarcated into segments and each segment labeled with a code. With this, all responses were written in a book and themes were identified for each response. The main identified themes were then itemized and coded. All the responses were then segmented under the coded themes, thus each response was given the theme code. After this categorization and coding, the coded data were fed into the SPSS-version 16. The same tools for analyzing and formats for presenting closed-ended responses were used for this.

However, not all responses were coded for the sake of emphasis and details. Such responses were logically analyzed through a logical reasoning process and results were presented as written descriptions and reports. Raw meteorological data on temperature, rainfall and evapo-transpiration obtained from the Ghana Meteorological Agency in Kumasi were also entered into Repeated Running Median and the results were presented in graphs.

CHAPTER FOUR

INDIGENOUS KNOWLEDGE AND VULNERABILITY TO CLIMATE CHANGE

4.1 Introduction

This chapter analyses the responses from farmers, fisher folks and staff of the Ministry of Food and Agriculture (MoFA)-Bosomtwe district on issues focused on the objectives related to indigenous knowledge and vulnerability to climate change. Thus the chapter covers indigenous knowledge on climate change, indigenous fishing and farming practices that contribute to climate change and how changes in rainfall and temperature patterns impact on livelihoods of the people (exposing their vulnerabilities). However, the section first captures the response rate and socio-demographic characteristics of the respondents. They are responses gathered from four communities: Nyameani, Yaase, Abono and Adwafo, and from MoFA-Bosomtwe.

4.2 Response Rate on Interviews

A total of 102 farmer and 43 fisher folk respondents were reached with structured interviews which were administered and filled with the help of field assistants. Whiles face-to-face interviews were conducted for 5 staff of MoFA. This helped achieve a response rate of 100 percent.

4.3 Socio-Demographic Characteristics of Farmer and Fisher Folk Respondents

Knowing the socio-demographic characteristics of respondents help understand and appreciate the responses they give. Details of these characteristics of farmer and fisher folk respondents such as age, sex, educational level, religion and duration of occupational practice have been detailed in tables. Table 4.1 shows the sex and age distribution of the farmer and fisher folk respondents.

Table 4.1: Sex and Age Distribution of Farmers and Fisher Folks within the Various Communities

Community	Gender	Age (years)			Total	
		50-59	60-69	70 and above	Freq.	%
Nyameani	Male	17	10	6	33	50.0
	Female	20	4	9	33	50.0
Total		**37**	**14**	**15**	**66**	**100.0**
Yaase	Male	13	6	2	21	58.3
	Female	6	3	6	15	41.7
Total		**19**	**9**	**8**	**36**	**100.0**
Abono	Male	22	3	1	26	89.6
	Female	2	0	1	3	10.3
Total		**24**	**3**	**2**	**29**	**100.0**
Adwafo	Male	12	2	0	14	100.0
	Female	0	0	0	0	0
Total		**12**	**2**	**0**	**14**	**100.0**
Grand total	Male	64	21	9	**94**	**64.8**
	Female	28	7	16	**51**	**35.2**

Source: Field survey, December, 2011.

4.3.1 Sex and Age Distribution of Farmers and Fisher Folks

From a total of 145 respondents, 94 were males whiles 51 were females representing 64.8 percent and 35.2 percent respectively. However, out of the 102 farmers, 54 were males and 48 were females. From the total of 43 fisher folks, only 3 were females. Also in all four communities, males outnumbered the females interviewed with the exception of Nyameani which had 50 percent of its respondents being females. The high male representation in the fishing communities (Abono and Adwafo) suggests that fishing is a man's occupation realizing the risks and dangers associated. The women involved were fish mongers who only assisted in the sales of fishes. For farming, the women could not sit back but support their partners knowing the challenges the climate poses to food production.

The age range was tactfully selected based on the definition that the climate of a place is measured between a period of 30 to 40 years, hence the age started from 50 years. It was presumed that because of the rural settings of the communities, these farmers and fisher folks started farming and fishing at an early age hence 50 years was an appropriate age to begin the range. Table 4.1 reveals that 92 respondents representing 63.4 percent were within the age range of 50-59, 28 respondents representing 19.3 percent fell within the ages of 60-69 whiles 25 respondents representing 17.2 percent were 70 years and above. Across the study area, majority of the respondents were within the 50-59 age brackets. Nyameani had a representation of about 57 percent of its respondents within ages 50-59, Yaase had about 53 percent, Abono had about 83 percent whiles Adwafo had about 86 percent of its respondents aged between 50-59 years.

This result implies that most of the energetic folks could withstand the challenges faced within their occupations though in an era of climate change and variability. Thus, fishing and farming have become more labour-intensive than before. Nevertheless, the elderly could not stay away since these are their only source of livelihood. Interestingly, in all the farming communities, more elderly females aged 70 and above were engaged in farming than their male counterparts. Only Nyameani had more females than males aged between 50-59 years engaged in farming.

4.3.2 Educational Status, Marital Status and Religion

Table 4.2 clearly shows that majority of the respondents (59.3 percent) had basic education. Thus their schooling ended at the primary level but none completed primary six. Most dropped-out from primary three. This was because either there was no financial support or their parents did not see the importance of schooling and wanted more hands to help on their farms or in their fishing business. Overall, about 37 percent had no schooling at all. Abono had most of its respondents (79.3 percent) with basic education followed by Adwafo which had 78.6 percent of its respondents with basic education and these are fishing communities. Each farming community only had about half of its respondents with basic education and recorded more respondents with no formal education compared to the fishing communities. Nyameani and Yaase had 40.9 percent and 47.2 respectively of their respondents with no formal education whiles Abono and Adwafo had 20.7 and 21.6 of their respondents respectively with no formal education. Only 4 out of the 145 respondents made it to the middle school, 3 from Nyameani and 1 from Yaase, none came from the fishing communities. These 4 practiced farming to supplement other sources of livelihood

Table 4.2: Educational Status, Marital Status and Religion of Farmers and Fisher Folks among the Various Communities

Educational status	**Community**				**Total**	
	Nyameani	Yaase	Abono	Adwafo	Frequency	Percentage
No formal Education	27	17	6	3	53	36.6
Basic school	35	17	23	11	86	59.3
Middle school	3	1	0	0	4	2.7
Tertiary	1	1	0	0	2	1.4
Total	**66**	**36**	**29**	**14**	**145**	**100.0**
Marital status						
Married	48	21	26	14	109	75.2
Single	1	2	1	0	4	2.7
Divorced	6	4	2	0	12	8.3
Widowed	11	9	0	0	20	13.8
Total	**66**	**36**	**29**	**14**	**145**	**100.0**
Religion						
Christianity	66	36	29	14	145	100.00
Islam	0	0	0	0	0	0.0
Traditional	0	0	0	0	0	0.0
Other	0	0	0	0	0	0.0
Total	**66**	**36**	**29**	**14**	**145**	**100.0**

Source: Field survey, December, 2011.

The responses in Table 4.2 reveals that most of the respondents were married, recording a percentage of 75.2 with only 2.7 percent being single. This is so for all the communities as well with Adwafo having all of its respondents as married. Most of the respondents had their spouses engaged in the same occupation especially the farmers. This is because the present nature of farming demands extra hands to help produce high yields and their spouses gave them such needed support. All the respondents without any

bias selection were Christians. This suggests that their belief systems in relation to the causes of climate change will have fewer variations.

4.3.3 Occupation and Duration of Practice

The study focused on agriculture in a rural setting hence the selection of only farming and fishing as they are the main occupations. Therefore, the respondents comprised of 70.3 percent farmers and 29.7 percent fisher folks. Only farmers were interviewed from Nyameani and Yaase, and only fisher folks were interviewed from Abono and Adwafo.

The number of years spent in practicing the occupation was a major criterion in selecting the respondents. It was important that one must have practiced the occupation (either fishing or farming) for not less than 25 years. This was such because a respondent should have in-depth knowledge of changes in the local climate and its impacts on their occupation and must have stayed and experienced the climate in the community for more than 30 years so as to give appropriate responses. Table 4.3 shows that 62.1 percent of the respondents had spent between 25-34 years practicing fishing or farming, 20 percent had spent 35-44 years, 8.3 percent had spent 45-54 years and the remaining 9.6 percent have practiced their occupation for more than 55years.

Though all the communities had more than half of their respondents having practiced the various occupations within 35-44 years, Adwafo had no one practicing fishing beyond 44 years. Nevertheless, all the respondents were appropriate for the study aside the fact that all were natives of their communities and had stayed there since childhood.

Table 4.3: Occupation and Duration of Occupational Practice of Farmers and Fisher Folks among the Various Communities

Occupation	Community				Total	
	Nyameani	Yaase	Abono	Adwafo	Freq,	%
Farming	66	36	0	0	102	70.3
Fishing	0	0	29	14	43	29.7
Total	66	36	29	14	145	100.0
Duration of Occupational practice (years)						
25-34	36	22	22	10	90	62.1
35-44	16	3	6	4	29	20.0
45-54	5	7	0	0	12	8.2
55+	9	4	1	0	14	9.7
Total	66	36	29	14	145	100.0

Source: Field survey, December, 2011.

Other respondents were 5 staff members from the Ministry of Food and Agriculture (MoFA)-Bosomtwe district making a total of 150 respondents. Table 4.4 details the socio-demographic characteristics of these respondents.

Table 4.4: Socio-Demographic Characteristics of Staff of MoFA

Staff position	Gender	Age range	Level of education	Years at MoFA
District Development Officer for Extension	Male	35-44 years	Tertiary	6 years
District Development Officer for Crops	Female	35-44 years	Tertiary	3 years
Agriculture Extension Agent of Nyameani	Male	35-44 years	Tertiary	17 years
Agriculture Extension Agent of Yaase	Male	35-44 years	Tertiary	11 years
Agriculture Extension Agent of Kuntanase East	Male	35-44 years	Tertiary	3 years

Source: Field survey, December 2011

Though none of the staff interviewed from MoFA had worked for about 3 decades, they were knowledgeable on the changes in climate within the district and its impacts on agriculture within the various communities. As such their knowledge was needed in order to achieve the objectives of the study.

4.4 Indigenous People's Opinions on Rising Temperatures and Decreasing Rainfall

There is the reality that the climate is changing (Adger et al., 2005). All over the world temperature and rainfall are among the common indicators of climate change. The study sought to find out the opinions of the farmer and fisher folk respondents on the changes in climate and whether they have observed continuous increase in temperature or continuous decrease in rainfall within their various communities. Their level of climate change awareness was also of importance to the study.

All the respondents (100 percent) admitted there have been changes in the climate over the past 30 years. About 97 percent of these respondents strongly believed there has been continuous increase in temperature within their communities over the past 10 years whiles 62.1 percent strongly admitted that there has been continuous decrease in rainfall over a decade.

4.4.1 Continuous Rise in Temperatures

Table 4.5 presents the opinions of respondents from the various communities on continuous rise in temperatures over the past decade within their localities. The table reveals that over 90 percent of respondents from each community had observed a

continuous rise in temperature within their localities. Proxy data (recorded at Bekwai) from the Ghana Meteorological Agency on temperature recorded over a period of 15 years (1997-2011) gave a similar scenario.

Table 4.5: **Respondents' Opinion on the Continuous Rise in Temperature**

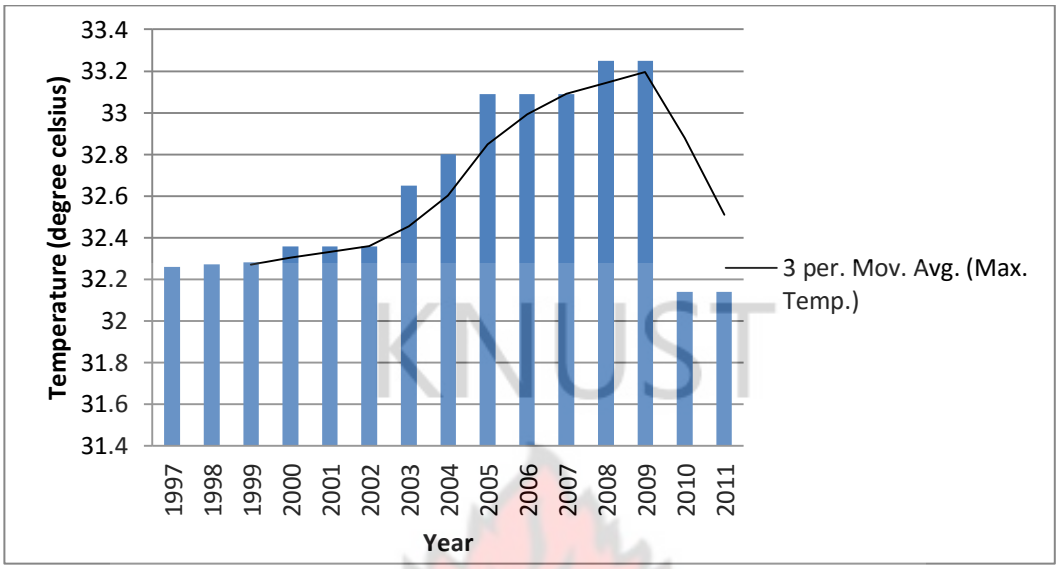
Response	**Community**				**Total**	
	Nyameani	Yaase	Abono	Adwafo	Frequency	Percentage
Strongly Agree	64	34	29	13	140	96.6
Somewhat Agree	2	2	0	1	5	3.4
Total	66	36	29	14	145	100.0

Source: Field survey, December 2011.

Figure 4.1 is a repeated running median graph showing the mean annual maximum temperature for the district-Bosomtwe. The graph shows a rising trend of temperature over a long period of time. From 1997 to 2002 temperatures were increasing steadily but from 2003 to 2009 the increase was more noticeable.

The years 2008 and 2009 had very high temperature recordings of over 33.2 degrees Celsius. Very significant was a sharp drop in temperatures in 2010 and 2011 which are the most recent years. Though temperatures were relatively low within the last two years (2010 and 2011), respondents failed to comment on that. To them, the heat has been unbearable within the past decade and they could not be sure if this trend of decreasing temperature will continue.

Figure 4.1: Mean Annual Maximum Temperature for the Bosomtwe District from 1997 to 2011



Source: Ghana Meteorological Agency, 2013.

It is of much importance to note that respondents' views on the continuous rise in temperature pertains to their local communities whiles the graph pertains to the whole district. Nevertheless, the district temperature pattern gives information on what could be happening within the various communities with the application of a deductive reasoning.

4.4.2 Continuous Decrease in Rainfall

From a total of 145 respondents, 90 (62.1 percent) strongly agreed that the rainfall in their communities has been decreasing over the years compared to 40 (27.6 percent) who somewhat agreed. However, a total of 14 respondents (9.7 percent) somewhat disagreed whiles only 1 respondent (0.6 percent) strongly disagreed. In all four communities, most respondents noticed a continuous decrease in rainfall within their localities, this is illustrated in Table 4.6.

Table 4.6: Respondents' Opinion on Yearly Decrease in Rainfall

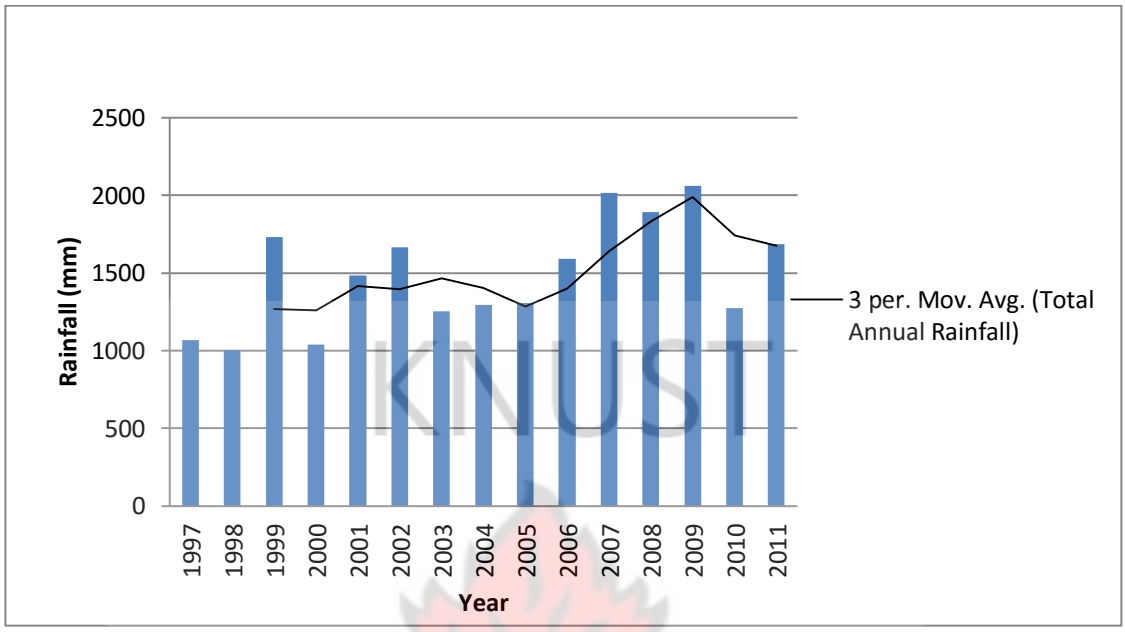
Response	Community				Total	
	Nyameani	Yaase	Abono	Adwafo	Frequency	Percentage
Strongly Agree	32	16	29	13	90	62.1
Somewhat Agree	26	13	0	1	40	27.6
Somewhat Disagree	7	7	0	0	14	9.7
Strongly Disagree	1	0	0	0	1	0.6
Total	66	36	29	14	145	100.0

Source: Field survey, December 2011.

In all four communities, most respondents noticed a continuous decrease in rainfall within their localities, this is illustrated in Table 4.6. All 29 respondents at Abono strongly agreed to a continuous decrease in rainfall, 13 out of 14 respondents at Adwafo strongly agreed as well. At Yaase, 16 out of 36 respondents strongly agreed whiles 13 respondents somewhat agreed and at Nyameani 32 respondents strongly agreed whiles 26 respondents somewhat agreed to a continuous decrease in rainfall. Figure 4.2 shows the rainfall pattern of the whole district and it contradicts the views given by majority (62.1 percent) of the respondents that there is a continuous decrease in rainfall.

The Figure 4.2 illustrates a varying trend in the rainfall pattern within the Bosomtwe district. An outstanding trend within the pattern is the continuous increase in rainfall from 2005 to 2009 until it decreased in the subsequent years 2010 and 2011. The year 2000 recorded a total annual of about 1,100 mm which is lower compared to a record of over 2000 mm in 2009. Therefore it is amazing for most respondents to strongly agree to a continuous decrease in rainfall. However, their responses were limited to the local climate within their communities.

Figure 4.2: Total Annual Rainfall for the Bosomtwe District from 1997 to 2011



Source: Ghana Meteorological Agency, 2013.

Although this rainfall pattern is limited to the Bosomtwe district and its environs, it challenges the observations made by the Environmental Protection Agency (EPA) that there is a continuous decrease in rainfall in all forest ecological zones in the country (EPA, 2010f). The temperature and varying rainfall patterns pose difficulties to farming and farmers are unable to predict weather trends and adjust easily.

4.4.3 Awareness on Climate Change

About 77 percent of the total respondents confirmed they were aware of climate change. More respondents at Nyameani (80.3 percent) were aware of climate change compared to 78.9 percent of respondents at Abono, 75 percent of respondents at Yaase and 71.4 percent at Adwafo. These respondents had heard of climate change on the radio aside observations within their own communities. A focus group discussion with fisher folks

at Abono revealed that they have heard of climate change from Non-Governmental Organisations (NGOs) such as 'Friends of Rivers and Water Bodies' and Government organisations such as the Ghana National Fire Service. On the contrary the remaining 23 percent respondents had not heard of climate change from any other source except through their own observations. This situation however does not nullify Mensah et al.'s view that there are low levels of climate change awareness in Ghana (Mensah et al., 2009) since their view is national based but respondents views were local based. Similarly, a study conducted by Dontwi et al., (n. d) on "Vulnerability and Adaptation Assessment for Climate Change on Fisheries' in Ghana" also observed that 85.7 percent of the study respondents were aware of climate change and majority had heard of it through the radio, television and other media channels. They concluded that the media is an effective communication channel which could be used to educate the masses on issues of importance such as climate change (Dontwi et al., n. d).

4.5 Indigenous Farmers' and Fisher Folks' Knowledge on Climate Change

In the previous section, respondents' opinions on continuous temperature increase and decrease in rainfall were presented. However this section discusses the indicators used by these indigenous people (their own indicators) in assessing climate change. These indicators are based on evidences they have observed within their communities as caused by climate change. Their indicators define how they perceive climate change and this is a first step in identifying their knowledge on climate change. Thus though indigenous knowledge encompasses technologies, know-how, skills, practices and beliefs of the indigenous people (UNEP, 2009 cited in Graff et al., n.d) it is first informed by their perceptions towards climate change.

From Table 4.7, it is clear that all observed evidences are related to temperature and rainfall and these are the main indicators on which their perceptions were based.

Table 4.7: Evidences of Changes in Climate Reported by Communities

Evidence	**Farming Community**		**Fishing community**		**Total**	
	Nyameani	Yaase	Abono	Adwafo	Frequency	Percentage
Intense heat (very high temperatures)	11	1	4	0	16	11.0
Unpredictable/unreliable rains	5	4	5	0	14	9.7
Low rainfall intensity (quantity)	10	1	1	1	13	9.0
Changes in rainfall pattern and higher temperatures	32	26	14	9	81	55.9
Changes in planting and growing seasons	4	1	0	0	5	3.4
Continuous lake retreat and low fish yields	0	0	5	2	7	4.8
Other evidences	4	3	0	2	9	6.2
Total	66	36	29	14	145	100.0

Source: Field survey, December 2011.

Their perceptions on climate change were captured through the following: observed evidences within the community, and their understanding of the causes of such evidences. As all of these contribute to their knowledge on climate change, their knowledge which is a very important capital further influences their adaptation strategies and this is captured in the next chapter. As pointed out in the conceptual framework (Fig

2.1 on page 54) knowledge (human capital) is among the livelihood assets that influence adaptation strategies and livelihood outcomes.

4.5.1 Temperature (Intense heat)

Table 4.7 illustrates that from the total of 145 respondents interviewed 16 admitted there has been changes in the climate due to intense heat which was not so about 30 years ago. These people perceived climate change as continuous rise in temperature. Thus they related the changes in climate to only temperature change. Whiles Nyameani had 11 of its 66 respondents attributing climate change to only temperature increase, Adwafo had none of its respondents attributing climate change to only temperature increase. A focus group discussion with farmers at Nyameani further attested to the fact that there has been continuous rise in temperature (intense heat) which destroyed most of their crops. However, responses from all 5 staff of MoFA interviewed gave a different impression of the district's temperature. They all reported that the temperature pattern has fluctuated over the years but this was not the trend portrayed by the district's temperature pattern illustrated in Figure 4.1 on page 93.

4.5.2 Rainfall

Another observed indicator which informed their perceptions of climate change is rainfall. Some respondents based their perceptions of the changes in climate on what had changed in the rainfall pattern. However, the observed changes focused on the following:

4.5.2.1 Low Rainfall Intensity and Quantity: Eleven farmers out of the total of 102 interviewed (10 from Nyameani and 1 from Yaase) and 2 out of 43 fisher folks (1 from Abono and 1 from Adwafo) reported that the rains do not fall as heavy as it used to be several years back. Further, the quantity has reduced likewise the number of rainy days. Even though this has been the situation over decades, few respondents realized the year 2011 has been exceptional, as there have been occurrences of heavy, destructive and more rains (compared to past years). This was confirmed earlier by 9.7 percent of the total respondents who somewhat disagreed that rainfall decreases every year.

Further confirmation came from focus group discussions with farmers at Yaase, where it was generally reported that even though recent times have seen a reduction in rainfall intensity, the rains this year (2011) have been heavy and accompanied by strong winds which destroyed most crops. On the contrary, responses from fisher folks during the focus group discussions at Abono and Adwafo revealed that when there were more rains, more fishes were caught from the Lake Bosomtwe but this has changed. Lately, few fishes are caught due to less rainfall amounts year after year.

4.5.2.2 Unpredictable and Unreliable Rains: In recent times, the rains do not start when expected thereby it is unreliable and difficult to predict. This was a general observation made by 9.7 percent of the respondents but no respondent from Adwafo shared this view. A 61 year old farmer from Nyameani lamented, "*the rains used to come from June to August, but it has changed now, it no more comes at this expected time*". This view was shared by most respondents who could no longer predict when the rains will next

come making the start of planting seasons unpredictable. To them the unreliable rains cause great harm to their occupation.

A general account of the district's rainfall pattern by the staff of MoFA interviewed could not be evaluated as they all did not agree on a particular pattern. From all 5 members interviewed, 1 reported on more rains over the years, 2 reported on less rains over the years whiles the remaining 2 reported of unstable rains over the years. According to the Agricultural Extension Agent (AEA,) for Nyameani droughts are usually recorded in early parts of the year but latter parts bring along heavy rains especially in August and September. However, the major raining season within the whole district starts from early March to July whiles the minor season starts from late August to November (MoFA, 2011). Table 4.8 details the responses from all 5 staff members of MoFA regarding years of more rains, less rains and droughts.

Table 4.8: An Account of Years of More Rains, Less Rains and Drought by MoFA Staff

Staff	Years of more rains	Years of less rains	Years of drought
District Development Officer for Extension-District Office	2000, 2004, 2008	2003, 2005	2006, 2007
Agriculture Extension Agent-Yaase	2005, 2007, 2009	2004	2010
Agriculture Extension Agent-Kuntanase East	2009	2010	2011
Agriculture Extension Agent-Nyameani	2011	2008	-
District Development Officer for Crops-District Office	2007, 2008	2009, 2010	2011

Source: Field survey, December 2011.

Table 4.8 records conflicting responses among all the MoFA staff interviewed and as such a generalization could not be made. However, Figure 4.2 on page 98 showing the rainfall pattern for the district recorded 1999, 2002 2007, 2009 and 2011 as years of more rains comparatively.Years of less rains recorded are 1997, 1998 and 2000. Comparing the responses of the MoFA staff interviewed with the meteorological data (Figure 4.2), some responses are in line with the meteorological data whiles others are not. It is important to note that the responses from the staff of MoFA were based on their observations rather than an instrument-recorded data. This is because there is no functional meteorological station within the district so proxy data from Bekwai has been used. MoFA's own observation is important as it could inform them on what to include when designing a plan to help farmers and fisher folks adjust to these climate variability.

Another important point to note is that even though the responses given by the MoFA staff pertained to the entire district, the Agriculture Extension Agents (AEAs) responses were more biased towards observations made within their local communities. Their generalizations for the entire district cannot therefore be relied upon instead it gives an idea of what happens within their local areas. Therefore an emphatic statement cannot be made after comparing the responses of the MoFA staff to that of the Ghana Meteorological Agency. Having an idea of the climate variability in their various localities is good because it could help in the design of projects that are location-specific to help farmers and fisher folks mitigate and adapt to climate change impacts.

Nevertheless the responses from the AEAs of the two farming communities of the study Yaase and Nyameani respectively were in line with the meteorological data. The AEA

of Yaase reported 2005, 2007 and 2009 as years of abundant rains whiles that of Nyameani reported on only 2011 as the year of more rains. The year of less rains reported by the AEA of Yaase was 2004 compared to 2008 for Nyameani. The year 2010 was considered a period of drought for Yaase but Nyameani had no year reported as such.

4.5.2.3 Changes in Both Rainfall Pattern and Temperatures

The majority of respondents (56.9 percent of farmers and 53.5 percent of fisher folks) based their perceptions on both changes in temperature and rainfall pattern. This differs from the responses of the few who based their perceptions on only changes in temperature and from those who based theirs on only changes in rainfall in concluding that there had been changes in the climate. On the other hand, the majority of respondents agreed that there has been excessive warming, indicating a continuous rise in temperature. In relation to that, rainfall keeps reducing in intensity, in the number of rainy days and has also become more unpredictable. According to a 59 year old farmer at Nyameani, "*the early morning rains 'Abrempong nsuo' which usually comes in October and waters our crops do not come anymore instead, the scorching sun burns up the few crops that struggle to grow and you often see very dry leaves dropping off plants*". Though MoFA (2011) reported that during the minor raining season, there is a peak fall in October, farmers admitted that they still relied on very early morning rains called 'Abrempong nsuo' which no more exist. These respondents therefore perceived climate change as excessive warming coupled with poor rainfall distribution throughout decades of years. Their perception is in accordance with that reported by the EPA that over the last 50 years, recorded data by the Ghana Meteorological Agency clearly shows

progressive and discernible rise in temperature and steady decline in rainfall in all agro ecological zones (EPA, 2010g).

4.5.2.4 Changes in Planting Periods

The evidence of changes in planting and growing periods was an indicator for 5 out of the 102 farmers interviewed (4 from Nyameani and 1 from Yaase). However, this evidence is connected to changes in temperature and rainfall pattern. For instance delayed onset of rains coupled with too little quantity of rains make planting and growing periods unpredictable.

4.5.2.5 Continuous Lake Retreat and Low Fish Yields

Weather events like droughts, dry spells and unreliable rainfall are strong determinants of the sustainability of water resources and water (EPA, 2010k). As such though all fisher folks confirmed that recent climatic conditions have caused continuous retreat of the Lake Bosomtwe, only 7 fisher folks from the total of 43 interviewed (5 from Abono and 2 from Adwafo) based their perception of climate change on the lake retreat. These fisher folks indirectly also agreed to the fact that temperature keeps rising whiles rainfall amounts keep decreasing in quantity. This is because the continuous intense heat causes the lake to evaporate yet the rains do not come to fill the lake up. Plate 4.1 shows a section of dry land around the lake on which the lake stretched decades ago.

Plate 4.1: The Stretch of Lake Bosomtwe Decades Ago

Source: Field survey, December 2011.

Below are other evidences outlined by both farmers and fisher folks associated with their respective occupations.

4.5.2.6 Other Evidences Observed by Farmers:

i. Extinction of some plant species like 'Acheampong' (Cromolaena odorata): This plant species has been in extinction in both Nyameani and Yaase since 1983.

ii. There has been the prevalence of strange plants like 'Esre' (Pennisetum purpureum) and crop diseases/ infestation since 1983.

iii. Reduced crop yield and smaller crop sizes have been realized by farmers since early 1990s.

iv. There has been an increase in dependence on use of agro-chemicals and irrigation since the year 2000.

v. There has been frequent drying up of water bodies about 3 decades ago both at Yaase and Nyameani. During the dry season, some rivers like 'Bankro' which

passes through both towns completely dries up making cultivation of vegetables difficult.

vi. Strong winds and loss of vegetation due to indiscriminate felling of trees by most inhabitants for fire wood.

4.5.2.7 Other Evidences Observed by Fisher Folks:

i. Extinction of some plant species like 'Acheampong' (Cromolaena odorata) since early 1980s.

ii. Appearance of strange plants like 'Esre' (Pennisetum purpureum) both at Abono and Adwafo since late 1980.

iii. Changes in fishing seasons and low fish yield: There have been changes in the months of bumper harvest and even during times of bumper harvest, there are very low fish catch compared to 3 decades ago.

iv. There have been changes in the times the harmattan starts and ends. In recent years the harmattan occurs at unexpected times (sometimes in January, other times in February or even March and ends within the same month or early the next month) unlike decades ago when it could be said to start from early December and end in late January.

These observations of increased variability in rainfall patterns and warming temperatures over the last thirty years made by farmers are consistent with the findings of similar researches carried out in other localities with similar characteristics. An example of such study is by Gyampoh et al., (2009), who researched on the topic, 'Using Traditional Knowledge to Cope with Climate Change in Rural Ghana-A Case Study of

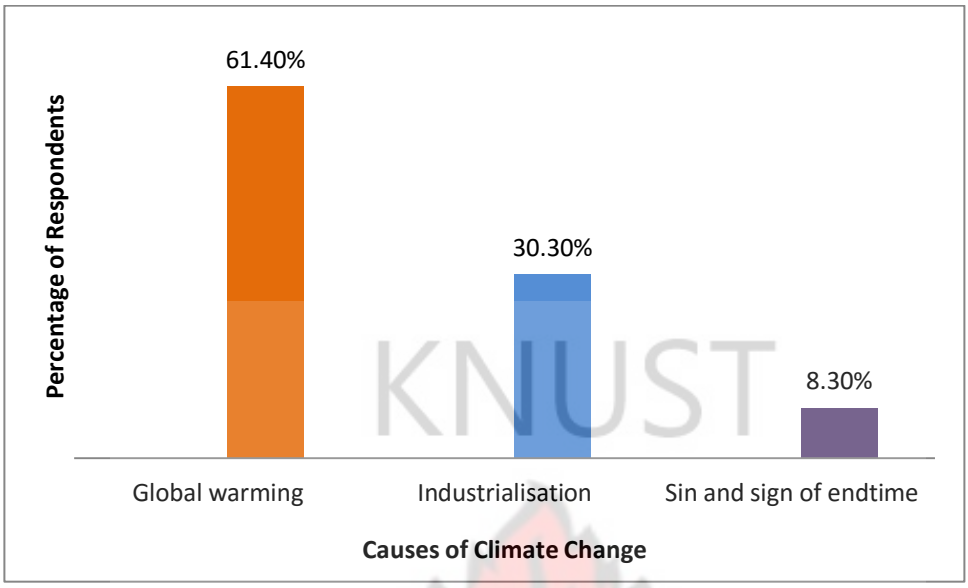
Surveyed Rural Communities in the Offinso River Basin'. From their study, they concluded that farmers' detailed perception of these climatic changes showed how dependent farmers are on weather patterns. Furthermore, Gyampoh et al., (2007) cited in Gyampoh et al., (2009) made the assertion that indigenous people observe and feel the effects of decreasing rainfall, increasing air temperature, increasing sunshine intensity and seasonal changes in rainfall patterns and the responses given by both farmers and fisher folks confirm this. The conceptual frame work on page 56 also illustrates that elements (such as temperature variation, rainfall variations, droughts, soil moisture deficit among others) make up climate change impacts and are the external environment over which people have limited or no control.

4.6 Views of Indigenous People on Causes of Climate Change

The causes of climate change are basically linked to human-induced activities that increasingly release carbon dioxide into the atmosphere (Jenson, 2009). This view is widely accepted and this section analyses the views of the indigenous people on the causes of climate change. Their responses are presented in Figure 4.3.

Overall, the majority (61.4 percent) of farmers and fisher folks interviewed were familiar with the concept of human induced climate change and have heard of global warming through the radio. Few cocoa farmers who have benefited from the mass cocoa spraying some years back also heard of global warming from their Agriculture Extension Agents. Most of these respondents identified gas emissions from factories as a major source of the warming.

Figure 4.3: Views of Indigenous People on Causes of Climate Change



Source: Field survey, December 2011.

During a focus group discussion with farmers at Nyameani, some members made mention of deforestation as another cause of the warming. For instance, a 54 year old female farmer at Yaase stated that '*trees are our natural air-conditioners (thus served as cooling agents) but in recent times, they are indiscriminately cut down and this makes the weather excessively warm causing high temperatures*'. She therefore attributed the cause of recent high temperatures to global warming and human activities.

Only 30.3 percent of the respondents mentioned industrialization (though linked indirectly to global warming) as a cause of climate change. This they have heard from enlightened relatives who visited occasionally from the cities. Others also claimed to have heard of it on the radio. Undoubtedly, 8.3 percent of the respondents held the view that the unpardonable sins of men and biblical prophesies concerning the end of time have caused so much changes in recent climate. This view of respondents is in line with

the assertion made by Ishaya and Abaje (2008) that usually traditional people's interpretation of climatic and weather phenomena are geared towards spiritual thoughts thus as signs of something more than mere biophysical processes. They interpret adverse weather conditions as well as more catastrophic events as punishment for human wrongdoings or events caused by the breach of taboos.

Although a minority of the respondents' views were in line with this assertion, the views of the majority of respondents showed that local views of climate changes are characteristically interwoven with other environmental and societal problems (Ishaya and Abaje, 2008). However the responses from majority of the respondents disagreed to this assertion made by Ishaya and Abaje, (2008). The causes of the change in temperature and rainfall patterns reported by the staff of MoFA are detailed in Table 4.9. Most of the causes detailed in the Table are human-induced.

Table 4.9: Causes of Changes in Temperature and Rainfall Patterns Reported by MoFA Staff

Staff	Cause of changes in temperature	Cause of changes in rainfall
District Development Officer for Extension	Release of carbon dioxide into the atmosphere	Indiscriminate felling of trees and excessive burning
Agriculture Extension Agent for Nyameani	Deforestation and the felling of trees along water bodies	El-Nino Oscillation
Agriculture Extension Agent for Yaase	Indiscriminate felling of trees for farming activities	Indiscriminate felling of trees for farming activities
District Development Officer for Crops	Extremely scorching sunlight accompanied by hotter atmospheric air.	Fluctuating intensity of rains over the years.
Agriculture Extension Agent-Kuntanase East	Excessive burning and indiscriminate felling of trees	-

Source: Field survey, December 2011.

4.7 Perceived Impacts of Climate Change on Indigenous Livelihoods-Farming and Fishing Activities

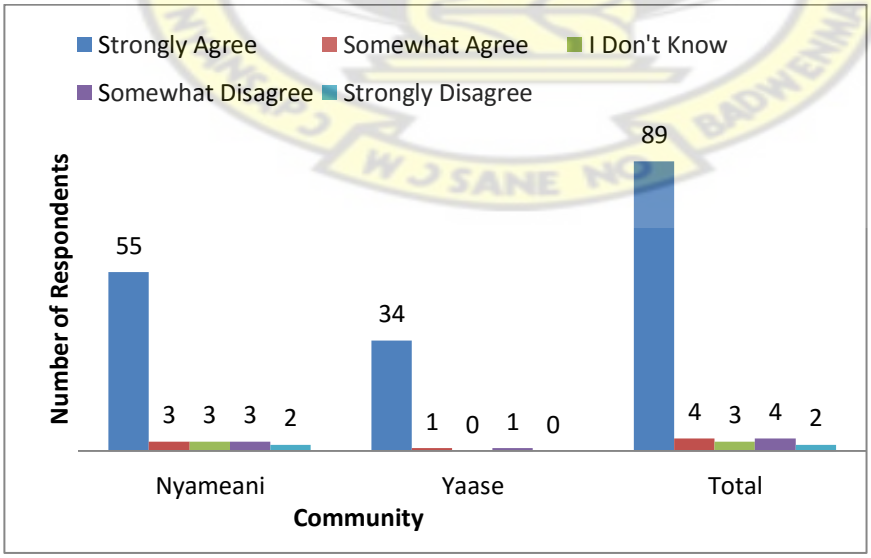
Climate change by these indigenous people is basically perceived as changes in temperature and rainfall pattern and these elements which make up climate change impacts among others pose serious threat to agricultural output and food security (this is illustrated in the conceptual framework on page 66). This section therefore examines how changes in the communities' temperature and rainfall pattern and other impacts affect their livelihoods.

4.7.1 Perceived Impacts on Indigenous Farming

4.7.1.1 Low Crop Production

It is seen from Figure 4.4, that recent farming activities face difficulties due to continuous rise in temperatures, and unpredictable and less rains.

Figure 4.4: Effects of Yearly Rains and Rising Temperatures on Current Crop Production

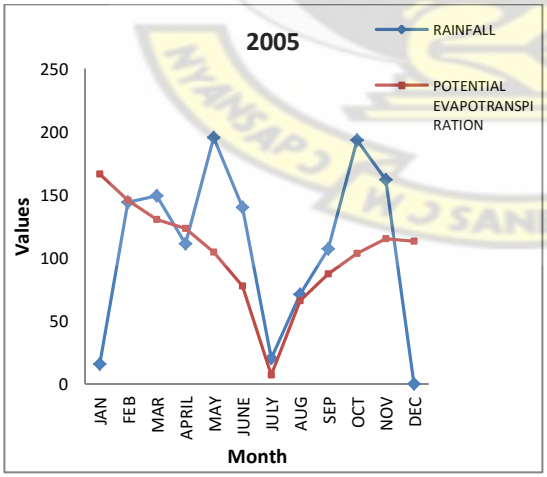


Source: Field survey, December 2011.

Figure 4.4 reveals that a total of 89 farmers (55 from Nyameani and 34 from Yaase) strongly agreed that there has been low crop production whiles only 2 strongly disagreed. Their disagreement stemmed from the fact that this year's rains have been good and supportive. Though supportive, these same farmers reported that crops they harvest of late are very small in size which was not the case years back. Nonetheless, this year's situation does not contrast the fact that crop yields in recent years keep reducing compared to about 30 years ago as reported by farmers. This was confirmed by all 5 staff of MoFA interviewed when asked of the impacts of climate change on agriculture within the district. However, meteorological data on evapo-transpiration rates plotted against rainfall data presents a different scenario. This is illustrated in Figures 4.5a to 4.5g.

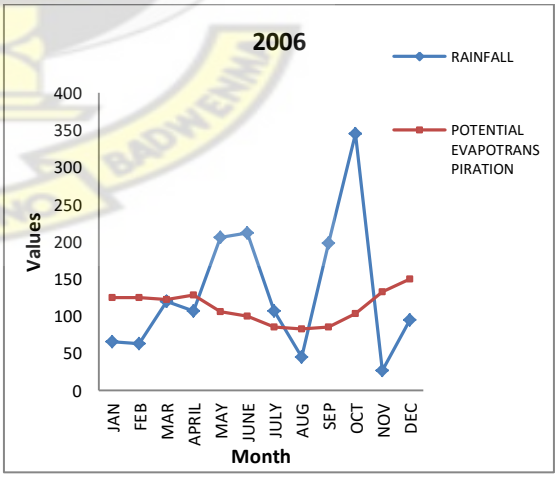
Figures 4.5a-4.5g: Potential Evapo-transpiration Pattern against Rainfall Pattern for the Bosomtwe District from 2005 to 2011.

Figure 4.5a: **PET against Rainfall for 2005**



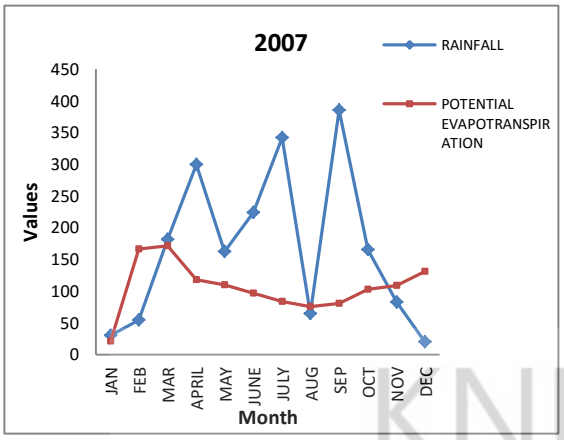
Source: Ghana Meteorological Agency, 2013

Figure 4.5b: **PET against Rainfall for 2006**



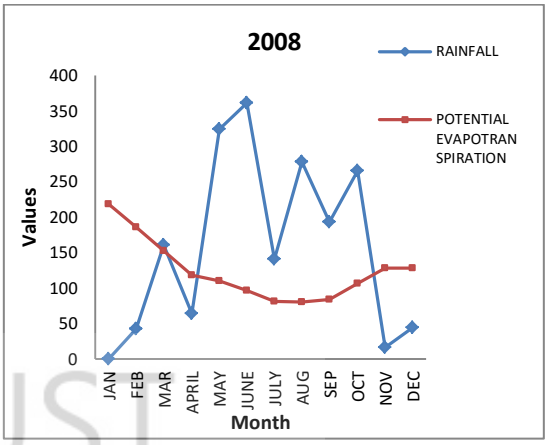
Source: Ghana Meteorological Agency, 2013

Figure 4.5c: PET against Rainfall for 2007



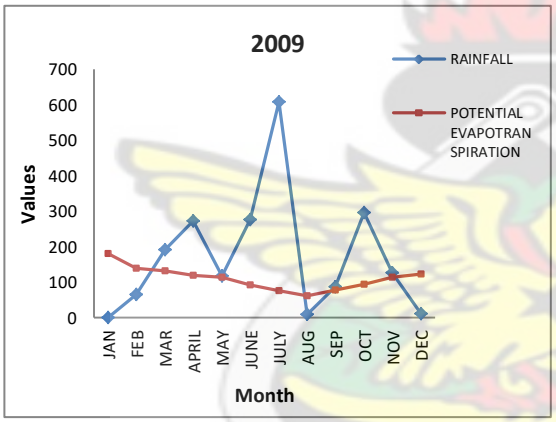
Source: Ghana Meteorological Agency, 2013

Figure 4.5d: PET against Rainfall for 2008



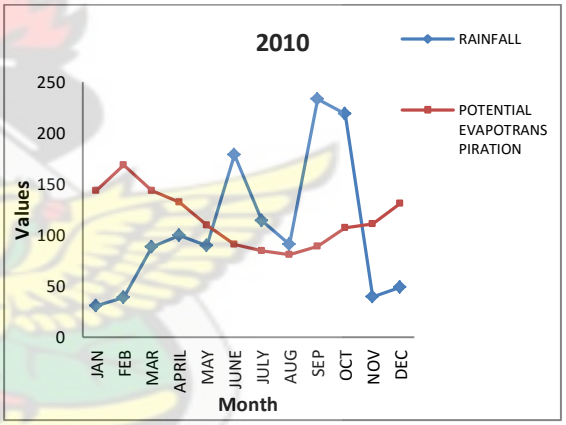
Source: Ghana Meteorological Agency, 2013

Figure 4.5e: PET against Rainfall for 2009



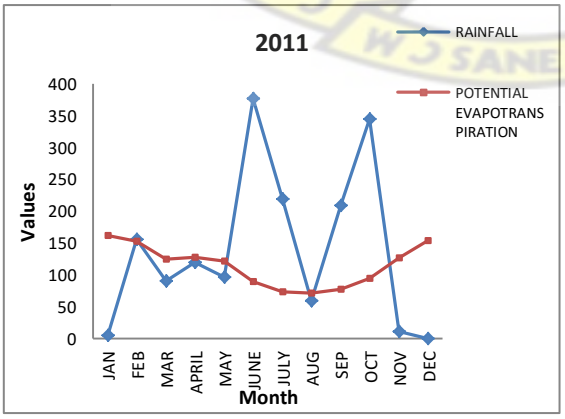
Source: Ghana Meteorological Agency, 2013

Figure 4.5f: PET against Rainfall for 2010



Source: Ghana Meteorological Agency, 2013

Figure 4.5g: PET against Rainfall for 2011



Source: Ghana Meteorological Agency, 2013.

According to Figures 4.1 and 4.2 (on pages 96 and 98 respectively) the Mean Annual Temperatures and Total Annual Rainfall, were both increasing in the years 2005 to 2009 and both dropped slightly in 2010 and 2011. Therefore although the rains were increasing they were coupled with increasing temperatures and these trends must have impacted on crop production. Hence the study sought to find out whether the recent trends in rainfall and temperature supported crop production.

Figures 4.5a to 4.5g show the relationship between rainfall and Potential Evapotranspiration (PET) which is the rate at which the soil loses water, thus water evaporates from the soil. This relationship can best inform whether water is retained in the soil long enough to aid in crop cultivation. This is a factor which could help in knowing whether recent rains support crop production or not. During the cropping seasons (major and minor seasons), when the PET rates are higher than rainfall, the soil loses more water and there is low soil moisture. When this happens, crops would not have enough soil moisture that is, water would not be retained in the soil long enough to support crop growth, hence low crop production. One the other hand, when the rainfall rates are higher than PET, it means there is enough soil moisture to support crop growth and this enhances crop production.

Generally, at the beginning of the year (January, February) and in December PET is higher than rainfall rates and dry weather conditions are experienced (see Figures 4.5a-4.5g). This period is the dry season and often characterised by the harmattan (MoFA, 2011). During this period the soil has minimal moisture and can hardly support crop cultivation. As such farmers prepare their farm lands during this dry season and start

planting just at the beginning of the major raining season (March to July). It can be observed from Figures 4.5a to 4.5g that the major rains start slowly from March and lasts till July. However it does not always peak up in June as reported by MoFA, (2011), see Figures 4.5a, 4.5c and 4.5e. However, Figures 4.5a-4.5g support MoFA's report that brief dry conditions are typically experienced in August just before the start of the minor raining season (September to November). This is because the rains in August are very low whiles PET is usually higher but the year 2008 (Figure 4.5d) was an exceptional case. In 2008, the August rains recorded were higher than in the months of September, October and November (minor season) and was coupled with lower PET rates. Therefore, the month of August in 2008 did not experience dry conditions and could perhaps support crop growth. As illustrated in Figures 4.5a-4.5g the minor rains start gradually in September and reach a peak in October and slows down in November.

During the major seasons, the rainfall levels recorded are typically higher than in the minor seasons however years like 2006, 2007 and 2010 proved otherwise. Within these years, the October rains were higher than the June rains. This could influence more farmers to change from planting in the major season to the minor season. Although the major rains are comparatively higher, they are often accompanied by high PET rates during the early parts of the season and these make crop growth difficult. A typical example are the years 2010 (Figure 4.5f) and 2011 (Figure 4.5g) which saw PET higher than rainfall from January to May. This could eventually lead to low crop production especially in the major season.

Within these past few years, farmers have complained of recent rains and temperatures not supporting crop production. This assertion could stem from the fact that the required water level for crop growth is not sustained throughout the farming seasons and therefore farmers seek other means to get the required soil moisture for crop growth. However this is not always the case as the years 2007 (Figure 4.5c) and 2008 (Figure 4.5d) are examples of periods with good water levels retained through both seasons to aid in crop growth.

Another fact that could be the reason why farmers complain of recent temperature and rainfall patterns not supporting crop growth is that the early months (March, April and May) of the major season usually have very minimal soil water level and sometimes experience dry conditions. Thus PET is often as high as rainfall levels or even higher than the rainfall levels. Typical examples are the years 2006, 2010 and 2011. Therefore farmers find difficulty in relying on the major rains and therefore blame the rains and temperature levels for not supporting crop production. Plate 4 shows a farmer illustrating smaller crop size as an effect of recent changes in temperature and rainfall patterns.

Plate 4.2: A Farmer Complaining of Smaller Crop Sizes

Source: Field survey, December 2011.

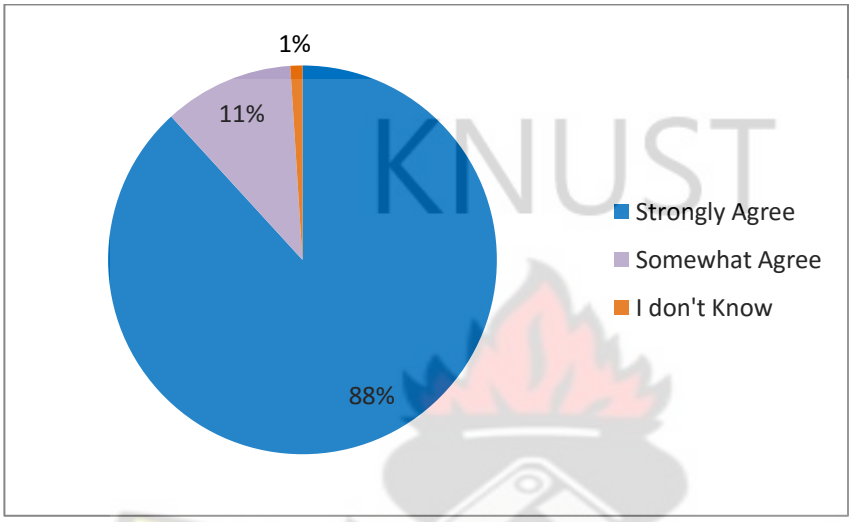
4.7.1.2 Appearance of Strange Plants on Farms

A change in species of plant composition, an increasing presence of invasive species in forests and farmlands are all evidence of climate change (EPA, 2010f). The appearance of strange plants on farms invades crop plants thereby threatening their survival. This is because these strange plants compete with crop plants for space, soil nutrients and sunlight which affects the proper growth of crops leading to low crop production. A total of 88 percent of farmers strongly believed that strange plants kept appearing on their farms. Nyameani had 83.3 percent of its farmers attesting to this whiles 97.2 percent of farmers from Yaase strongly agreed as well. These strange plants are destructive to crop plants; they absorb soil nutrients, they grow faster, spread on the farms and usually out-compete the crop plants for the use of sunlight thereby killing the crop plants. This finally reduces crop yields. Typical of such strange plants is the elephant grass locally known as 'Esre' (Pennisetum purpureum). This grass grows from sea level to 2000m altitude where the rainfall exceeds 1000mm (Bayer, 1999 cited in Zewdu et al., 2003) and can withstand considerable periods of drought (Butt et al., 1993 cited in Zewdu et al., 2003). The district's total annual rainfall exceeds 1000mm (see Figure 4.2 on page 98) and therefore supports the growth of the elephant grass. It also takes advantage of the rich soil associations of the district for its growth since they are rich with nutrients. An elderly female farmer from Yaase lamented as follows: "*after all the effort an old woman as me puts into cultivating my land, 'esre' being the landlord harvests all my crops and leaves me with nothing*".

During a focus group discussion with farmers at Nyameani, it was reported that much time is spent uprooting these strange plants on farms instead of caring for their crops. As

a result, the few crops that are left do not grow well causing them great loss. Figure 4.6 shows the stance of respondents on the appearance of strange plants on farms.

Figure 4.6: Responses on the Appearance of Strange Plants on Farms



Source: Field survey, December 2011.

One old man from Nyameani said, '*what I know is that 'esre' is a grass type found in the savannah areas in Northern Ghana where temperatures are extremely high. For them to keep appearing here means that temperatures have risen so high that they favour the growth of these grass unlike before, meaning our land is gradually transforming into a savannah and in future will be a desert land*'.

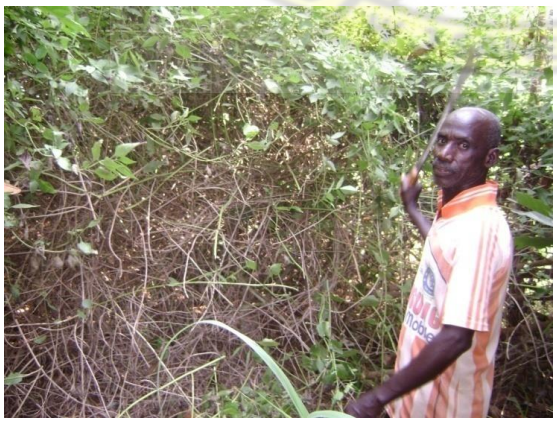
Nevertheless some of these farmers after uprooting the 'esre' leave them on the farm to serve as mulch. This is a common method of maintaining soil fertility in their day-to-day activities. Plate 4.3 shows a farmer uprooting 'esre' on her farm.

Plate 4.3: A Farmer at Nyameani Uprooting 'Esre' (Pennisetum purpureum) on Her Farm.

Source: Field survey, December 2011.

It was also confirmed by most farmers (98 percent) that there has been the extinction of some plant species like 'Acheampong' (Cromolaena odorata). "*These plants first appeared during the reign of Col. Ignatius Kutu Acheampong when the weather was so cool and fresh, gradually as the weather became warmer and warmer, they kept disappearing and now you hardly find them around*" an elderly male farmer from Nyameani reported. Plate 4.4 shows a farmer indicating 'Acheampong' on his farm.

Plate 4.4: A Farmer at Nyameani Showing 'Acheampong' (Cromolaena odorata) on His Farm



Source: Field survey, December 2011.

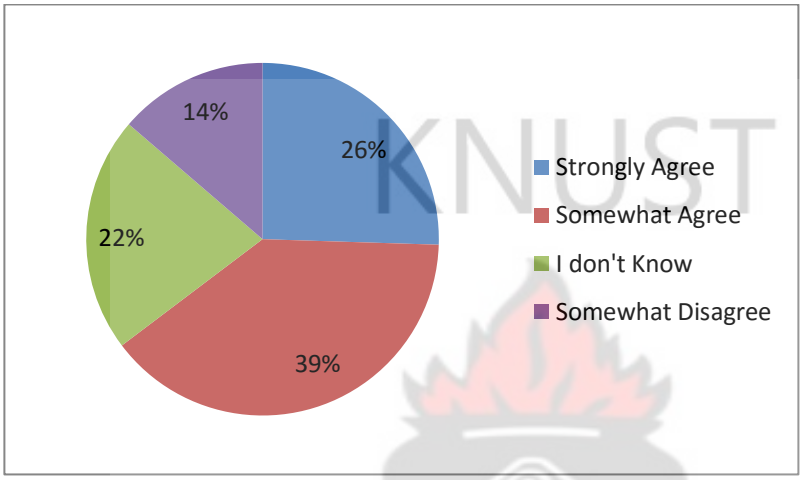
4.7.1.3 Increasing Incidence of Drought (Prolonged Dry Season Accompanied by High Temperatures)

According to farmers from both Nyameani and Yaase, the changes in the rainfall pattern within their communities had caused increased incidence of drought which impacts negatively on their farming activities. A total of 26.0 percent of farmers strongly believed that frequent events of prolonged dry season with very high temperatures has an effect on their farming. These farmers were made up of 24.2 percent of farmers from Nyameani and 27.8 percent of farmers from Yaase. However, 39 percent of farmers (34.8 percent of Nyameani farmers and 47.2 percent of Yaase farmers) somewhat agreed that the challenges they faced in farming resulted from an increasing incidence of drought. Nevertheless, 22.0 percent of farmers had mixed feelings about this; therefore they could not give an affirmation on whether periods of drought have been increasing. Meanwhile, 14.0 percent simply disagreed. Farmers who reported on drought said they experienced these dry conditions during the early parts of the major season (which usually have very high PET rates sometimes higher than rainfall).

During droughts planting becomes difficult for especially vegetable growers and as such some of these farmers resort to the practice of irrigation. The lack of water bodies near farms also made planting during droughts stressful. Responses from 96 percent of these farmers showed that periods of drought were associated with crop infestations and diseases which lead to crop failure and reduced crop yield. These affected their finances and their ability to provide basic needs for their families since they only had few surplus crops to sell during periods of droughts. This was most reported by cocoa farmers. These

farmers had no doubt that drought was gradually increasing and they felt its impact. Figure 4.7 shows the respondents' views on the increasing incidence of drought.

Figure 4.7: Respondents' Views on Increasing Incidence of Drought



Source: Field survey, December 2011.

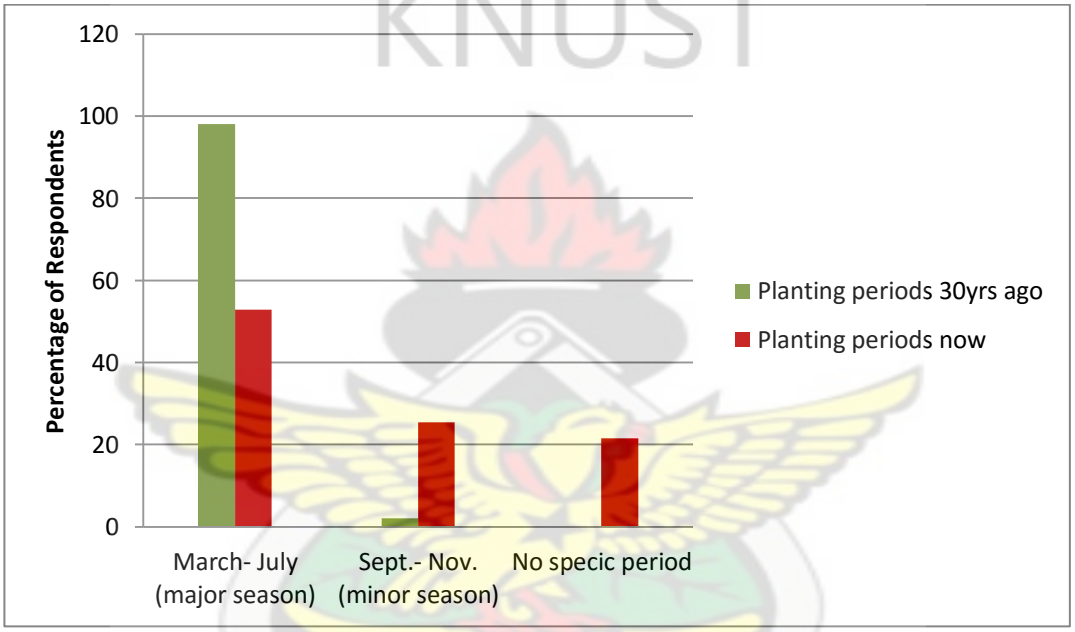
4.7.1.4 Changes in Planting and Harvesting Times

Changes in temperature and rainfall patterns definitely affect cropping seasons. About 96 percent of farmers from Nyameani and 100 percent of farmers from Yaase admitted there have been changes in their planting and harvesting times. The periods within which these farmers planted their crops about 30 years ago have changed in recent times. Figure 4.8 details both past planting periods and recent planting periods.

There are two cropping seasons in the district which fall within the major and minor rainy seasons. The major rains start from March to July and the minor rains start from September to November (MoFA, 2011). From Figure 4.8 it is realized that about 30 years ago, majority of farmers (98 percent), planted their crops between March and July

just in time for the expectant major rains whiles 2 percent planted their crops within September and November for the expectant minor rains. However in recent times only 52.9 percent of farmers plant within the major rainy season whiles 25.5 percent plant within the minor rainy season.

Figure 4.8: Changes in Planting Periods-Responses from Farmers



Source: Field survey, December 2011.

Farmers who prepared and planted their crops within March to July (major rainy season) about 3 decades ago reported that they waited till the harmattan period (which predictably started from December of the previous year and lasted till usually early February) was over before they start preparing their lands for planting. This period is the dry season (from December to February) so planting was not done within these months. As such planting was usually done in early March just in time for the major rainy season

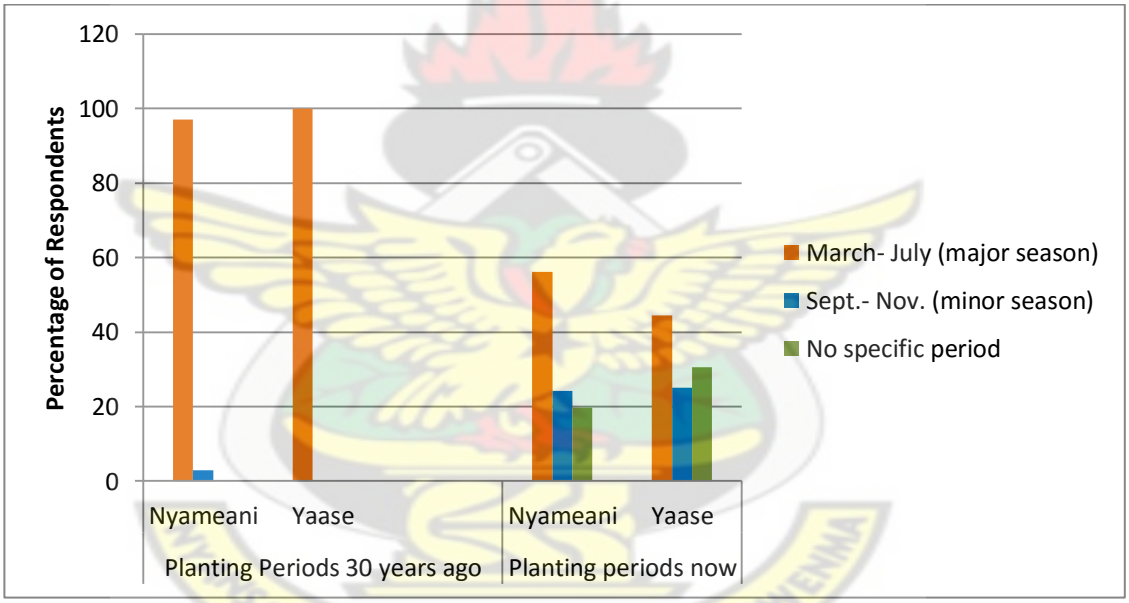
which starts from March and ends in July. Most food crop farmers planted their crops within this period.

Usually vegetable growers planted their vegetables within April to June (which falls within the major rainy season) several years ago. They expected to see the signs of the rains before they planted even though they prepared the land early. They reported that sometimes the early rains starts in around mid-April so they plant just in time to meet the rains. To these farmers, the month of May usually has the right rainfall amounts to support crop growth so planting within this period was suitable for them. Few farmers then preferred to plant their crops in early September so as to benefit from the minor rains which lasted from September to November.

In very recent years, 52.9 percent of farmers planted their crops within the major season compared to 98 percent thirty years back. Majority of these farmers usually planted their crops between April and June. This is because these farmers claimed that now the harmattan typically comes around January lasting till late February which delays their land preparation as they have to wait till the dry season is over. Moreover, the rains, expected to come in March delay and come in around April-May. As such, they planted within April hopeful for the major rains. Interestingly, 25.5 percent of farmers now planted their crops from September through to November compared to 2 percent of farmers 30 years back. These farmers trusted that the minor rains are more timely and reliable than the major rains. Most significant in recent cropping period is the fact that about 22 percent of farmers could no longer predict the best times to plant their crops. These farmers could not be specific with the exact periods they planted their crops

because they did not strictly follow the usual cropping seasons. They waited until the rains set in before they planted. Hence, they usually experience crop failures and might not get enough surplus to sell during the market season. This affects their ability to fend for their families since they do not make much money from the crop sales. Figure 4.9 gives the responses of farmers on their planting periods from the two farming communities.

Figure 4.9: Changes in Planting Periods-Responses from Farmers on Community Basis



Source: Field survey, December 2011.

It is observed from Figure 4.9 that about 3 decades ago, all farmers in Yaase planted their crops within March to July targeting only the major rains unlike in recent years when some farmers (25 percent) planted during the minor season as well. However, a significant total of 30.6 farmers from Yaase and about 19.7 percent from Nyameani had no specific planting periods in recent years. Another observation is that 30 years back,

97 percent of farmers from Nyameani planted within the major season but now, only 44.4 percent of these farmers did so. These farmers attributed the change in their planting periods to the unreliable nature of recent rains during the two cropping seasons. Nevertheless they believed the minor rains come in time and in the right quantity for crops growth compared to the major rains. This gives evidence that there have been changes in the rainfall pattern and these have affected cropping times. Farmers who are not able to adjust to the cropping seasons are not able to provide enough food for their families' consumption because they hardly make good yields from the seasons in which they plant.

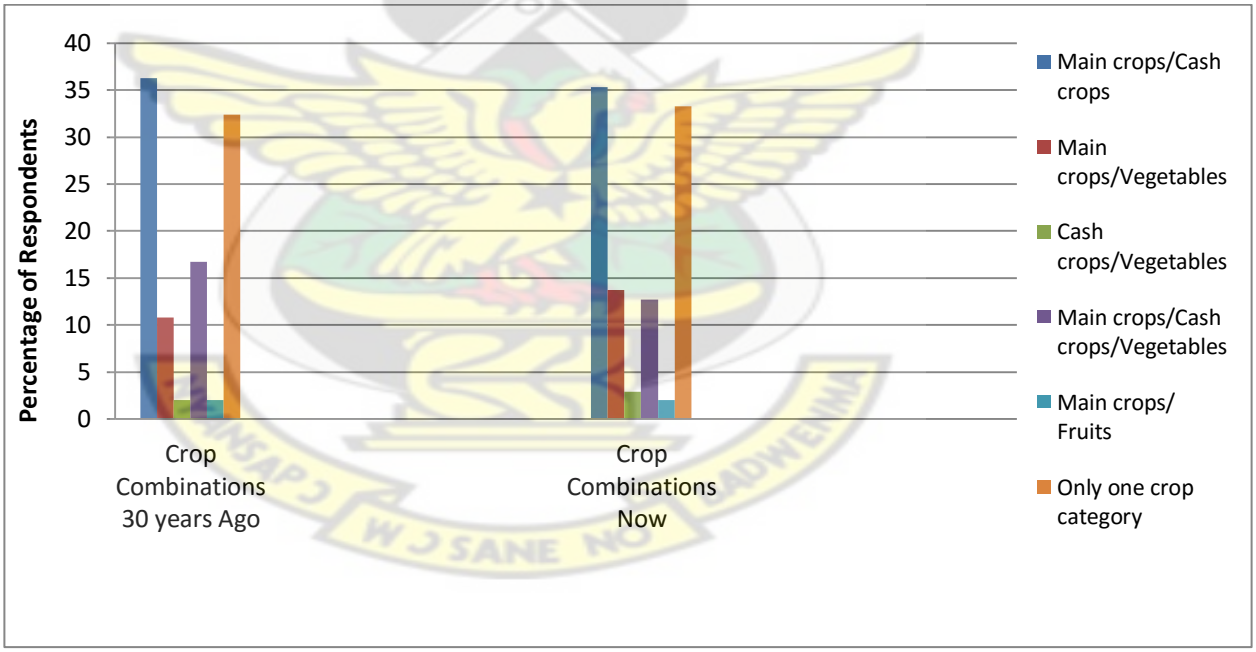
In comparing the percentage of farmers who planted in the minor season 3 decades ago to the percentage who planted in the minor season now, it could be said that in recent times, the minor rains are more reliable and supports crop growth than the major rains. A reason that supports this assertion is that the early parts of the major season have low water level in the soil to support crop growth. This is because in the early parts of the major season PET is usually as high as the rainfall rates and even sometimes record higher rates than rainfall. This is not typical of the minor season (see Figures 4.5a-4.5g on pages 113 and 114).

Also it is of importance to know the crop combinations farmers planted during the cropping seasons 30 years back and whether these have changed in recent times. The categories of crops planted in the farming areas are main crops (example maize, yam, cassava and cocoyam), vegetables (such as cabbage, tomatoes, garden egg, onions and pepper), cash crops (mainly cocoa) and fruits (such as oranges and pawpaw).

Figure 4.10 reveals that the crop combinations planted by these farmers both 3 decades ago and in recent times are:

i. Main crops/Cash crops
ii. Main crops/Vegetables
iii. Cash crops/Vegetables
iv. Main crops/Cash crops/Vegetables
v. Main crops/Fruits
vi. Only one crop category

Figure 4.10: Crop Combinations Planted by Farmers 30 Years Ago and in Recent Years



Source: Field survey, December 2011.

From Figure 4.10 it is observed that in recent years farmers barely plant the same crop combinations as 30 years back. Majority of farmers (36.3 percent) planted a combination

of main crops and cash crops 30 years back and in recent years majority of them still do (35.3 percent) though there has been a reduction by one percent. However there has been an increment of about one percent among farmers who planted only one crop category thus from 32.4 percent of farmers 30 years ago to 33.3 percent in recent times.

Again farmers who planted main crops and vegetables increased from 10.8 percent to 13.7 percent whiles those who planted main crops, cash crops and vegetables reduced significantly by 4 percent, thus from 16.7 percent to 12.7 percent. Moreover, farmers who planted mains crops and fruits still maintained their combination. Overall, there was no significant change in crop combinations planted by farmers. Even though some farmers changed into other crop categories the whole scenario gives the impression that farmers probably changed their cropping times also to suit the crops they planted and not the vice versa.

4.7.2 Perceived Impacts on Indigenous Fishing Activities

4.7.2.1 Changes in the Season of Bumper Harvest and Low Fish Catch

The responses of the fisher folks interviewed revealed that several years ago, the months of August and September were characterised by more rains and moderate temperatures and these were the months more fishes were caught from the Lake Bosomtwe. The explanations given were that:

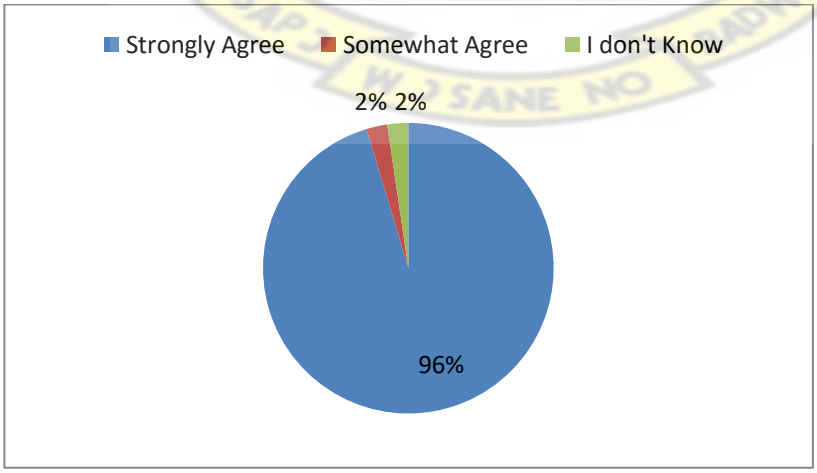
i. During the months of June, July, August and September-the months of more rains, streams and rivers around Lake Bosomtwe overflow their banks and drain into the lake. When this happens, the water underneath becomes very cold and

drives the fishes to the surface for warmth. This allowed more catches to be made.

ii. Another thought was that during these months when the streams and rivers drain into the lake, the colour of the water turns green because of the presence of algae. This informed them of bumper harvest because the fishes move up to the surface of the water for oxygen.

Unfortunately, recent periods of low rains have made these processes impossible hence no more seasons of bumper harvest. During recent times extremely high temperatures cause the fishes to move downwards into the deep (bottom) of the lake and this makes fishing difficult. Studies by Dontwi et al., (n. d) however observed overfishing, annual turnover, deforestation, agrochemicals (internal factors) as well as physical development and socio-economic (external factors) as major threats to fishing in the Lake Bosomtwe. Figure 4.11 exhibits the responses of fisher folks concerning changes in recent temperature and rainfall patterns on fish catch (yields).

Figure 4.11: Effects of Changes in Temperature and Rainfall Patterns on Current Fish Catch



Source: Field survey, December 2011.

Fisher folks who agreed that the change in temperature and rainfall pattern does not support high fish catch were 41 out of a total of 43 interviewed. During a focus group discussion with fisher folks at Abono, there was a100 percent consent to this.

4.7.2.2 Extinction of Some Fish Types

There was 86.1 percent of fisher folks interviewed who agreed that some fish types have been highly endangered with recent climatic changes. Such fish types were caught in large quantities in the past but are gradually missing out of late. Examples of such are 'Apatefufuo' (Sarotherodon multifaciatus popularly known as white fish), 'Kaabire' (Tilapia discolor), 'Komfoo' (Hemichromis fasciatus), 'Yenkunhwia' (Chromidotilapia guentheri) and 'Papari' (Tilapia busumana). Table 4.10 shows the responses of fisher folks on the extinction of such fishes in the lake.

Table 4.10: Response on Fishes Gone into Extinction

Type of fish	**Abono**		**Adwafo**		**Total**	
	Freq.	%	Freq.	%	Freq.	%
White fish (Apatefufuo)	20	70.0	12	85.7	32	74.4
Kaabire/ Adwene	1	3.4	1	7.1	2	4.7
Komfuo/ Essinua	2	6.9	1	7.1	3	7.0
Yenkunhwia	1	3.4	0	0	1	2.3
No Response	5	17.2	0	0	5	11.6
Total	**29**	**100.0**	**14**	**100.0**	**43**	**100.0**

Source: Field survey, December 2011.

A total of 74.4 percent of fisher folks confirmed that the white fish locally called 'Apatefufuo' is the most endangered fish type in the lake whiles 'Yenkunhwia' is the least endangered. The white fish used to be in abundance and it was the favourite of the inhabitants. For over 40 years, fisher folks have relied on its sale for their income but unfortunately the rate of its extinction has affected their income negatively.

However, only few fisher folks related the extinction of these fishes to climate change. Majority, about 49 percent related the cause to superstitions. Further interviews with these fisher folks revealed that about 12 years ago, a research was conducted to discover the basis of the lake formation by an American researcher. It is said that he took out a black substance from the lake which some believed was gun powder (Atuduro). People believed 'Atuduro' was a god and the source from which the fishes came in the olden days. They believed 'Atuduro' exploded during specific times of the year (usually between August and September), and brought out fishes during the explosion. This brought about bumper harvest. Unfortunately after the research, the explosion ceased and never has there been a bumper harvest since most fish types have gone into extinction. They therefore attributed the cause of the extinction to this researcher who took away their god. This explanation lends support to the study by Ishaya and Abaje (2008) who assert that whiles many traditional people see climate change as having spiritual and social causes, there are also inverse examples of climate changes being perceived as a threat to local deities and spiritual powers.

About 49 percent of fisher folks from Abono and 50 percent of fisher folks from Adwafo believed in this superstition as a cause of extinction of the fishes. All the same, Table

4.11 shows that some respondents attributed the cause of extinction to changes in temperature and rainfall pattern (11.6 percent), and continuous retreat of the lake (9.3 percent) which are all evidence of climate change impacts in their environment.

Table 4.11: Respondents' Views on the Causes of Extinction of Fishes

Cause	**Abono**		**Adwafo**		**Total**	
	Freq.	%	Freq.	%	Freq.	%
Increased temperature, and low rainfall intensity and quantity	3	10.3	2	14.3	5	11.6
Continuous retreat of the lake	3	10.3	1	7.1	4	9.3
Superstitious beliefs on research to discover the formation of the lake	14	48.3	7	50.0	21	48.8
High population and unfavourable human practices	3	10.3	1	7.1	4	9.3
Others	2	6.9	2	14.3	4	9.3
No Response	4	13.8	1	7.1	5	11.6
Total	**29**	**100.0**	**14**	**100.00**	**43**	**100.0**

Source: Field survey, December 2011.

However, a percentage of 9.3 of the respondents thought that the continuous increase in the community's population coupled with unfavourable human practices such as washing and bathing in the lake has driven some fishes into extinction. These responses are in line with the internal and external factors identified by Dontwi et al. (n. d) as

threats to fishing in the Lake Bosomtwe. These threats were discussed in chapter 3, under the section 'Fishing in the Lake Bosomtwe'.

The changes in temperature and rainfall patterns affect indigenous livelihoods in diverse ways. Yet all impacts posed on farming and fishing lead to lower yields which eventually result in low income and poor living conditions. Responses from all farmers and fisher folks interviewed proved that poor income and low standard of living are the end results of all the impacts they experience. When asked of recent cost of their occupational activities, about 44.0 percent strongly agreed on a rising cost each time whiles 10.3 somewhat agreed to that. Meanwhile a total of 39.3 percent disagreed on an increasing cost in their occupations. To them, the cost fluctuates and is never stable with time even though usually it is on the high side.

A rising cost affects profits made and this has made the occupation less lucrative in recent times. A percentage of 72.4 of respondents strongly agreed to this as against 10.4 who somewhat disagreed. During focus group discussion with farmers at Yaase, the group reported that it was getting more difficult to provide the basic needs for their families and their living conditions were deteriorating. Just as the conceptual framework (Fig 2.2) illustrated, impacts posed by climate change affects agricultural output which further influence people's access to livelihood assets like financial capital.

4.8 Indigenous Occupational Practices Compounding the Impacts of Climate Change

4.8.1 Farming Practices

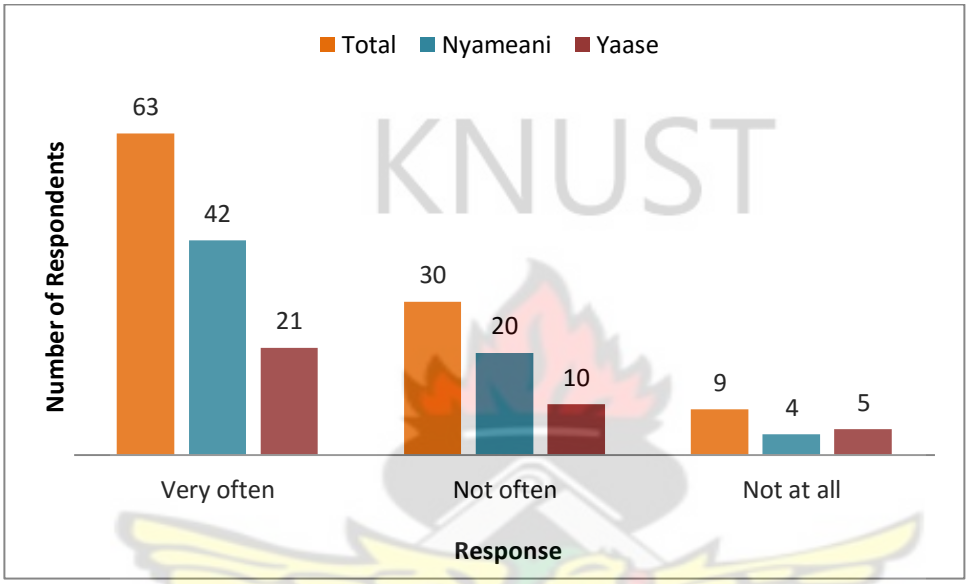
4.8.1.1 The Practice of Bush Burning: Bush burning is a process of clearing farmland in preparation for cultivation by setting up the land on fire (usually unprotected). There has been intense education on the devastation of unprotected fires on farm properties and the precautions needed to be taken in practicing this age-old activity by Agricultural Extension Agents (A.E.As) from MoFA. Unfortunately the effects of the continuous release of carbon dioxide from the smoke into the atmosphere has not received much attention. Carbon dioxide is the main greenhouse gas that causes global warming contributing to climate change and its frequent release exacerbates the situation.

Bush burning as a farming practice has been on the increase in the Nyameani and Yaase communities because of the frequent appearance of strange weeds on farms. It is a practice for controlling these weeds. Unfortunately 93 out of 102 farmers interviewed practiced bush burning from which 63 farmers practice it very often. A total of 9 farmers did not practice bush burning, they rather cleared the land by weeding and used the cleared weeds as mulch. Figure 4.12 shows how often farmers from Nyameani and Yaase practiced bush burning.

More farmers (42 out of 66 farmers) from Nyameani practiced bush burning very often as well as 21 out of 36 farmers from Yaase. From the total of 30 farmers who practiced but not often, 20 were from Nyameani whiles the remaining 10 were from Yaase.

Farmers from Nyameani practiced bush burning very often compared to those from Yaase.

Figure 4.12: Respondents' Views on the Causes of Extinction of Fishes



Source: Field survey, December 2011.

4.8.1.2 Clearing of Trees on Farm

Trees on farms do not only serve as windbreaks, shades or shelter to protect crops from winds, erosion and the effects of the scorching sun. They help maintain soil fertility as their leaves rot down and fertilize the soil. These are among the numerous positive impacts trees have on farms. Most importantly, trees on farms absorb carbon which then reduces the amount of carbon exposed into the atmosphere. Therefore when these trees are cleared, there exists more carbon dioxide in the atmosphere which in the long run causes changes in the climate. It was pleasing to discover that a lesser percentage (44.1 percent) of farmers cleared all trees on their farms whiles the remaining 55.9 percent had some trees kept on their farms, this is illustrated in Table 4.12.

Table 4.12: Farmers' Responses on the Clearing of Trees on their Farms

Response	Nyameani		Yaase		Total	
	Freq.	%	Freq.	%	Freq.	%
Clear all trees on farm	33	50.0	12	33.3	45	44.1
Do not clear all trees on farm	33	50.0	24	66.7	57	55.9
Total	**66**	**100.0**	**36**	**100.0**	**102**	**100.0**

Source: Field survey, December 2011.

Whiles Yaase had more of its farmers (66.7 percent) leaving some trees on their farms, only half of the farmers interviewed from Nyameani did so. Farmers' views were sought on other farming practices they believed could affect the environment especially the climate in the long run. From the total of 102, only 13 farmers mentioned excessive use of chemicals on farms, 9 referred to the clearing of trees on farms, one mentioned the over-dependence on water bodies for irrigation and 2 mentioned bush burning and the tilling or ploughing of farm lands for cultivation. The remaining 77 gave no answer because they had no idea of the effects of their practices on the climate.

4.8.2 Fishing Practices

Fisher folks interviewed could not identify fishing practices that exacerbate the impacts of climate change. No chemical was allowed in fishing in the Lake Bosomtwe so they mainly depended on their own strength and God to give them yields. This was the response of all the fisher folks interviewed. However in a focus group discussion with fisher folks at Abono, members made mention of breaching of taboos as a cause of

impacts like low fish catch from the lake. They reported that it was a taboo for a woman in her menses to go near or into the lake. Also no one was to enter the lake in a black cloth and sacrifices were to be made to the god of the lake at specified times. Unfortunately no one observes these taboos and customs in recent times and this has led to low fish catch from the lake. Other human activities such as washing and bathing in the lake and immoral acts by holiday makers termed 'meet me there' have all contributed to low fish catch. Though these were not related to fishing practices, they were identified as contributing factors to low fish catch.

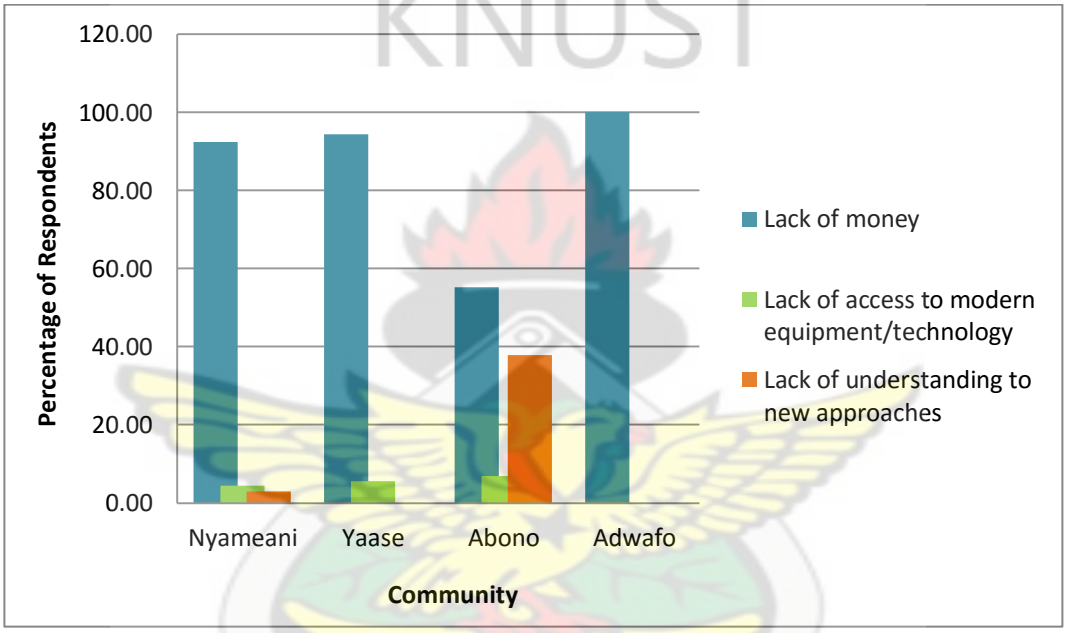
4.9 Identifying Indigenous People's Vulnerabilities to Climate Change

Vulnerability according to the International Strategy for Disaster Reduction (ISDR) is the characteristics and circumstances of a community, system or asset that make it susceptible to the damaging effects of a hazard (UN/ISDR, 2002). It is widely accepted that the indigenous community is more vulnerable to the impacts of climate change (Rai, 2008). If so, then there should be some characteristics or circumstances whether natural or human-induced which make them vulnerable. This section identifies these characteristics and circumstances.

First it was inquired from the respondents whether they agree to the widely accepted notion that they are the most affected by climate change. About 90.0 percent of the respondents agreed to this, about 8.0 percent disagreed and the remaining 2.0 percent were indifferent. In knowing the characteristics or circumstances that made them the most affected or vulnerable, 125 respondents representing 86.2 percent identified the

lack of money as the main condition that made them very vulnerable to climate change. Whiles 7 respondents identified inaccessibility to modern equipment/technology and 13 respondents identified their lack of understanding to new approaches representing 4.8 percent and 9.0 percent.

Figure 4.13: Respondent's Views on What Made Them Most Affected



Source: Field survey, December 2011.

4.9.1 Lack of Money: This was seen in most cases as a cause of poverty which is a major characteristic of indigenous people. Most of them had no higher education (only 4 out of the 145 respondents had education to the middle school level) or completely had no formal education (36.6 percent of respondents) which could get them a well-paid or white collar job. They depended on their rudimentary ways of struggling with nature to make ends meet. Another reason could be that they did not make much money from crop sales because of low crop yields as a result of the changes in temperature and rainfall

patterns. It is therefore of no surprise that most of them identified this characteristic (lack of money) as what made them most vulnerable to climate change. They argued that they could not afford the purchase and use of modern technology which they saw as a solution to the negative effects posed to their various occupations by climate change. About 93 percent of farmers from Nyameani and 95 percent of farmers from Yaase identified their lack of money as what makes them most vulnerable. All the fisher folks from Adwafo and about 56 percent from Abono felt vulnerable because they lacked money.

4.9.2 Inaccessibility to Modern Technology/ Equipment: On the contrary, the respondents who attributed their vulnerability to their inaccessibility to modern technology and equipment did not think that lack of money was the hindrance. Rather they thought of themselves as not skilled enough to operate such technology and that prevented experts from reaching their doorstep with such needed technology. Whiles about 7 percent of respondents from Abono attributed their vulnerability to their inaccessibility to modern technology/equipment, no respondent from Adwafo made mention of this. However, 4.5 percent of respondents from Nyameani also attributed their vulnerability to this likewise 5.6 percent of respondents from Yaase.

4.9.3 Lack of Understanding of New Approaches: Also the last group of 13 respondents (2 from Nyameani and 11 from Abono) reported they had been exposed at least once to new approaches but could not understand them. As a result, they were unable to use these approaches and resorted to their old rudimentary ways. No respondent from Adwafo and Yaase reported on this and the reason could stem from the fact that they had

never been exposed to new approaches. Furthermore, all the 11 out of the 14 respondents from Adwafo and 17 out of the 36 respondents from Yaase who had access to basic education believed they could better understand these new approaches when introduced to them.

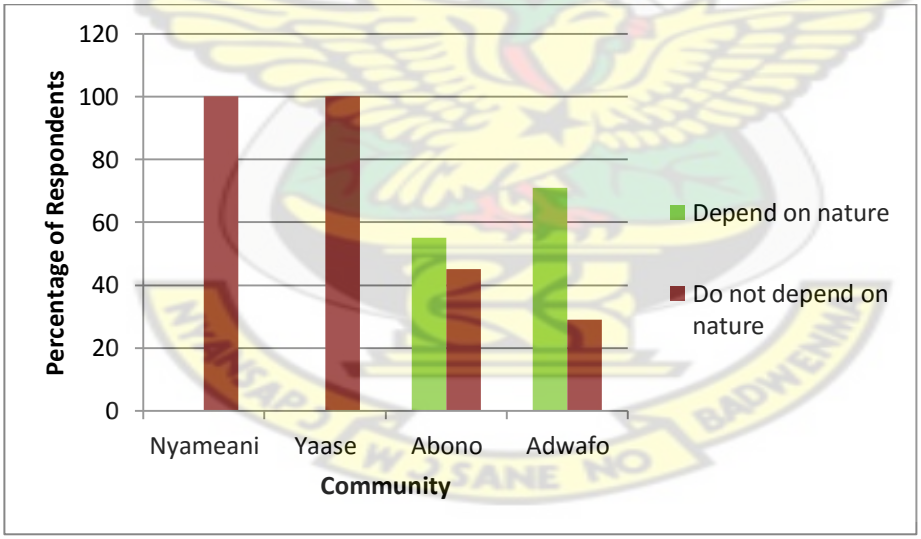
The responses from these farmers and fisher folks suggested that monetary poverty has a major role to play in their vulnerability. In such a circumstance, they could not have access to modern technology or even be adequately equipped to operate new approaches which could increase their resilience to climate change impacts.

4.9.4 Dependence on Nature: Their dependence on nature is another characteristic that makes them more prone to the impacts of climate change. Both farming and fishing are nature-dependent occupations and these are their main sources of income. Now that nature is being tampered with, they are the worse victims of the consequences. Out of the total of 145 respondents, 129 believed they were over-dependent on nature whiles the remaining 16 did not think so.

To further assess their vulnerabilities, the study sought to know their alternative sources of livelihood and whether these were nature-dependent as well. About 18.0 percent of respondents engaged in other activities that were nature-dependent against 82.0 percent whose activities were not nature-dependent. Specifically, a total of 27 fisher folks out of the 43 (62.8 percent of fisher folks) interviewed were engaged in farming as their alternative economic activity whiles the remaining either engaged in activities that were not nature-dependent or they had no alternative economic activity at all. Such non-nature

dependent alternative economic activities included trading in non-perishable products, shop-keeping, hairdressing, driving, barbering and tailoring. For all the 102 farmers interviewed, none was engaged in any other nature dependent occupation. Moreover they could not resort to fishing because they were not close to the lake and even saw farming as a better option. This was reported at a focus group discussion with farmers at Nyameani. Those fisher folks who farmed as well even complained about the challenges they faced in farming, neither fishing nor farming worked for them. In this case fisher folks seem more vulnerable to climate change impacts than farmers because they either resorted to farming as their main alternative source of livelihood or stayed idle.

Figure 4.14: Responses on Engaging in Alternative Source of Livelihood that Depends on Nature



Source: Field survey, December 2011.

To better assess the extent of vulnerability and how prepared they were to build their resilience, the study further sought to know from the respondents what other occupations they would opt for should climate change still affect all economic activities in which

they were currently engaged. Tables 4.13 and 4.14 presents the responses of farmers and fisher folks respectively.

Table 4.13: Farmers' Responses to Future Alternative Sources of Livelihoods

Source of livelihood	Nyameani		Yaase		Total	
	Freq.	%	Freq.	%	Freq.	%
Artisanry	10	15.2	2	5.6	12	11.8
Trading	33	50	19	52.7	52	51
Animal rearing	1	1.5	3	8.3	4	3.9
Others	10	15.2	6	16.7	16	15.7
No other occupation	12	18.1	6	16.7	18	17.6
Total	66	100.0	36	100.0	102	100.0

Source: Field survey, December 2011

Table 4.14: Fisher Folk's Responses to Future Alternative Sources of Livelihoods

Source of livelihood	Abono		Adwafo		Total	
	Freq	%	Freq.	%	Freq.	%
Artisanry	5	17.2	1	7.1	6	13.9
Trading	9	31	6	42.9	15	34.9
Farming	1	3.4	3	21.4	4	9.3
Others	4	13.4	3	21.4	7	16.3
No other occupation	10	34.5	1	7.1	11	25.6
Total	29	100.0	14	100.0	43	100.0

Source: Field survey, December 2011.

Majority of respondents from both occupations thus 51 percent of farmers and 34.9 percent of fisher folks preferred trading especially in non-perishable products as an alternative source of livelihood under the stated condition. Thus 50 percent of farmers from Nyameani and 52.7 percent of farmers from Yaase preferred trading as an alternative livelihood source. Whiles 31 percent of fisher folks from Abono and 42.9

percent from Adwafo preferred trading as well. Artisanry including carpentry, hairdressing, shoemaking, mechanic and tailoring was preferred by a total of 18 respondents out of the 145 respondents. These 18 respondents constituted 10 farmers from Nyameani, 2 farmers from Yaase, 5 fisher folks from Abono and one fisher folk from Adwafo.

Other occupations preferred by 15.7 percent of farmers and 16.3 percent of fisher folks were palm wine tapping, palm oil processing, distilling 'akpeteshie', security guards, commercial driving, shop-keeping among others. Most significant is the response of 17.6 percent of farmers and 25.6 of fisher folks who preferred no other occupation in future no matter the impacts of climate change on their present occupations. This shows how prone these people will be to future negative impacts as they have made no preparations towards sustaining or improving their livelihood sources.

Another significant item on Table 4.14 is the response of 4 fisher folks (1 from Abono and 3 from Adwafo) who opted for farming as a preferred future occupation. These fisher folks should have better opted for no occupation since farming is yet to face more challenges if nothing is done now to improve their rudimentary ways. Outlined are the views of MoFA staff on the factors that make these indigenous farmers and fisher folks vulnerable to climate change impacts.

i. Over-dependence on rain-fed agriculture.
ii. Inability to purchase irrigation equipment and other agricultural inputs.
iii. The unpredictable nature of recent weather conditions.

iv. Inability to adopt improved farming systems because of financial deficiency.

In all these circumstances, one may wonder between farmers and fisher folks, who is more vulnerable to the impacts of climate change and who is likely to build more resilience against the negative impacts of climate change. In answering this question, it is best to identify the adaptations practiced by these indigenous farmers and fisher folks against these impacts. The next chapter analyses their adaptations to better assess their efforts towards resilience.

In conclusion, the study shares the opinion of the EPA, (2010a), that increasing temperatures, decreasing rainfall and its unpredictable nature, are likely to jeopardize the employment of about 60 percent of the active population of Ghana, majority of whom are small scale rural farmers. Agriculture and food security are interrelated and thus climate change induced unsustainable livelihoods will result in negative consequences on food security, poverty, health, education, gender equality and environmental degradation.

CHAPTER FIVE

ADAPTATIONS AND GOVERNMENT'S SUPPORT FOR LOCAL ADAPTATIONS

5.1 Introduction

This chapter focuses on analyses of data related to indigenous adaptations to climate change and the government's support for such adaptation strategies. As the previous chapter revealed the vulnerabilities of these indigenous farmers and fisher folks to climate change impacts, it is of much importance to know how they adapt to these changes. It is also appropriate to know the government's support towards these local adaptation strategies and how the support can build their resilience towards the impacts.

5.2 Indigenous Adaptations to Climate Change

Indigenous communities with their long experience have developed strategies to face and minimize climate change impacts (Ishaya and Abaje, 2008). Burton (1992 cited in GebreMichael and Kifle, 2009:3) simply defines adaptation as "the process through which people reduce the adverse effects of climate on their health and well-being, and take advantage of the opportunities that their climatic environment provides". By this definition, this section focuses on the various methods adopted by both farmers and fisher folks to reduce climate change impacts on their livelihoods. Most importantly it examines how sustainable and cost effective their adaptation methods are.

5.2.1 Farmers Adaptation Methods

In the previous chapter, it was observed that farming in both Nyameani and Yaase currently undergoes serious challenges which threaten food security in the country. Farmers' adaptations are seen as the first-hand solution. The methods adopted by these farmers are:

1. **Planting different varieties of the same crop (both local and improved varieties)**: Maize is one of the very common crops which had several varieties (both improved and local) cultivated at a time. Examples of the improved varieties are 'Mamaba', 'Obaatampa', Pan 53 and a very common local variety is 'Edabow'. Another is tomatoes and the very common varieties cultivated are 'Heinze' and 'Power' which are both improved varieties. This method was a common practice among all farmers in both Nyameani and Yaase. Farmers adopted this method because they believed that if one variety of a specific crop does not grow well under a climatic condition, the other variety (usually an improved variety) might grow very well. This method helps them make some yields no matter the climatic conditions that persist. This has been in practice for over 25 years now.

2. **Cultivating different crops**: Farmers usually planted vegetables alongside food crops. Very common combinations of food crops were cassava, maize, cocoyam and plantain. Common vegetables also planted were tomatoes, okro, pepper and cabbage. This practice was very common among all farmers interviewed from both Nyameani and Yaase. Farmers believed this method enabled them harvest some crops even if other crop types fail because of unfavourable climatic conditions. For instance a food crop

such as cassava can withstand prolonged dry season compared to cabbage, as such if the rains fail to come, cassava could be harvested even if cabbage goes bad. This method has been in practice for over 5 decades.

3. **Changing the extent of land put into crop production**: The desire to increase yield and make more profits motivated some farmers who had available land to expand their farmlands so as to cultivate more crops. They believed that if some crops do not do well others will, at least they would have some crops to harvest since the crop-base is large. However due to population increase, this practice is no more common as it was in the 1980s. This was often practiced in Nyameani.

4. **Practicing irrigation**: Irrigation though not a common practice was still an adaptation method for some vegetable growers especially at Yaase who seasonally depended on the River Bankro to grow their crops. Yaase comparatively has many smaller streams than Nyameani. The drying up of most streams usually in August made this practice difficult for most vegetable growers especially at Nyameani even though the River Bankro runs through the town. However, few cabbage growers from Nyameani depended on the Stream Asuasu (usually dries up during the dry season) which is occasionally replenished with waste waters running from a nearby sachet water-producing factory to grow their cabbages. The practice of irrigation was quite expensive to most farmers since they had to acquire a pump to operate with and this made the practice uncommon. Nonetheless, irrigation helps vegetables to grow well even during periods of fewer rains or no rains and has been an adaptation method for the past 15 years. Therefore vegetable growers are able to make some yields during dry seasons.

5. **The use of agrochemicals (fertilizers/weedicides/pesticides)**: Though this practice has been in existence for about 2 decades, it was in the year 2000 that most farmers started embracing it because they could no longer rely on only nature to grow their crops. This method was very common and highly practiced in all the farming communities especially Nyameani. The very common weedicides used are 'roundup', 'gramozone' and 'power'. These weedicides have Glyphosate as their active ingredient and are used for the control of annual, perennial grasses and broadleaf weeds in cereals and vegetables. Fertilizers that were commonly used are NPK 15-15-15 for vegetables like cabbage, tomatoes and carrots, NPK 15-5-15 and Urea for maize, and Confidor and Aketemaster for cocoa. These were purchased from Kumasi and from as far as Kade in the Eastern region because of moderate prices. Prices of these agrochemicals determined how often they were used. The use of weedicides to fight 'esre' and the use of fertilizers to enrich the soils with nutrients for crop growth and maturity are ways of promoting good crop yields.

6. **Improvement in water maximization**: Rain water harvesting and the sinking of bore-holes are the main ways farmers maximized water to aid in cultivating their crops. Though the rains were reported to be unpredictable and less in quantity, some farmers made sure that anytime it rained, they collected the rainwater with barrels and stored for use on their farms during periods of less or no rains. Other farmers also sunk bore-holes (drew out water with buckets) near their farms to water their crops. Very few farmers cultivated along streams in order to maximize the stream water during times of flow. This was usually practiced by farmers from Yaase. This method helps in getting water

for crop growth during dry periods which promotes good harvest. It has been in existence for over 35 years now.

7. **Cultivating only improved seed varieties (agric)**: For about a decade now, some farmers from both Nyameani and Yaase have gained interest in the cultivation of only improved seed varieties commonly known as 'agric'. They did not cultivate the local seeds at all because they believed that improved seeds are more tolerant of unfavourable climatic conditions compared to local seeds. Common crops that were grown with improved seed varieties are maize, oil palm, cocoa, coconut and rice (grains). An example is 'upland rice' which is grown because it does not need much water to thrive in the harsh climatic condition. Another is the hybrid type of oil palm which is the cross breed of two varieties-Dura and Tenara. Table 5.1 illustrate the various adaptation methods farmers practiced in order to reduce the climate change impacts.

Table 5.1: Farmers' Adaptation Methods to Reduce Climate Change Impacts

Adaptation method	Nyameani		Yaase		Total	
	Freq.	%	Freq.	%	Freq.	%
1and 2	11	16.7	8	22.2	19	18.6
1, 2 and 3	1	1.5	1	2.8	2	2.0
1, 2 and 4	0	0	2	5.5	2	2.0
1, 2 and 5	30	45.5	12	33.3	42	41.2
1, 2, 3 and 5	10	15.1	2	5.5	12	11.8
1, 2, 4 and 5	8	12.1	9	25	17	16.7
1, 2, 4 and 6	1	1.5	1	2.8	2	2.0
2, 5, 6 and 7	5	7.6	1	2.8	6	5.9
Total	66	100.0	36	100.0	102	100.0

Source: Field survey, December, 2011.

Table 5.1 shows the combination of methods mostly used by these farmers in reducing climate change impacts in their occupation. From Table 5.1, it is seen that no farmer adopted a single method in surviving these harsh climatic conditions on their livelihood. It was a combination of two or more. This tells how stressful farming has become in this era of climate change. The most common adaptation methods practiced were the cultivation of different varieties of the same crop, cultivating different crops and the use of agro-chemicals such as fertilizers and pesticides. This combination of methods was practiced by 41.2 percent of the farmers. However, more farmers (45.5 percent) in Nyameani adopted this method than farmers (33.3 percent) in Yaase.

A percentage of 18.6 also practiced the combination of planting different varieties of the same crop and cultivating different crops. This practice was however common among farmers in Yaase (22.2 percent) than in Nyameani (16.7 percent). Nevertheless, a careful study of Table 5.1 reveals that almost all farmers practiced these two methods. It was the commonest combination. A discussion with farmers disclosed that these two methods are easier to practice and are very helpful. Thus when one cultivates different varieties of the same crop and the climate does not favour the growth of one variety, the other will hopefully survive. So it is for the cultivation of different crops. For instance when a farmer cultivates maize, yam and plantain and the climate does not favour the growth of yam he will definitely get produce from either his plantain or maize or both. To them, this is a better option than the farmer cultivating only yam and losing all due to unfavorable climatic condition. This is the reason why these two methods were most practiced.

The methods of changing the extent of land put into crop production and practicing irrigation were adopted though but by only a few farmers. These two methods were also practiced in combination with others. Only 14 farmers out of the total of 102 practiced different combinations of methods that included changing the area of land devoted to crop production (usually extending the land under cultivation). Eleven out of the 14 farmers were from Nyameani whiles only 3 were from Yaase. The remaining farmers who did not practice this argued that it is not the best of methods to adopt. They believed it rather adds to the stress of farming where one has to expand the area cultivated and yet get lower yields because of the influence of the recent harsh climate. However, these 14 farmers thought otherwise and since they practiced this in combination with others; usually the cultivation of different varieties of the same crops and cultivating different crops, to them was beneficial. Though all the farmers interviewed owned their farmlands only those with available arable lands could extend their farm plots for cultivation.

The practice of irrigation was also a challenge to most farmers even though a couple of them adopted that. It is obvious that it is not the irrigation per se that they preferred but with the combination of others. From Table 5.1, it is seen that irrigation is included in three distinct method combinations. In two of these combinations only 2 farmers practiced such combinations respectively. The third combination included the use of chemical fertilizers, weedicides and pesticides and this was practiced by 17 farmers out of the total of 102. Of these 17 farmers, 8 were from Nyameani and 9 from Yaase.

Using agrochemicals on farms close to water courses contaminate the water bodies thereby reducing the water quality for human consumption. The use of agrochemicals on

farms though not the best in terms of health and nutrition was helpful to an extent to these farmers. In this era of strange plants such as 'esre' and pests appearing on farms, the best way to control them is through the application of weedicides and pesticides. This was the response from a focus group discussion with farmers at Nyameani. An elderly farmer from Nyameani said, "*without the application of chemical fertilizers on my farm, nothing grows*". This strategy though not the best is an ideal way of adapting to these climate change impacts as claimed by the farmers. The drying up of water bodies and less rains made the practices of irrigation and water maximization difficult hence only few farmers preferred using these methods. Most farmers wondered how they could maximize water with recent low rainfall amounts. The planting of only improved seed varieties (no local seeds) was practiced by 6 farmers in combination with other methods. In the conceptual framework, one's livelihood assets influence their adaptation strategies. The main asset these farmers own is' knowledge' (human capital); knowledge of climate change impacts and knowledge of ways to reduce these impacts. Their knowledge influenced the various adaptation strategies they practiced.

5.2.1.1 Farming Methods Identified by MoFA Staff as Practiced by Farmers in the Study Communities

Table 5.2 shows common adaptation methods identified by MoFA staff interviewed as those practiced by the indigenous farmers in order to increase their yields in this period of unfavourable climatic conditions. The adaptation methods identified by the DDO for crops applied to other farming communities aside Nyameani and Yaase.

Table 5.2: Farmers' Adaptation Methods Identified by MoFA

MoFA Staff	Adaptation Method
Agriculture Extension Agent for Nyameani	Cultivation of crops with very short growing seasons/early maturing crops Mixed cropping and mixed farming.
Agriculture Extension Agent for Yaase	Practicing irrigation. Planting of trees on farms and especially around water bodies for protection.
District Development Officer (DDO) for Crops-District Office	Cultivation of drought-resistant crops Adoption of safe farming practices, example, minimum/zero tillage.

Source: Field survey, December 2011.

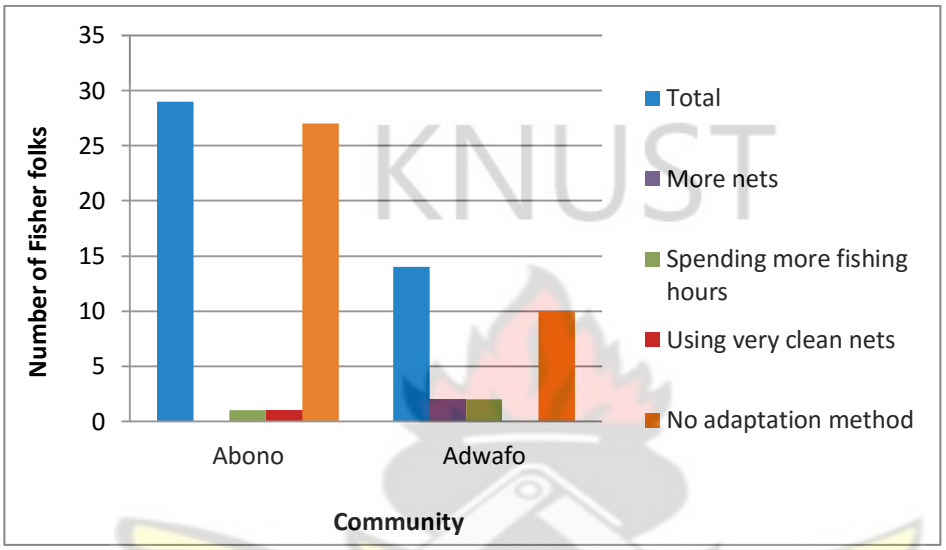
These adaptation methods practiced by farmers are not perculiar to the district as these are common practices from different regions of the world. The people of Jema'a local government area of Kaduna in Nigeria adopted same strategies in adapting to climate change impacts (Ishaya and Abaje, 2008). Also a study on 'Indigenous Peoples and Climate Change' conducted by Salick and Byg (2007) revealed similar adaptation practices as those practiced in places like the Kalahari, Amazon and Guyana.

5.2.2 Adaptation Methods of Fisher Folks

Unlike farmers, most fisher folks did not practice any adaptation method. From a total of 43 fisher folks interviewed, only 6 had adopted methods whiles the remaining 37 had done nothing but only looked up to God. Of the 6 fisher folks, none practiced a combination of methods. Figure 5.1 shows that 2 fisher folks (all from Adwafo) adopted the use of more nets in fishing, 3 (one from Abono and 2 from Adwafo) spent more

hours on the lake unlike they used to, and the remaining one (from Abono) made sure he always had very clean nets to fish.

Figure 5.1: Fisher Folks' Adaptation Methods to Reduce Climate Change Impacts



Source: Field survey, December, 2011.

Dontwi et al., (n. d) also identified that fisher folks around the Lake Bosomtwe spent several hours on the water and used a variety of fishing gears, some of which were permanently set in the water in order to catch sufficient quantities of fish to make a living. Having more fishing nets meant catching more fishes even within few hours spent on the lake. Spending more hours fishing also meant catching some more fishes than usual. With no resting day, fish stock could be depleted within few years and these could further affect their livelihoods.

During a focus group discussion with fisher folks at Abono, it was observed that fishes are deterred by dirty nets and in order to attract more fishes, one always had to keep very

clean nets. Though the group knew this, only one fisher folk admitted using clean nets as an adaptation strategy. He added that he inspected his nets as often as possible and sewed all torn parts before he went fishing. One may suggest the use of modern fishing equipment like the use of outboard motors. Unfortunately, these fisher folks are glued to the use of simple and indigenous fishing equipment because taboos of the lake prevented the use of certain equipment and items in the lake. For example the use of chemicals for fishing in the lake is prohibited. In the conceptual framework, culture (taboos and belief systems) is seen as an influence on assets, vulnerabilities and the ability to adapt. For instance the non-use of chemicals (a physical asset) for fishing in the lake (a natural asset) limits fisher folks' ability to adapt to the impacts they face which contributes to making them more vulnerable. Also financial inadequacy made the purchase of authorized modern equipment difficult to some fisher folks. As the conceptual framework illustrates, livelihood assets such as financial capital not only knowledge also influence people's adaptation strategies.

Plate 5.1: A Fisher Folk Inspecting His Net at Abono

Plate 5.2: A Fisher Folk on an Expedition at Abono

Source: Field survey, December 2011.

The 37 fisher folks who reported there was nothing they could do but wait upon God to bring better days, 27 were from Abono whiles the remaining 10 were from Adwafo. They also believed nature is dynamic and hoped that these harsh periods shall pass away soon. To them, one could never compete with nature so any adaptation method they practiced would prove futile and as such would be a waste of effort in adapting to these changes in climate. These fisher folks obviously practiced almost no adaptation. However, the 6 fisher folks who practiced adaptation methods made mention of costly fishing nets, skin infections and body weakness as some challenges they face. Unfortunately, most fishes are in extinction mainly as a result of over-fishing and other human activities like bathing and washing in the lake which kills most of the fishes. Therefore, practicing these adaptation methods only worsened the situation by catching the few fishes who could multiply if left untouched. Anyway, who could blame these fisher folks since their lives depend mainly on fishing?

5.3 Addressing the Sustainability of the Various Adaptation Strategies in Indigenous Farming

Climate change adaptation is complete if the adaptation methods are sustainable and can make positive impacts as they are intended to (Macchi, 2011). Coping methods might not necessarily focus on sustainability but adaptation methods do since adaptation is a proof of coping methods that have survived over time (Macchi, 2011). The sustainability of an adaptation method is as important as the method itself, as such the various methods adopted by these indigenous farmers need to be assessed for their sustainability. In this context, sustainability of these methods means finding out whether they could create

lasting positive impacts in the lives of the people. Therefore the cost-effectiveness of these methods had to be known likewise the challenges faced in using them. Foremost, the study sought to know from these indigenous farmers whether they believed their methods are cost effective. Approximately 78 percent of farmers gave an affirmative response, 15.7 percent responded 'no' whiles the remaining 5.9 percent did not know whether their methods are cost effective or not.

The majority of farmers preferred planting different varieties of the same crop and cultivating different crops as adaptation methods. Crop varieties are usually developed to resist unfavourable conditions and to ensure that agricultural production can continue and even improve despite uncertainties about future impacts of climate change. The introduction of adapted and accepted varieties can potentially strengthen farmers' cropping systems by increasing yields, improving drought resilience, boosting resistance to pests and diseases and also by capturing new market opportunities (Clements et al., 2011). Hence, there is no doubt this adaptation method had a level of benefit to these farmers. However challenges associated with this method cannot be over-looked. About 17 percent of farmers from Nyameani and 23 percent from Yaase confessed high cost of labour as a challenge they faced in practicing their adaptation methods. The purchase of seed varieties from agro-chemical shops are quite expensive for these farmers yet not all tend to survive in this unfavourable condition. They still incurred loss through crop failures. Both farmers from Nyamaeani (10.6 percent) and Yaase (19.4) voiced out that the high cost of crop seedlings and seed varieties were challenging to them. However, sometimes they lacked the necessary skills to care for these crop varieties.

Cultivating different crops demand so much attention, time and money. Therefore it is not surprising that 4 farmers out of the total of 36 from Yaase complained that cultivating different types of crops is quite tedious. The agrochemicals (pesticides and weedicides) needed to fight away a pest or weed of one crop is not the same for the other. Meaning one has to purchase different chemicals for these different crops. Moreover the cost of these agrochemicals are quite expensive to these farmers. The majority of farmers from both Nyameani (59.1 percent) and Yaase (41.7 percent) reported that the high cost of agrochemicals was of great challenge to them as they practiced their adaptation methods. Even when all these are done, getting good yields is not guaranteed always. Therefore, another limitation of this method is the difficulty of farmers to achieve a high yield given that they have a greater range of crops to manage. These farmers invest so much money and time into these methods but do not get enough profit to support their welfare let alone save for tomorrow. Hence their standard of living is not improved.

Farmers who expanded their farm sizes are those who had enough arable land to do so. This method comes with the high cost of doubling up almost everything; labour, farm tools and seedlings. Should farming practices such as excessive ploughing degrade the land and drought still persist coupled with the higher cost of farm inputs, what would be the end result of this method? With the seasonal drying up of water bodies like the River Bankro one may speculate the sustainability of practicing irrigation. Aside this, low and untimely rains makes the practice of water maximization questionable as to how long this practice can survive in this era.

The use of agrochemicals on farms in itself affects the produce in a couple of ways. For example, although pesticides help fight away pests, sometimes wrong uses and storage cause the problem of poisoning (Clements et al., 2011). This usually happens when the farmers lack the understanding in applying them which most do. Majority of these farmers (59.3 percent) ended their education at the basic school level whiles 36.6 percent had no formal education at all. This could be a contributing factor to their lack of understanding in the application of agrochemicals on their farms. In the conceptual framework, even though one's livelihood assets influence his or her adaptation strategies, it is important to know that to better adapt, the quality and quantity of assets available and the ability to put the assets into productive use is key. Therefore should farmers purchase agro-chemicals which are of low quality and less quantity and also lack the know-how in applying them to their farms, they would not get the best out of them. As such, the use of agro-chemicals as an adaptation strategy would not be of much benefit to them. Furthermore, the chemicals are costly and these farmers desiring higher effects misapply them usually beyond the right measurements. This turns out to have negative impacts on yields and the cost exceeds the benefits in most cases. At a focus group discussion with farmers at Yaase, one lamented, "*it cost me so much to apply chemicals on my garden egg farm, yet during harvest, I realized that most of them were rotten and this took me back to zero'*. Another said the use of chemicals on his cocoyam farm prevented the crops from maturing.

Cultivating improved seeds also come with high cost of purchasing the seeds which drains the pockets of the farmers. The introduction of improved seeds is a technology aimed at enhancing plant productivity, quality, health and nutritional value and/or

building crop resilience to diseases, pest organisms and environmental stresses. Yet when the crops are unable to survive the climatic stress usually because of lack of the needed attention and care given them, they fail to bring higher yields and this affects profits negatively. It is certain that financial resources (lack of it) are among the limitations experienced by developing countries that make adaptation difficult despite their strategies and plans to implement adaptation strategies (UN General Assembly, 2008). Table 5.3 details the challenges experienced by the farmers as they practiced their adaptation methods.

Table 5.3: Challenges Faced by Farmers in Using Their Adaptation Methods

Challenge	**Nyameani**		**Yaase**		**Total**	
	Freq.	%	Freq.	%	Freq.	%
High cost of labour	11	16.7	8	22.2	19	18.6
High cost of agrochemicals and farm tools	39	59.1	15	41.7	54	52.9
High cost of crops seedlings/seed varieties.	7	10.6	7	19.4	14	13.7
Tedious nature of cultivating different crops	0	0	4	11.1	4	3.9
Others	9	13.6	2	5.6	11	10.8
Total	66	100.0	36	100.0	102	100.0

Source: Field survey, December, 2011.

Other challenges voiced out by the farmers include the seasonal drying up of water bodies which prevented proper irrigation and their financial incapability to adopt

mechanized farming. Most of these adaptation methods required extra hands on the farm before higher yields could be achieved. Extra hands in terms of both labour and ideas from Agricultural Extension Agents in the form of providing training for these farmers so as to well adopt these methods and obtain the maximum benefits. In view of this, the next section finds out whether these adaptation methods as practiced by the farmers is supported by the Ministry of Food and Agriculture (MoFA) in the Bosomtwe District. Though majority of fisher folks practiced no adaptation, they would also need support to adapt to climate change impacts. Table 5.4 details the challenges experienced by the 6 fisher folks who practiced adaptation methods.

Table 5.4: Challenges faced by Fisher folks in using their Adaptation Methods

Challenge	Abono		Adwafo		Total	
	Freq.	%	Feq.	%	Freq.	%
Costly nets	1	3.4	1	7.2	2	4.7
Skin infections and general body weakness	0	0	2	14.2	2	4.7
No challenge faced	1	3.4	1	7.2	2	4.7
Not Applicable	27	93.1	10	71.4	37	86.0
Total	29	100.0	14	100.0	43	100.0

Source: Field survey, December, 2011.

Table 5.4 shows that among the 6 fisher folks who practiced adaptation methods, 2 reported on costly nets whiles 2 others reported on skin infections and general body weakness as the challenges they faced. The remaining 2 faced no challenges. Those who

adopted the use of more nets faced the challenge of high cost whiles those who spent long hours fishing said they sometimes get skin infections like rashes from bacteria/fungi in the water, and body weakness as they paddle for long hours. The fisher folks who adopted the use of clean net experienced no challenge.

5.4 Ministry of Food And Agriculture's Support for Indigenous Adaptations

Indigenous people need the support of their local government in terms of both finance and technology to improve their adaptation methods. This is because as projected impacts become severe, traditional coping/adaptation mechanisms may not in themselves be sufficient to deal with these impacts (Rai, 2008).

The institution in-charge of the overall development of agriculture at the district level is MoFA. In line with the Government's policy on decentralization, MoFA was restructured by developing extension activities to the district level to facilitate grass root participation in the implementation of agricultural policies and programmes. MoFA is known to have improved agriculture within the Bosomtwe district through diverse initiatives and their contributions have added up to the total development within the district and the country at large. In agreement with Rai (2008), the study sought to know the support given to these indigenous adaptation methods by MoFA.

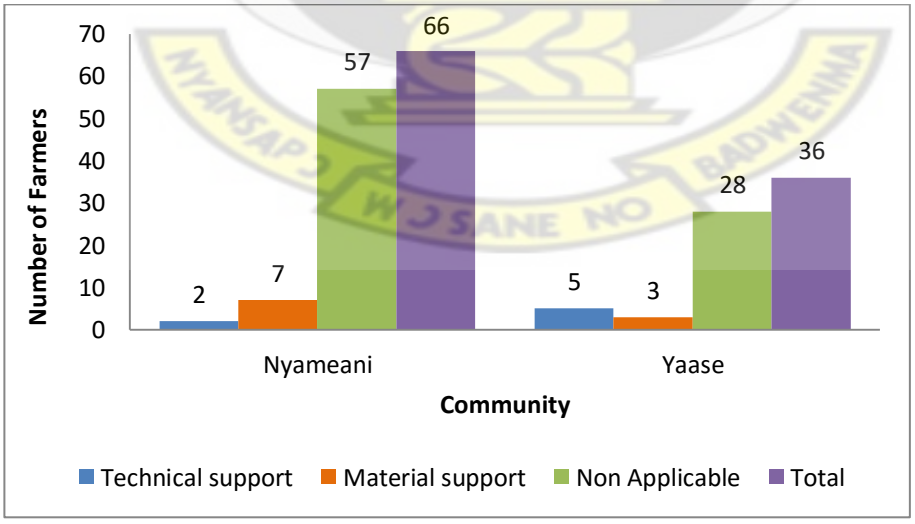
5.4.1 Forms of Support Given by MoFA for Indigenous Adaptation Methods

The conceptual framework revealed that institutions, in this wise MoFA acts as the external mediating environment that supports people to build their livelihood assets and

translate them into adaptation strategies and outcomes thereby enhancing or reducing resilience. Therefore policies implemented by MoFA in support of indigenous adaptation methods are expected to boost agricultural production. However, the study observed that the two fishing communities; Abono and Adwafo had no form of support at all from MoFA. They had no AEAs unlike the two farming communities; Nyameani and Yaase.

A total 17 farmers out of the 102 interviewed consented that they had support. The remaining 85 had no support of any kind at all. From these 17 respondents, 7 said they had technical support which usually comes in the form of education whiles the remaining 10 said the support they had was in material form, usually the distribution of agro-chemicals. Figure 5.2 illustrates the forms of support these farmers received from MoFA.

Figure 5.2: Forms of Support Received by Farmers from MoFA



Source: Field survey, December 2011.

Figure 5.2 shows that farmers from Nyameani benefited from material support than technical as 7 out of the total of 10 came from Nyameani and the remaining 3 from Yaase. Moreover, farmers from Yaase also benefited more from technical support than material since out of the total of 7 farmers, 5 came from Yaase as against 2 from Nyameani.

Unfortunately, in regards to the technical support respondents could not give much detail on the education they got but mentioned education on bush fire prevention and on how to apply certain agrochemicals on tree crops; this was especially for cocoa farmers. These farmers were usually grouped on occasions for the education. None had any financial support. The AEA for Nyameani said he had tried on several occasions to get these farmers to form associations so they could access loans but all attempts proved futile. He added that several years ago loans granted to these farmers were never recovered in full and this has prevented any financial support since money could not be given for free.

All 17 farmers reported that the support has been in existence for 10 years, and it is for free except 2 who claimed they had never enjoyed any support for free. These two farmers detailed that the chemicals and other farm implements given were either loaned out to them or they made small payments for them.

5.4.2 Benefits of MoFA's Support to Indigenous Farmers

However, not all these 17 farmers have benefited from MoFA's support. Fifteen claimed to have benefited whiles 2 did not. Table 4.5 shows that from the support, 10 farmers

were able to control crop pest and diseases, 2 increased their yields and 3 reduced cost in farming.

Table 5.5: Benefits from MoFA's Support

Benefits from MoFA's support	Nyameani		Yaase		Total	
	Freq.	%	Freq.	%	Freq.	%
Controlled pest and diseases	5	7.6	5	13.9	10	9.8
Increased yields	2	3.0	0	0	2	2.0
Reduced cost in farming	2	3.0	1	2.8	3	2.9
Not Applicable	57	86.4	30	83.3	87	85.3
Total	66	100.0	36	100.0	102	100.0

Source: Field survey, December 2011.

Interestingly, no farmer at Yaase realized an increment in his/her crop yields upon having support meanwhile 2 farmers from Nyameani observed an increment in their food crop production. Moreover only one farmer from Yaase reported to have reduced cost in farming as against 2 from Nyameani. Five farmers each from both communities were able to control pest and diseases. It is seen from the table that all 9 farmers from Nyameani who reported to have had support from MoFA benefited from the support. Unfortunately only 6 out of the 8 respondents from Yaase who also had support from MoFA, benefited whiles the remaining 2 who claimed to have had technical support did not. A reason to this could be their lack of understanding of new approaches introduced to them and this is one of the characteristics that makes farmers vulnerable to climate

change impacts. Though not many claimed to have received support or benefited the few who did would gradually build their resilience towards the impacts of climate change.

5.4.3 Support Forms Preferred by Indigenous Farmers and Fisher Folks

To make greater impact in the lives of these farmers and fisher folks interviewed, they were asked to suggest the support forms they preferred from MoFA or any other organization which they believed could better build their resilience. Table 5.6 details out responses from farmers whiles Table 5.7 details out responses from fisher folks.

Table 5.6: Support Forms Preferred by Indigenous Farmers

Preferred type of support	Nyameani		Yaase		Total	
	Fr.	Pct.	Fr.	Pct.	Fr.	Pct.
Financial support	46	69.7	21	58.3	67	65.7
Material support	11	16.7	12	33.3	23	22.5
Technical support	5	7.5	3	8.3	8	7.8
Other	4	6.1	0	0	4	3.9
Total	66	100.0	36	100.0	102	100.0

Source: Field survey, December 2011.

Financial support was paramount among the needs of the farmers interviewed. About 66 percent of farmers requested for money in the form of loans as the main support they need to improve upon their livelihood activities. They believed these loans could help them purchase fertilizers, improved seeds and also practice mechanized farming. About 23 percent preferred material support in the form of free distribution of fertilizers, seeds, pesticides, and the likes. Whiles about 8 percent preferred technical support specifically training on best farm practices. This they claimed will equip them with knowledge to

help manage their farms in order to increase their yields. An example is the management of farms against bush fires during the dry seasons. The remaining 4 percent of farmers preferred that MoFA assists them in:

i. Getting better markets and price for their farm produce
ii. Forming groups so as to access support from other institutions especially the financial institutions.
iii. Building irrigation dams so they could cultivate rice.
iv. Subsidizing agrochemicals and improved seedlings.

Table 5.7: Support Forms Preferred by Indigenous Fisher Folks

Preferred type of support	**Abono**		**Adwafo**		**Total**	
	Freq.	%	Freq.	%	Freq,	%
Financial support	20	69	9	64.3	29	67.4
Material support	4	13.8	1	7.1	5	11.6
Technical support	1	3.4	2	14.3	3	7.0
Other	4	13.8	2	14.3	6	14.0
Total	29	100.0	14	100.0	43	100.0

Source: Field survey, December 2011.

Though fisher folks had no support from MoFA, they also reported on the support they preferred to receive. Most fisher folks thus 67.4 percent preferred loans, 11.6 percent preferred the provision of fishing equipment and 7 percent preferred being given technical advice. Other forms of support suggested by 14 percent of these fisher folks are:

i. Good roads to support rapid development
ii. Developing the lake into a tourist site

iii. Create other employment opportunities so they could give rest to the fishes to replenish

iv. Periodic meetings with MoFA staff to discuss and find joint solutions to their specific problems

MoFA needs to integrate all these proposed support forms into their set of policies and act on them in order to have immense positive impact on the livelihoods of these indigenous farmers and fisher folks. These support forms also lay emphasis on the need to build all five livelihood assets (human, social, natural, physical and financial capitals) of both farmers and fisher folks taking into consideration all the interrelated components of the livelihood framework to enable them better adapt. This will build their resilience and make them less vulnerable to the impacts of climate change. As a result, their livelihoods will be improved even in this era of climate change, and food security will be enhanced.

5.4.4 MoFA's Account of their Support for Indigenous Adaptations

Only 3 out of the 5 MoFA staff interviewed responded to the section on their support for indigenous adaptations and these respondents are the District Development Officer for Crops, the District Development Officer for Extension and the Agricultural Extension Agent for Nyameani. This section reflects the views and responses of all 3 respondents.

MoFA's main support for indigenous adaptations is through the provision of technical advice to farmers. Farmers are usually advised on early warning signs and the need to plant drought resistant crops. There are occasional farm and home visitations by field

officers where they demonstrate and transfer new innovative technologies to these farmers. This is done for farmers to learn and adopt practicable technologies which are environmentally friendly. This form of support is reported to have been in existence for over 20 years and will continue until the government decides otherwise. There is no monetary support given since the financial institutions that can assist with loans to these farmers always demand for collateral security which is not available.

The main purpose for giving out the support is to achieve the goal of MoFA which is to enhance food security in the district and country at large. That is to enable farmers improve upon their farming practices, increase food production, improve their standard of living as well as protect their environment. This purpose they believed is being achieved. However, there are few challenges encountered by the Ministry in giving out their support. These include:

i. Inaccessibility of remote farming communities usually as a result of bad roads and lack of means of transportation. This makes it difficult to reach majority of farmers who need such support. For instance Yaase has bad road network and farmers living there are hardly reached with support from the Ministry.
ii. Inadequate number of field officers, thus high farmer to officer ratio. One officer is to over 1000 farmers and this does not enable much work to be done and done effectively.
iii. Unwillingness to adopt new technologies usually because of financial constraints. Most farmers also claimed to have been successfully involved in farming for years despite unfavourable climatic conditions, they therefore need

no new technology to help them. More so, the youth are more interested in monetary support and any other support given them is ignored.

iv. There are no demonstration farms on which farmers can try out new technologies by themselves and observe the benefits.

5.4.5 Future Support for Indigenous Farmers

The Ministry of Food and Agriculture-Bosomtwe has so much interest in supporting local adaptations though much has not been done. Although there is no documentation of future support for indigenous adaptations, there are ideas to improve indigenous farming. Future support will focus on training of these farmers to acquire the requisite technical know-how so as to increase yields of all crop types they cultivate notwithstanding recent unfavourable climatic conditions. Another is to form groupings of these farmers so as to be in a position to access loans from financial institutions especially rural banks. This will enable farmers become financially adequate in order to adopt new technologies with ease and build their resilience. According to the District Development Officer for Extension, *'Farming entails huge investment of resources such as money, time and manpower and as such the plan is to equip farmers in order to compete in the global market'*. He again said that the Ministry is determined to help farmers take agriculture as a business than just a way of life and approaches to achieve this is in the planning stages.

Interaction with the staff of MoFA revealed that there is no budgetary allocation from central government for the support of indigenous adaptation methods. This situation has compromised the capacity of the institution to financially assist farmers in the

various communities. However, the need to support indigenous adaptation methods especially of farmers is very critical because Ghana is an agrarian economy and its food security hugely lies in the domain of these farmers. Therefore to enable effective adaptation measures, both governments and non-governmental organizations, must consider integrating climate change in their planning and budgeting at all levels of decision making (UN General Assembly, 2008).

5.4.6 Conclusion

From the analyses, it is observed that the relationship between adaptive capacity and vulnerability (in terms of potential impacts, sensitivity and exposure) is complex. However, it seems evident from the above that the low adaptive capacity of these indigenous farmers and fisher folks makes them more vulnerable to the effects of climate change. Majority of the respondents may have acquired traditional skills and knowledge in order to better cope with future challenges, however, the nature of the acquired skills suggests that individuals can adequately cope with impacts only in the short term.

CHAPTER SIX

SUMMARY OF FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

6.1 Introduction

This chapter focuses on the summary of the findings of the study, the conclusion which is based on the findings and recommendations drawn that aim at improving indigenous adaptations.

This study was undertaken to find out the knowledge, experiences and adaptations of farmers and fisher folks in the Bosomtwe district to climate change. The study assessed how indigenous knowledge and exposure to climate change have impacted on the vulnerability of farmers and fisher folks and how it has helped them adapt to changes within the climate. Further, the farming and fishing practices that contribute to climate change impacts were assessed likewise the impacts of changes in the rainfall and temperature patterns on their livelihoods. The study was also concerned about reporting on the local government's support given to indigenous adaptations. Findings on these would serve as a blue print for communities within the same or similar climatic zones.

To achieve these objectives, 2 farming communities; Nyameani and Yaase and 2 fishing communities; Abono and Adwafo were purposively selected out of the total of 63 communities within the Bosomtwe district. Nyameani and Yaase were selected based on their notability in crop production whiles Abono and Adwafo were selected based on their closeness to the Lake Bosomtwe. In all 102 farmers were selected; 66 from

Nyameani and 36 from Yaase, and a total of 43 fisher folks; 29 from Abono and 14 from Adwafo. The sample size for each community was scientifically derived based on the community's population who were into agriculture. Each subject within the sample size was attained through snowballing. Also 5 staff from MoFA were purposively selected to give the appropriate data for the study. Interviews were conducted for a total of 145 farmers and fisher folks, and the 5 staff of MoFA. Two Focus Group Discussions (FGDs) were held for each community (one for only males, one for only females) so there were 8 FGDs in all and each group constituted between 8 and 12 people. Interview guides aided in all the discussions and were used to collect the data. All responses obtained were analyzed using the Statistical Product for Service Solution (SPSS)-version 16 and Microsoft Excel. Proxy meteorological data for the Bekwai district, obtained from the Ghana Meteorological Agency-Kumasi were plotted into graphs using Repeated Running Median. Results were presented in tables, graphs, charts (bar graphs and pie charts), written descriptions, pictures and reports (chapters 4 and 5).

6.2 Summary of Findings

6.2.1 Indigenous Knowledge on Climate Change

The first major finding made was that though the study was undertaken in separate spatial locations, thus two farming communities (Nyameani and Yaase) and two fishing communities (Abono and Adwafo), they were all confronted with similar impacts of climate change because they all shared the same climatic characteristics. This is based on the fact that all farmers and all fisher folks although from different communities reported on the same observations, impacts, vulnerabilities and adaptations related to

climate change within their respective locations. This is to say that all the communities (farming and fishing communities) shared the same climatic characteristics and other physical conditions irrespective of their separate spatial locations.

In order to achieve the objective of determining how indigenous knowledge and exposure to climate change have impacted on their level of vulnerability and adaptations, first the knowledge base of the respondents on climate change was assessed. As such it was observed that the knowledge about climate change expressed by these indigenous farmers and fisher folks was based on their perceptions of what climate change is. Moreover, their perceptions were informed by their observations of changes in their environment and their understanding of what has caused these changes. Their knowledge centered mainly on changes in temperature and rainfall pattern which were the major indicators of change among others observed within their communities. The other observed changes (climate change impacts) they reported were also not peculiar to only their environment, they are widely accepted evidences. Examples are the retreat of the Lake Bosomtwe, prevalence of new plants, pest and diseases, changes in planting and harvesting seasons and the extinction of some fish types.

Over 90 percent of respondents' views on the continuous rise in temperature were in line with the proxy meteorological data from Bekwai. Both reported on continuous rise in temperatures over the years since 1997, except that the meteorological data recorded decrease in temperatures in years 2010 and 2011 which respondents failed to mention. Moreover views of 89.7 percent of respondents who agreed to a continuous decrease in rainfall contradicted the meteorological data which presented a varying trend of the

rainfall pattern. Most significant was the increase in rainfall recorded from 2005 to 2009 which these respondents failed to report on. This scenario supports the assertion made by Mukta (2009) that one major impact of climate change is that people's predictions about the weather do not match with the reality.

Even though these data were proxy data and represented the whole district, they still gave a reflection of real situations within each community. Though the validity of respondents' views is very important, the study was focused on documenting indigenous knowledge and as such respondents' views were paramount as it strictly pertains to their communities and informs them of the adaptation strategies to adopt.

Evidence from the study shows that respondents' understanding of the causes of climate change was geared much towards human-induced happenings other than natural and spiritual thoughts. Though only 8.3 percent of the respondents attributed the causes of climate change to the unpardonable sins of men and biblical prophesies concerning the end of time, the majority attributed the causes to global warming (61.40 percent) and industrialization (30.30 percent). This contradicts assertion made by Ishaya and Abaje (2008) in their study on 'Indigenous People's Perceptions on Climate Change and Adaptations in Jema'a Local Government area of Kaduna State, Nigeria' that interpretations of climatic and weather phenomena made by indigenous people are geared towards spiritual thoughts such as signs of something more than mere biophysical processes.

Even though only 8.3 percent of the respondents as a whole attributed the causes of changes in climate to superstitious beliefs, about 48 percent of fisher folks based their causes of extinction of some fish types from the Lake Bosomtwe on beliefs about a research conducted to identify the basis of the Lake formation. They held superstitious beliefs about the research conducted and attributed to it as the cause of extinction of some fish types. On an account of this, it can be said that such superstitious beliefs are location specific because farmers living far away from the lake thought otherwise. In addition, responses from the staff of MoFA interviewed were in line with that of the majority response that causes of climate change is mainly human-induced.

In a study conducted by Mensah et al. (2009), they concluded that there are low levels of climate change awareness in Ghana. However, responses from the farmer and fisher folk respondents challenged this view. Over 75 percent of the respondents were aware of climate change and had heard of it through the radio aside observations within their own communities. They had also heard of it from Non-Governmental Organisations (NGOs) like 'Friends of Water and River Bodies' and Government organisations like the Ghana National Fire Service. It is possible that since 2009 when Mensah et al. carried out their study to 2011 when this study was carried out, much progress has been made in disseminating climate change throughout the country.

6.2.2 Indigenous Farming and Fishing Practices Contributing to Climate Change Impacts

The study also observed that farming practices by these indigenous farmers that contribute to climate change impacts are bush burning and the clearing of trees on farms.

Bush burning releases harmful substances into the atmosphere that gradually leads to warming. Though trees absorb carbon dioxide released into the atmosphere, reduce warming and provide shade for some crops, 44.1 percent of these farmers cleared all trees off their farms. Unfortunately this practice contributes to warming as well as intensifies the impacts of climate change as some crop plants are scorched by the intense heat resulting in low crop yields. Fishing with chemicals in the Lake Bosomtwe is prohibited and as such fisher folks did no such thing and were confident that no practice of theirs contributed to climate change impacts.

6.2.3 Perceived Impacts of the Changes in Rainfall and Temperature Patterns on Livelihoods of the People

Climate change was perceived by the majority of respondents as changes in the temperature and rainfall patterns. These changes affect both farming and fishing in many ways. Impacts of these changes on farming include increasing incidence of drought, appearance of strange plants on farms and the changes in planting and harvesting seasons all lead to low crop production. Also, fisher folks realized some impacts which contributed to their low fish catch and these include changes in the seasons of bumper harvest and the extinction of the white fish locally called 'Apatefufuo' (confirmed by 74.4 percent of fisher folk respondents). These impacts have worsened their standard of living as their occupations have become less lucrative now compared to decades ago.

6.2.4 Indigenous People's Vulnerability to Climate Change

In terms of vulnerability, the study observed that characteristics and circumstances that made indigenous people more vulnerable to climate change impacts are their inaccessibility to modern technology and equipment, lack of an understanding of new approaches, their overdependence on nature and most outstanding is their lack of money. About 86 percent of both farmers and fisher folks believed that if they were financially adequate, they could be more resilient in the midst of all the challenges posed by climate change. The characteristics of the indigenous farmers and circumstances contributing to their vulnerability indicated by the staff of MoFA are farmers' over-dependence on rain-fed agriculture, their inability to purchase irrigation equipment and other agricultural inputs, the unpredictable nature of recent weather conditions, and their inability to adopt improved farming systems because of financial deficiency. These entire characteristics sum up to one thing-that is their lack of money and this is a proof of most indigenous people being absolutely poor.

The study observed that, only fisher folks (62.8 percent) were engaged in alternative sources of livelihood that also depended on nature. These fisher folks engaged in farming and that made them seem more vulnerable than their farmer counterparts. The remaining fisher folks and all farmers were either engaged in non-nature-dependent activities like trading in non-perishable products, shop-keeping, hairdressing, driving, barbering and tailoring or had no alternative economic activity. However in choosing their future alternative source of livelihood, majority of respondents preferred trading in non-perishable goods. About 35 percent of fisher folks and 51 percent of farmers

preferred to trade if they no longer practice their respective occupations. However others preferred livelihood sources like carpentry, hairdressing, shoemaking, mechanic, tailoring, palm wine tapping, palm oil processing, distilling 'akpeteshie', security guards, commercial driving and shop-keeping. Unfortunately, some farmers (17.7 percent) and fisher folks (25.6 percent) preferred no other occupation than what they practiced currently despite the challenges they faced. To them they did not have the skills to engage in any lucrative business and they simply preferred their current occupations to any other.

6.2.5 Indigenous Adaptations (Local Innovations) to Climate Change

Adaptation methods are supposed to be sustainable in order to reduce the vulnerabilities of the indigenous people to climate change. The study however observed that the adaptation methods practiced by the farmers and fisher folks were short-term adjustments and autonomous in nature notwithstanding the fact that they have been practiced over a long period of time. The study also observed that farmers' adaptation methods were a mix of both technical/formal knowledge and local knowledge (experiences and instincts). For instance the application of agrochemicals, and the collection and storage of rain water (water maximization) were of both formal and local knowledge respectively. The most practiced adaptation methods were planting different varieties of the same crop and mixed cropping. These were practiced by almost all farmers in both Nyameani and Yaase. The application of weedicides like 'roundup' and 'power' had also gained much interest among most farmers. Other methods though not practiced by many farmers include irrigation mostly practiced in Yaase and the extensification of land put into crop production practiced mostly by farmers in

Nyameani An adaptation method which was catching up in both communities is the cultivation of only improved seed varieties (no local seed) usually known as 'agric'. Mostly cultivated were 'Mama ba' and 'Obaatampa' which are improved varieties of maize and the hybrid type for oil palm which is the crossbreed of two varieties-Dura and Tenara. This adaptation method was practiced mostly by farmers in Nyameani. Since the impacts of climate change are diverse and complex, each farmer practiced a combination of two or more methods at a time.

Most fisher folks 37 (86.1 percent) out of the 43 interviewed practiced no adaptation method within their occupation. The remaining 6 who practiced some adaptation, 2 (4.7 percent) adopted the use of more nets in fishing, 1 (2.3 percent) adopted the use of clean nets and 3 (6.9 percent) spent long hours in fishing.

6.2.6 Relationship between Indigenous Knowledge, Vulnerability and Adaptation Strategies

The study observed that the adaptation methods practiced by these farmers were based on their knowledge (influenced by perceptions and experiences) and exposure to climate change. Their adaptation methods were ways of diversifying their risk against the adverse variability of the climate in order to reduce their vulnerability to climate change impacts. For instance different crops were cultivated because of the unpredictability of the rainfall pattern, and agro-chemicals like weedicides were used as a result of the prevalence of weeds like 'esre' (Pennisetum purpureum) on farms. Irrigation, water maximization and the use of improved seedlings (usually drought resistant) were also practiced as strategies against drought and low rainfall amount. Farmers who left some

trees on their farms did so to provide shade for their crops, a strategy against the intense heat which easily scorched growing crop plants. MoFA identified the cultivation of early maturing crops as an adaptation method practiced by many farmers.

The sustainability of these adaptation methods are of much worry to these farmers and fisher folks because after all their efforts, they still could not see much improvement in their living standards. Both fisher folks and farmers complained about the high cost in practicing these methods

Most farmers and fisher folks would prefer to diversify their livelihood sources (change their occupations) as a livelihood adaptation strategy. Thus though only few adjusted to changes within their respective occupations (farming and fishing), majority of these farmers and fisher folks desired to leave their occupations to pursue new ones. This becomes a threat to food security. Even though adaptation methods need to reduce the vulnerability of farmers and fisher folks to climate change impacts, the challenges they faced as they practiced these methods and their inability to overcome these challenges still made them vulnerable. However, these adaptation methods they confessed have helped reduce impacts of climate change on their livelihoods.

6.2.7 Support for Indigenous Adaptation Strategies

The study assumed that Government's support for indigenous adaptation strategies helps build the resilience of indigenous people towards climate change impacts. The Ministry of Food and Agriculture (MoFA) is the main institution in charge of the overall development of agriculture at the district level and as such the support for indigenous

adaptations greatly lies within their jurisdiction. In verifying the above assumption, it was observed that the fishing sector in Abono and Adwafo had no form of support at all from MoFA unlike the two farming communities; Nyameani and Yaase which had Agriculture Extension Agents (AEAs) to support their farming activities. In spite of this, only 17 farmers out of the 102 farmers interviewed consented that they got support, the remaining 85 farmers reported they had no support of any kind at all from MoFA. The types of support given these farmers were technical support-in the form of education, and material support-in the form of distribution of agrochemicals. Farmers from Nyameani benefited from material support than technical support. Thus from the total of 10 farmers who received material support, 7 were from Nyameani whiles the 3 remaining were from Yaase. Farmers from Yaase benefited more from technical support than material support since out of the total of 7 farmers who had material support, 5 were from Yaase as against 2 from Nyameani. No financial support was given.

These support were for free as consented by 15 out of the 17 farmers who were supported, the remaining 2 reported that materials given them were either loaned out or small payments were made. MoFA's support is very important in building the resilience of farmers to climate change impacts. This is because farmers who had support have been able to control crop pest and diseases, increased their yields and reduced cost of farming. Only 2 farmers of the 17 claimed not to have benefited from the support they received. From the remaining 15 who benefited, 9 were from Nyameani and 6 were from Yaase. The 2 farmers who claimed not to have benefited from MoFA's support were from Yaase.

Undoubtedly, financial support was paramount among the needs of both farmers and fisher folks interviewed. About 66 percent of farmers preferred loans to purchase fertilizers, improved seeds and also practice mechanized farming. About 23 percent preferred material support in the form of free distribution of fertilizers, seeds, pesticides, and the likes. Whiles 7.8 percent preferred technical support specifically training on best farm practices which they believed would equip them with knowledge to help manage their farms in order to increase their yields. Other support preferred were getting better markets and price for their farm produce, building irrigation dams so they could cultivate paddy rice and subsidies on agrochemicals and improved seedlings. Among the fisher folks, about 68 percent preferred loans, 11.6 percent preferred the provision of fishing equipment and 7 percent preferred being given technical advice. Other support suggested by 14 percent of these fisher folks were the construction of good roads to support rapid development, developing the lake into tourist site, creating other employment opportunities and having periodic meetings with MoFA staff so as to find joint solutions to their specific problems. Unfortunately, MoFA provides more of technical support which was the least on the preference list of these farmers and fisher folks.

MoFA in providing support for farmers faced several challenges including bad road networks and lack of means of transportation, high farmer to officer ratio, no demonstration sites for farmers, and farmers' unwillingness to adopt new technologies. These made their support inadequate and unable to enhance the livelihoods and resilience of most farmers in the communities.

Finally, the study observed that there was no budgetary support for farmers' adaptations but future plans include helping them access loans from financial institutions especially the rural banks. Providing technical support for farmers still remains a priority to MoFA but focus would be on empowering these farmers to see farming as a business than a mere way of life in order to increase their yields season after season. As earlier stated, majority of respondents had no support from MoFA and not all who had the support claimed to have benefited from it. Moreover, their lack of understanding of new approaches made them vulnerable to climate change. These suggest that support for indigenous people should focus on improving their own strategies in order to help build their resilience towards climate change impacts.

6.3 Conclusions

There was no rich and peculiar knowledge expressed by the indigenous farmers and fisher folks interviewed about climate change. However, their adaptation methods were based on the knowledge they had acquired through observations and experiences of the changes that had occurred within their environment, especially related to rainfall and temperature over decades of years. These adaptation methods have helped reduce their vulnerabilities to an extent though some existing characteristics, circumstances and the level of sustainability of these methods have compromised the attainment of better resilience.

It would be better to conclude that MoFA is inadequately equipped to provide immense support for indigenous adaptation methods rather than to conclude that they provide

inadequate support. Unfortunately their inadequacy has had a negative impact on the level of resilience expressed by these indigenous farmers and fisher folks. The adaptation methods practiced by these people would have greater and sustained impacts on their livelihoods when MoFA offers greater support.

What is most important is to see the main source of indigenous livelihood-farming and fishing-improved in the long run. If the local government fails to support their adaptations, they would resort to other livelihood sources (diversification of livelihood) which could be of great danger to a country that depends so much on agriculture. The whole country's food security and development is much dependent on improved adaptations within farming and fishing.

6.4 Recommendations

These recommendations are made based on the responses from all respondents of the study. They are focused on promoting and enhancing indigenous farmers and fisher folks' adaptations to climate change impacts so as to reduce their vulnerabilities and build their resilience. From the study, it was made clear that the Ministry of Food and Agriculture (MoFA) in the Bosomtwe District is the main government representative that sees to the overall progress of agriculture within the district. In this wise, suggestions made will pivot around strengthening MoFA's support for both indigenous farming and fishing.

The study observed that a major challenge faced by MoFA is the low number of Agricultural Extension Agents (AEAs) available for fair distribution among and within all communities. Thus, not all communities had AEAs, for instance the two fishing communities; Abono and Adwafo had no AEAs. The communities which had AEAs were also challenged by a high officer to farmer ratio of about 1:1000 meaning 1 officer to a 1000 farmers. MoFA should therefore carefully recruit and train a number of farmers from each community to serve as Community Field Assistants (CFAs) to assist the AEAs available whiles measures are put in place to increase the number of AEAs. These CFAs should be given on-farm training that are technical in responding to the challenges posed day-in and day-out by the changes in temperature and rainfall patterns. They should have frequent farm visits and report on complex findings to the AEAs who would come in when needed. This would help MoFA maintain a strong relationship with farmers in the community. These CFAs could also help in promoting effective communication between MoFA and farmers.

Unfortunately, MoFA does not support direct fishing from Lake Bosomtwe and as such these fishing communities have no AEAs. In that wise, MoFA should encourage and promote fish farming within all fishing communities by sending specialized AEAs in fisheries to help fisher folks in the communities. Moreover most fishes are endangered and getting the fingerlings to grow in ponds would be of much benefit to the fisher folks and the communities at large. The first approach should be discourses with fisher groups to buy into the idea. Though fish farming is expensive than directly fishing from the lake, fisher folks should be made to understand the need for fish farming, benefits that could be derived and the support that could be given them.

In the study, there were some characteristics and circumstances outlined by farmers and fisher folks which made them very vulnerable to climate change impacts. In order to reduce these vulnerabilities, MoFA should introduce very simple modern farming/fishing equipment that could easily be purchased and used by these farmers and fisher folks. MoFA through their extension officers and CFAs should encourage farmers to form small groups (20 members per group) to facilitate frequent group training where new approaches and best farm practices would be taught them. Education on the effects of bad farming practices that exacerbate the impacts of climate change could be fused with such training sessions.

All farmer groups could also be requested to obtain or one should volunteer a piece of land to serve as their demonstration farm where they could practice what has been taught and understand before applying on their individual farms. This could help farmers increase yields through best farm practices-proper application of agrochemicals and best use of modern farm equipment. In order to reduce farmers' over-dependence on rainfall, MoFA should help build irrigation dams on streams near cluster of farms. This could also help crops survive during drought seasons and periods of low rainfall.

MoFA should stay committed to its future plan of assisting farmers to access loans from financial institutions. The first step is to form the suggested groups with leaders who are trustworthy and could easily influence their members to repay the loans. Effort should be made to get these loans at low interest rates. Granting farmers access to loans would empower them adopt new modern approaches, purchase, and use modern equipment. Most importantly it would build their resilience because they could better practice their

various adaptation methods to avoid most challenges. CFAs should bargain for subsidies on modern tools, improved seedlings and agrochemicals from MoFA on behalf of the farmer groups. They should also lead these groups in bargaining for better market prices for their produce.

MoFA complained of inability to reach some communities because of bad road networks and lack of means of transportation. The District Assembly should be encouraged by MoFA to construct and rehabilitate road networks leading the various communities to make them accessible. Proposals should also be made by MoFA to the central government for vehicles that could ply the roads connecting the communities. It would be prudent for central government to respond to this proposal with urgency because it is related to agriculture which is the pivot of the economy.

Finally, MoFA should research and document all adaptation methods practiced by farmers and fisher folks within the district, assess them critically and advise on the pros and cons related to each and how to get the best out of each method. This would help make these methods sustainable and beneficial to all farmers and fisher folks.

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APPENDICE

APPENDIX 1

INDIGENOUS KNOWLEDGE AND ADAPTATIONS TO CLIMATE CHANGE

STRUCTURED INTERVIEW FOR FARMER AND FISHER FOLK RESPONDENTS

Record number:			
Interviewer's name:			
Date of interview:	D	M	Y
District:			
	Community:		

A. Demographic data

1. Gender

Male	**1**	
Female	**2**	

2. How old are you?

50 – 59years	**1**	
60 – 69years	**2**	
70+	**3**	

3. What is your marital status?

Married	**1**	
Single	**2**	
Divorced	**3**	
Widowed	**4**	

4. What is your highest level of education?

No formal Education	**1**	
Basic	**2**	
Secondary/Vocational	**3**	
Tertiary	**4**	

5. What is your religion?

Christianity	**1**	
Traditional	**2**	
Islam	**3**	
Other_____	**4**	

6. Are you originally from this town?

Yes	**1**	
No	**2**	

7. Were you raised in this town?

Yes	**1**	
No	**2**	

8. What is your occupation?

Farming	**1**	
Fishing	**2**	

9. How long have you practiced this occupation?

25-34 years	**1**	
35 – 44 years	**2**	
45 – 54	**3**	
55 years and above	**4**	

B. <u>Traditional Perceptions on Climate Change impacts</u>

Kindly use the options below to answer the following questions according to your level of agreement or disagreement:
1–Strongly Agree, **2**–Somewhat Agree, **3**–I Don't Know **4**–Somewhat Disagree, **5**–Strongly Disagree

10. Over a decade, the temperature, within this community keeps rising. ☐

11. Rainfall is decreasing every year. ☐

12. The climate is changing. ☐

13. What makes you think that the climate of this area has changed?

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14. What are your indicators of change?

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15. What was the climate in times past and how is it now?

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16. Is there serious awareness on climate change?

Yes	**1**	
No	**2**	

For farmers only

17. The yearly rains and rising temperatures are not supporting crop production as before. ☐

18. Some plant species on the farms are going into extinction. ☐

19. Strange plants keep appearing on farms. ☐

20. There has been increasing incidence of droughts. ☐

21. The change in climate has led to crop infestations and diseases. ☐

22. Has planting seasons for some crops changed?

Yes	**1**	
No	**2**	

23. Has harvest seasons for some crops changed?

Yes	**1**	
No	**2**	

24. When were your growing and harvesting periods and has it changed now?

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25. What were the crop combinations in the past and how is it now? Main crops / cash crops

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26. State other evidences of the changing climate.

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<u>For fishermen only</u>

27. The climate is not supporting high fish catch (yields) as before. ☐

28. Some fishes are going into extinction. ☐

29. Name some of such fishes …….....

30. What do you think is the cause of the extinction? …….....

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……...……...……
……..…….....
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31. Has there been the appearance of new types of fishes which were not present before?

Yes	**1**	
No	**2**	

32. Has the seasons of bumper harvest changed?

Yes	**1**	
No	**2**	

33. By your own observation, is the lake retreating?

Yes	**1**	
No	**2**	
I don't know	**3**	

34. State other evidences of the changing climate.

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C. <u>Indigenous occupational activities that compound the impacts of climate change</u>

For farmers only

35. How often do you practice bush burning?

Very often	**1**	
Not often	**2**	
Not at all	**3**	

36. How often do you apply chemical fertilizer on your farm?

Very often	**1**	
Not often	**2**	
Not at all	**3**	

37. Do you clear all trees on you farm?

Yes	**1**	
No	**2**	

38. State any other farming practices you think can affect the climate in the long term.

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<u>For fishermen only</u>

39. Do you put any chemical in the lake when fishing?

Yes	**1**	
No	**2**	

40. How often do you do that?

Very often	**1**	
Not often	**2**	

41. State any other fishing practices you think can affect the climate in the long term

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D. <u>Impacts of climate change on livelihoods and identifying indigenous peoples vulnerability to climate change</u>

Kindly use the options below to answer the following questions according to your level of agreement or disagreement:
1–Strongly Agree, **2**–Somewhat Agree, **3**–I Don't Know **4**–Somewhat Disagree, **5**–Strongly Disagree

42. The cost of your farming/ fishing activities is rising. ☐

43. The occupation is no more lucrative as it was before. ☐

44. It is getting more difficult in providing the basic needs of the family. ☐

45. Your living condition is not getting any better. ☐

46. Would you say you are the most affected by climate change?

Yes	**1**	
No	**2**	
I don't know	**3**	

47. If yes, what makes you most affected?

Lack of money	1	
Lack of access to modern equipment/technology	2	
Other, specify	3	

48. Would you say your livelihood depends solely on nature?

Yes	**1**	
No	**2**	
I don't know	**3**	

49. Are you engaged in any other economic activity that depends on nature?

Yes	**1**	
No	**2**	

50. If yes, specify …….....

51. In the face of climate change impacting negatively on your occupation, what other occupation would you opt for? ……..

E. <u>Indigenous Adaptations to Climate Change</u>

52. In relation to your occupation, what are the strategies you use in adapting to climate change impacts?

For farmers only

Planting Different Varieties of the same crops	**1**	
Cultivating Different crops	**2**	
Changing the extent of land put into crop production	**3**	
Changing to irrigation	**4**	
The use of chemical fertilizer	**5**	
Improvement in water maximization	**6**	
Other, specify	**7**	

For fishermen only

The use of chemicals in fishing	**1**	
Other, specify	**2**	

53. Do you think these adaptive strategies you use are sustainable?

Yes	**1**	
No	**2**	
I don't know	**3**	

54. Are these strategies cost effective?

Yes	**1**	
No	**2**	
I don't know	**3**	

55. What challenges do you face in using these adaptation strategies?

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F. District Assembly's support for Indigenous Adaptations

56. Does the District Assembly (MoFA) support your adaptation strategies?

Yes	**1**	
No	**2**	
I don't know	**3**	

57. In what form does the support come?

Financial support	**1**	
Technical support	**2**	
Material support	**3**	
Other, specify	**4**	

58. Is this support free?

Yes	**1**	
No	**2**	

59. If **No,** what are the conditions attached?

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60. How long has this support been in existence? .....

61. Is this type of support beneficial?

Yes	**1**	
No	**2**	

62. If **Yes**, how has it benefited you?

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63. What other support would you need from the either the District Assembly (MoFA) or any other organization?

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APPENDIX 2

INTERVIEW GUIDE FOR FOCUS GROUP DISCUSSION

INDIGENOUS KNOWLEDGE AND ADAPTATIONS TO CLIMTE CHANGE

Record number:				
Interviewer's name:				
Date of interview:		D	M	Y
District:				
		Community:		
Group type				

1. Has the climate changed?

2. What are the indicators of change?

3. What has brought about this change in your view?

4. What do you know about climate change?

5. Is there much awareness on it?

6. How does its impacts affect your livelihood?

7. How are you able to survive each growing season?

8. What things are being done now which were not done in the past (or vice versa)?

9. During the lean seasons of farming/fishing how do you survive?

10. What indicators do you use in predicting:

a. favourable seasons
b. unfavourable seasons

11. What mechanisms do you put in place to face each of these seasons?

12. Do you agree you are the most affected by climate change, if so why is that?

13. What are some farming/fishing practices you engage in that you think can affect the environment/climate?

14. What adaptation strategies do you use in combating climate change impacts?

15. How are these strategies improving your occupational conditions?

16. What challenges do you face using these adaptation strategies?

17. Do you get support for your adaptation strategies?

18. Where does this support come from?

19. In what form is the support?

20. How has it benefited you?

21. What other support would you need in enhancing your occupation?

APPENDIX 3

STRUCTURED INTERVIEW FOR STAFF OF MOFA

INDIGENOUS KNOWLEDGE AND ADAPTATIONS TO CLIMATE CHANGE

Record number:				
Interviewer's name:	Interviewee's Position:			
Date of interview:		D	M	Y
District:				
	Institution:			

A. Demographic data

1. Gender

Male	**1**	
Female	**2**	

2. How old are you?

35 – 44years	**1**	
45 – 64years	**2**	
65+	**3**	

3. What is your marital status?

Married	**1**	
Single	**2**	
Divorced	**3**	
Widowed	**4**	

4. What is your highest level of education?

No Formal Education	**1**	
Basic	**2**	
Secondary/Vocational	**3**	
Tertiary	**4**	

5. What is your religion?

Christianity	**1**	
Traditional	**2**	
Islam	**3**	
Other_____	**4**	

6. How long have you worked in this institution? .....

Perceptions on climate change

7. For the past decade, what is your account of your district's temperature pattern?

Getting warmer over the years	**1**	
Fluctuate over the years	**2**	
Stable over the years	**3**	
Getting colder over the years	**4**	

8. What has been the rainfall pattern over the years?

More rains over the years	**1**	
Less rains over the years	**2**	
Stable over the years	**3**	
Other, specify_____	**4**	

9. State the years in which there were;

i. More rains.....
ii. Less rains.....
iii. Drought.....

10. What do you think is the cause of change in:

i.Temperature(explain).....

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

ii.Rainfall(explain).....
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11. Examining these factors, do you think there has been a change in your district's climate?

Yes	**1**	
No	**2**	

12. In your own terms, define climate change?

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Climate change impact on Agriculture

13. Has climate change had any significant impact on Agriculture (crop farming and fishing) in this district?

Yes	**1**	
No	**2**	

14. If yes, explain how it has impacted on Agriculture?

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Climate change Vulnerabilities

15. Do you think the local farmers and fishermen are most affected by climate change?

Yes	**1**	
No	**2**	

16. If yes, in what ways are they affected?

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17. What factors make them vulnerable to climate change impacts?

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Local adaptations to climate change

18. Have you identified any strategies adopted by the local people in adapting to climate change impacts?

Yes	**1**	
No	**2**	

19. If yes, can you outline some of such local adaptation strategies/ innovations?

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20. Are these strategies sustainable?

Yes	**1**	
No	**2**	

21.Why?(explain)

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Local government's support for Indigenous adaptations

22. In what ways do you support such local adaptation strategies/innovations?

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23. Where does the support come from?

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24. If it's: i. Monetary support, what are the terms and conditions?

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ii. Technical support, how is it provided?

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iii. Material support, what kind of materials are supplied and how are they distributed?

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25. What is the main reason or objective for giving out this support?

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26. Has this objective been achieved?

Yes	**1**	
No	**2**	

27. What are the challenges you face in giving out such support?

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28. How long has this support been in place? .....

29. How long has this support been planned to last? .....

30. What is the future plan in supporting the local farmers and fishermen?

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31. Any reason for this plan?

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