

**ASSESSMENT OF ADAPTATION STRATEGIES TO CLIMATE CHANGE
ON LIVELIHOOD OF RURAL COMMUNITIES IN ZARIA, KADUNA
STATE, NIGERIA**

BY

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M.Sc./SCIE/1963/2011-2012 (P16PSGS8577)
M.Sc. ENVIRONMENTAL MANAGEMENT**

**A DISSERTATION SUBMITTED TO THE SCHOOL OF
POSTGRADUATE STUDIES,
AHMADU BELLO UNIVERSITY,
ZARIA**

MAY, 2018

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**IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE
AWARD OF MASTER DEGREE OF SCIENCE IN ENVIRONMENTAL
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**DEPARTMENT OF GEOGRAPHY AND ENVIRONMENTAL
MANAGEMENT,
FACULTY OF PHYSICAL SCIENCES,
AHMADU BELLO UNIVERSITY,
ZARIA NIGERIA**

MAY, 2018

DECLARATION

I hereby declare that the contents of this dissertation titled “**Assessment of Adaptation Strategies to Climate Change on Livelihood of Rural Communities in Zaria, Kaduna State, Nigeria**” was carried out by me **Felicia Meka, OGUDU** under the supervision of Dr. R.O. Yusuf and Prof. B. Abdulkarim. All information obtained from literature has been acknowledged in the text as well as the list of all references. No part of this dissertation was previously presented for another degree or diploma at this or any other institution

Felicia Meka, OGUDU

.....
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CERTIFICATION

This dissertation titled “**Assessment of Adaptation Strategies to Climate Change on Livelihood of Rural Communities in Zaria, Kaduna State Nigeria**”, by **Felicia Meka, OGUDU** meets the regulations governing the award of degree of Masters of Science in Environmental Management of the Ahmadu Bello University, Zaria, and is also approved for its input to knowledge and literary presentation.

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DEDICATION

I dedicate this study to my family for their support in making it a reality.

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My foremost appreciation is to the Almighty GOD for the privilege given me to run this programme from the start to finish. The wisdom strength and health as well as mercies cannot be overemphasised. To Him be all the glory forevermore.

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ABSTRACT

The study assessed the adaptation strategies to climate change on livelihood of rural communities in Zaria, Kaduna State, Nigeria. A total of 399 questionnaire were distributed to respondent in the 7 wards that were purposively sampled for the study. Data was analysed descriptively using frequency distribution tables, graphs and charts. Focus Group discussions were also held in each Local Government Area in order to obtain in-depth information on climate change. The result revealed that majority of the respondents (74%) got their information about climate change from mass media. A five point Likert scale (LS) was used to determine perception of climate change by respondents, the study identified environment is suffering from devegetation as the most significant and having the highest average mean score (4.68) followed by domestic fuel scarcity (4.64), cost of food crop are increasing (4.61) among other perceived impact. The results also revealed that majority of the respondent (75%) agreed Climate-induced vulnerabilities have impact on their sources of livelihoods by compromising their health and food supply. Common hazards that affect the communities are flood, drought, erosion and attack of invasive species on crops and animals. These hazards/risk were found to occur across the four seasons of the study area in different magnitudes and with the wet season having the most unpredictable trends in temperature and rainfall patterns. Public enlightenment, use of improved variety of crop, irrigation and migration were among the most effective adaptive strategies to reduce climate change impact on the livelihood of the communities. Climate change will continue to have dangerous impact on the study area's resilience unless the rural people's adaptation strategies is documented, their capacity is strengthened and effective adaptation strategies integrated into policy formulation. In view of this the study recommends among others, more awareness creation, afforestation, intensification and diversification, capacity building and integration of rural people in policy formulations on climate change.

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CHAPTER ONE

BACKGROUND OF THE STUDY

1.1 INTRODUCTION

Climate change is one of the most outstanding challenges facing the global community and as such has been viewed by different authors according to their perception and the way it affects them. One of the commonly used definitions was by the Intergovernmental Panel on Climate Change (IPCC, 2007) which defines climate change as statistically significant variations in weather averages that persist for long periods (typically decades or longer). Climate change is attributed to natural internal processes or external forcing or to persistent anthropogenic changes in the composition of the atmosphere or in landuse (NOAA, 2007). Recent scientific evidences demonstrated that climate change is a reality and a primary environmental threat to sustainable development in the 21st century (Stern, 2006, UNDP, 2010). It includes shifts in the frequency and magnitude of sporadic weather events as well as the slow continuous rise in global mean surface temperature. The National Oceanic and Atmospheric Administration (NOAA) in 2007 reported that the last decade of the 20th Century and the beginning of the 21st have been the warmest period in the whole world measurement of temperature records, which commenced in the mid-19th century. Global warming resulted to variation in temperature and precipitation that are already noticed in many parts of the world including Nigeria (Odjugo, 2010; Oladipo, 2010).

Similarly, for the next coming decades, it is estimated that billions of people, especially those in developing countries will encounter deficit of water and food with negative effect to health and life due to climate change. Consequently, entire global action is required to make developing countries to withstand the effects of climate change that are occurring now and will continue in the future. However, because of global warming, the type, rate and magnitude of extreme events, such as tropical cyclones (including hurricanes and typhoons), floods, droughts

and intense rainfall events, heat waves are expected to rise even with little rise in temperature (UNFCCC,2007; Meehl et al, 2007).

The effect of climate change is increasingly impacting the global physical environment people's resilience and livelihoods. The adverse effect of climate change in Nigeria range from drought and aridity, increased environmental exposures, increased crop failures, pest and diseases, depletion of livelihoods migrations biodiversity loss, natural resource base, shift in ecological zones and decline in soil fertility others are, increased health risks and the spread of infectious diseases, changing livelihood patterns (Ishaya and Abaje, 2008, Oladipo, Adeshina and Abdulkarim, 2009; Oladipo, 2010; Sawa and Adebayo, 2011). Thus, these conditions make communities highly vulnerable. High levels of vulnerability and low adaptive capacity in Africa have been linked to factors such as limited adaptive capacity in terms of access to development resources and high poverty rates.

Vulnerability to climate change among countries, regions within economic sectors and social groups differs within a wide margin of the elements of the weather being measured. For example temperature, wind pattern and precipitation indices are unevenly globally and corresponding ecological zones adjust to the thresholds of these indices (USAID, 2007). As communities within different and ecological zones have different degrees of resources, so also their abilities to cope with the impact of the change in climate. The level of vulnerability in each country is a measure of stress level and adaptive capacities, inability to cope with adverse effects of climate change, including climate variability and extremes. According to (Ellis, 2000; Kurukulasuriya et al., 2006) High levels of vulnerability and low adaptive capacity in Africa have been linked to factors such as limited adaptive capacity in terms of access to development resources and high poverty rates. For example, sub-Saharan Africa is predicted to be particularly hard hit by effects of climate change because it is already experiencing high temperatures and low (and highly variable) precipitation, the

economies are highly dependent on rain fed agriculture with a very low system for adopting modern technology.

In Nigeria, just as in many developing countries vulnerability to climate change is very high (Mendelsohn, 2006). With particular reference to northern Nigeria as they have lower adaptive capacity and depend more on local ecosystem services, such as water and agriculture and food security (Abaje and Giwa, 2010; Sawa and Adebayo, 2011 ; Farauta, 2011) In other words landless farmers, livestock keepers, people in poor health, those who are undernourished, people with low economic power, women headed households, those with low level of education, and those with low technological know-how are more exposed to risks of climate change (Barber, 2003). Effective institutional frameworks both national and international do provide mitigation strategies that enable communities with high vulnerability index to cope or plan for alternative sources of livelihoods (IPCC 2001, Abdulkarim, Balarabe & Oladipo, 2015) albeit, the rural communities participation in policy and implementation is lacking.

Adaptation to climate change refers to adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities (IPCC, 2001). Adaptation strategies are also considered as, coping strategies, resilience development and flexibility (Fussler and Klein, 2006). Coping refers to strategies that have evolved over time through peoples' long experience in dealing with known and understood natural variation that they expect in seasons combined with their specific responses to the season as it unfolds (Thomkins and Adger, 2004). A common example is that of agro-pastoralists who have adapted to changing conditions of climate, water and vegetation variability by optimizing the mix of cattle, sheep, goats and camels in their herds. Adaptation as a strategy spans a wide variety of issues, from good governance to early warning system or sea walls to wetland restoration (DWC, 2006; IPCC2007; Agrawal, 2008;

Crawford, 2008). Adaptation strategies to be adopted however, will depend on the adaptive capacity of a system, region, community or household. Adaptive capacity is therefore the whole of capabilities, resources and institutions of a country, region, community or household to implement effective adaptation strategies. It characterizes the responsiveness of a system and its abilities to exploit opportunities and resist or recover from the negative effect of a changing environment (Boko et al, 2007). Climate change however will continue to change at all scales and levels. Thus a good understanding of rural peoples' climate change induced vulnerability and adaptation strategies is crucial in responding to the impact of climate change.

Livelihood is also central to the definitions of resilience, adaptation, improvement, diversification and transformation. Livelihoods are universal. Poor and rich people both pursue livelihoods to make a living. According to the Department of International Development (DFID, 2000) a livelihood comprises the capabilities, assets and activities required for a means of living. They depend on access to natural, human, physical, financial, social, and cultural capital (assets); the social relations people draw upon to combine, transform, comprise and expand their assets; and the ways people deploy and enhance their capabilities to act and make lives meaningful. However, the adverse impacts of weather events and climate increasingly threaten and erode basic needs, capabilities, and rights, particularly among poor and disenfranchised people (Adger 2010, Olson et al 2014).

Some livelihoods are directly climate-sensitive, such as rainfed smallholder agriculture, seasonal employment in agriculture (e.g. tea, coffee, and sugar), fishing, pastoralism, and tourism which is typical of rural communities. However, infrastructure and technology as well as diversification of assets, activities, and social support capabilities can boost livelihoods, spreading risks and broadening opportunities (Clot and Carter, 2009; Carr, 2013). There are a number of livelihoods adaptation strategies which are already existing at various locations and scales in the region; although many of such are not informed by

specific researches nor integrated into a policy framework in climate service and adaptation portfolio.

This research therefore, is making a case for urgent actions towards assessment of the perception of rural people on adaptation to climate change on livelihood of rural communities in Zaria communities. Though, this community is small compared to the whole nation, issues discovered here could apply to similar communities scattered across the nation and be of relevance to policy makers and respective stakeholders working on climate change vulnerability and adaptation in Zaria and Kaduna State generally.

1.2 STATEMENT OF RESEARCH PROBLEM

Zaria is an urban center with adjoining rural settlement all pursuing diverse ecological and non-ecological livelihood which are sensitive to climate change. The study area is vulnerable to climate change because of the dependence on rain-fed agriculture which relies directly or indirectly on climate change and variability. Moreover, agricultural activities from planting to harvesting are dependent either directly or indirectly to climate change and variability.

Worldwide local climate variability can influence peoples' decisions with consequences for their social, economic, political and personal conditions, and effects on their lives and livelihoods. The effects of climate change imply that the local climate variability that people have previously experienced and have adapted to is changing at relatively great speed (UN, 2007). Climate change is anticipated to have far reaching effects on the sustainable development of developing countries (UN, 2007). Consequently, climate change and variability has already set development efforts back, and made the achievement of the Millennium Development Goals (MDGs) significantly more tedious in Nigeria.

UNDP (2008) predicted that the impacts of climate change such as sea-level rise, droughts, heat waves, floods and changes in precipitation, could, by 2080, push 600 million

people into food shortages and the number of people facing water scarcities would reach 1.8 billion. Sub-Saharan Africa is predicted to be particularly hard hit by effects of climate change because it is already experiencing high temperatures and low (and highly variable) precipitation, the economies are highly dependent on rainfed agriculture with a very low system for adopting modern technology (Ellis, 2000; Kurukulasuriya et al., 2006). Coastal communities, urban slums and marginalized rural communities who depend on climate-sensitive resources for livelihoods are likely to share the hottest heat of the risk's flame (Boko, et al., 2007).

The investigation of climate vulnerability assessment has emerged to address the need to quantify how communities adapt to changing environmental conditions. Human beings have been adapting to the variable climate around them for centuries. Various researchers have tried to bridge the gap between the social, natural, and physical sciences and contributed new methodologies that confront this challenge (Polsky, Neff and Yarnal, 2007).

Farauta, Egbule, Idrisa and Agu (2011) examined the incidence of climate change and adaption measures in northern Nigeria. Data were drawn from both primary and secondary sources; using both qualitative and quantitative approaches. Multistage sampling technique was used in selecting 500 respondents for the study. Simple descriptive statistics were used for data analysis. Findings show that respondents were aware and knowledgeable on the issue of climate change; and obtained information mainly from mass media. The study revealed an increase in the incidence of climate change in the area as typified by receding rainfall and extreme temperatures. The study further revealed the prominence of overgrazing deforestation and bush burning in the area. The findings also noted that key problems associated with the changing climate were: increase in cost of farm inputs, poor crop yields, and increase in pest and disease incidence and loss of forest resources. The adaptive measures being used by respondents were changes in planting and harvesting dates,

afforestation, use/planting by wetland/fadama and use of resistant varieties. The major constraints respondents faced in their bid to adapt to the impact of climate change were: poor access to information, poor/low extension services and limited adaptation measures.

Abaje, Sawa and Ati (2014) assess local peoples' perceptions on climate variability and change and strategies adopted in combating the impacts of the changes in Dutsin-Ma Local Government Area of Katsina State. A total of 242 questionnaires were administered to households' heads in the eleven wards of the Local Government Area. Descriptive statistics such as frequency distribution, percentage and mean scores were used in data analysis. The result revealed that majority of the local people have a very good knowledge of climate variability and change in terms of higher temperature, higher rainfall intensity and variability, and the occurrence of extreme weather events such as flood and drought. Findings also revealed that community disobeying God, deforestation, bush burning, combustion of fossil fuel and pollution were the major causes of climate variability and change as perceived by the respondents.

The most significant impacts of climate variability and change as perceived by the local people were decline in crop yields, decline in forest resources, water shortages and decrease in soil fertility. These impacts have resulted to rural-urban migration in the area. Sustainable adaptation strategies adopted by the local people are water harvesting, the use of fertilizer/animals dung to improve crop yield, irrigation agriculture, planting of crop varieties and drought resistant crops. It is recommended that strategies for combating impacts of climate variability and change should take into account the traditional and religious beliefs of the people; and there is need to educate the local people to appreciate the scientific basis of climate variability and change.

In a similar vein, Ishaya and Abaje (2008) examined how communities in Jema'a Local Government Area of Kaduna State perceived climate change and explore adaptive

strategies to mitigate climate change. A total of 225 copies of questionnaire were administered in five settlements within the study area, although only 200 copies of this questionnaire were used for the purpose of analysis. Findings revealed that indigenous people in the study area perceived that the environment, climate in particular, has been changing over the years due to diverse human activities. Findings also revealed that the threat of climate change is more on health, food supply, biodiversity lost and fuelwood availability than on businesses and instigating of disaster; and it is the poor, who depend heavily on the natural resources that are mostly affected by incidence of climate change. In adapting to climate change indigenous people cultivate different/varieties of crops which are tolerant to climate change and shortening of growing season as adaptation strategies. The Result also revealed that lack of improve seeds, lack of access to water for irrigation, lack of current knowledge of modern adaptation strategies, lack of capital, lack of awareness and knowledge of climate change scenarios are the hindering factors to the adoption of modern techniques of combating climate changes in the area.

Adamu (2014) did a study on analysis of climate change impact on agriculture in Zaria Local Government Area of Kaduna State. Annual rainfall and temperature data of four decades (1971-2010) for Zaria Local Government Area of Kaduna State were obtained from Nigerian Meteorological Agency (NIMET), Zaria, and analysed in order to establish climate variability in the area. Three methods were used to study the climate variability namely: statistical differences between the two equal-length time scales of 1971-2000 and 1981-2010, respectively, coefficient of variability (CV); and the Anomaly approach. However, trend analysis using t test, Sen's estimator slope and Mann Kendall were also carried out in order to determine the trend in the climatic variables. On other hand, multiple non-linear regression analysis was performed for the annual maize, millet and sorghum yields on the climatic variables using Sigma plot 11.0. The three models of the crops developed were evaluated

using statistical error measurement. Additionally, 1000 questionnaires were self-administered in order to study the perceptions of residents of the area on climate change. It was coupled with some Focus Group Discussions with farmers and Key Informant Interviews. The results revealed that climate change affect agricultural activities because the planting dates as well as harvesting dates are affected. Finally, it was concluded that climatic variables affect agriculture and some mitigation measures and adaptation options were proposed in order to control the climate change impacts.

From the array of literature reviewed the researchers found the knowledge of climate change is gaining recognition as more impact is widely felt in their various socio economic life such as health, agriculture forestry, water regime, biodiversity loss food supply fuelwood availabilities etcetera. As regards adaptation, people have been employing adaptive strategies based on their traditional knowledge. Some informed recommendations on adaptation to climate change include reduced utilization of biotic energy obtained from forest and animal resources, reduced carbon emissions from vehicular and other sources, sustainable integrated waste management in rural and urban areas for instance use of waste in farmlands to boost fertility and a combination of several synthetic materials. Albeit, the adaptive strategies employed by the rural people in the study area is not enough to withstand the adverse experiences of climate change.

As a result of the consequence of climate change impact on the rural people, communities will experienced inexplicable changes in their livelihood option such as food supply, health, income, security water resources biodiversity distribution social interaction education and others. The literature examined have centred on perception, vulnerabilities, landuse and implication of climate change. This study however will focus specifically on assessment of adaptation strategies on “livelihoods” of rural communities in Zaria.

Zaria is an urban centre with adjoining rural settlements with people pursuing ecologically and non-ecologically dependent livelihoods. For those in the former category (who apparently are more), the impact of climate change will be more devastating hence this needs to be understood. Besides there's need to document the effectiveness of the adaptation strategies adopted by the people for both policy intervention and accumulating knowledge for future use.

In order to fill the existing gap in knowledge, this study therefore will set to address the following research questions:

- i. What are the sources of information on climate change in the study area?
- ii. What is the perception of climate change by communities in the study area?
- iii. What types of climate-induced vulnerabilities affect the communities?
- iv. What is the impact of climate-induced vulnerability on the livelihood of the communities?
- v. What strategies do communities adopt to mitigate impact of the climate-induced vulnerabilities on their livelihoods?

1.3 AIM AND OBJECTIVES OF THE STUDY

The aim of this research is to assess the adaptation strategies to climate change on the livelihood of communities in Zaria, Kaduna State with the view to providing information for policy intervention and accumulating knowledge for future use. The specific objectives are to:

- i. identify and characterize the sources of information on climate change in the study area,
- ii. determine the perception of climate change by communities in the study area.
- iii. examine the types of climate-induced vulnerabilities in the communities

- iv. examine the impact of the climate-induced vulnerabilities on livelihoods of the communities,
- v. identify the strategies adopted by the communities to mitigate the impact of climate-induced vulnerability on their livelihoods.

1.4 SCOPE OF THE STUDY

The study focuses on assessment of adaptation strategies to climate change effect on rural livelihood of communities in Zaria. Zaria as employed comprises of two local government areas (L.G.As) and twenty four (24) wards; Sabon-Gari and Zaria LGAs respectively. The spatial scope cover only 7 ward from the 24 wards in Zaria and the targeted populations are the rural communities in Zaria area, the temporal scope will cover 3 decades. The major content of the research include; how rural people perceive climate change, impact and vulnerability of climate change on the rural people's livelihood and the adaptation methods adopted to mitigate the impact of climate change.

1.6 JUSTIFICATION OF THE STUDY

The study of climate change and variability is crucial considering the fact that its impacts are numerous which include: its effects on water availability, quality and quantity, food security, agriculture, health, availability of land, species migration and sea level rise. The impact of climate change pose great environmental challenges as well as economic losses to the area, country and world at large. The Outcome of this study is expected to be used by stakeholders in planning and delivering community adaptations within a functional institutional framework and for action plans for implementation at the community levels. An understanding of climate change effect on livelihoods of rural people in Zaria and adaptive

capacity is very important without which plans support programs in order to enhance their resilience to withstand climate change impact will be difficult.

This study therefore, will provide reference for future researchers who may wish to undertake further study on similar subject matter, also serve as a guide and reference to policy makers in taking decisions as regards climate change and adaptation measures. The study will also benefit the Federal, State, Local Government NGOs, development agencies and communities affected on the importance Information and knowledge for an effective adaptation planning. This study will also add to the pool of existing knowledge in related areas

CHAPTER TWO

CONCEPTUAL ISSUES AND LITERATURE REVIEW

2.1 INTRODUCTION

This chapter is a summary of the reviews of literature on climate change under the major subheadings; concept of climate change, livelihood rurality perception and adaptations. A Review of past literatures on impact of climate change, vulnerability and adaptation and policy were also considered in this chapter

2.2 CONCEPTUAL FRAMEWORK

2.2.1 Climate and Climate Change

Climate is the long term average weather conditions of a region while weather refers to the daily fluctuating state of the atmosphere (Onwualu and Ogunwusi, 2012). The main elements of weather are temperature, rainfall, dew, humidity, mist, sunshine, clouds and haze. The International Panel on Climate Change (IPCC), defines climate change as statistically significant variations in climate condition that persists for an extended period, typically for decades or longer. It is any change in climate, rainfall or productivity caused by natural variability and direct or indirect human activities that alter the composition of the atmosphere (IPCC, 2001; IPCC, 2007). Climate change is defined as any change in climate over time whether due to natural variability or as a result of human activity (Bates et al, 2008; Pielke, 2005). It refers to a change in the state of the climate that can be identified (e.g., using statistical tests) by changes in the mean and/or the variability of its properties, and that persists for an extended period, typically decades or longer (Hegerl, *et al* 2007).

According to IPCC reports, climate change can be understood as the long-term change in temperature and precipitation average whether high or low. But climate change not only refers to changing means of variables over a long period of time (IPCC, 2007). According to Smith, Burton, Klein & Street (2000), the frequency and intensity of extreme

climate events such as droughts, floods, storms and hurricanes, are also part of global climatic change. Several scholars argue that the frequency and intensity of extreme weather events is increasing (Harmeling, 2008; IPCC, 2007; Mercy, 2007).

The term climate change and global warming are often used interchangeably. Unlike climate change which refers to long term change in the statistical distribution of weather patterns globally or in a specific region over periods ranging from decades to millions of years regardless of cause; global warming refers to increases in global temperatures as a result of accumulation of greenhouse gasses in the atmosphere (Adeoye et al, 2012; Trenberth *et al*, 2007). Global warming which is caused by greenhouse effect (increase in greenhouse gases – these are notably carbon dioxide (CO₂), methane (CH₄), nitrous oxide (N₂O), Ozone (O₃), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), sulphurhexafluoride (SF₆) and water vapor (H₂O); variations in earth's orbital characteristics (example: solar output, earth-sun geometry and interstellar dust); and volcanic eruptions - which invariably release large amounts of sulphur dioxide into the atmosphere (BNRCC,2011; Ibe, 2011). For example instrumental observations over the past 157 years show that temperatures at the surface have risen globally, with important regional variations. Other contributory factors to global warming include some human activities like deforestation, desertification, pollution, degradation, erosion, emission of greenhouse gases, bush burning, oil spills, gas flaring, waste disposal and population growth (Adejo, Ibrahim and Onuche, 2010; Onumadu, 2012).

2.2.2 Perception

Perception is the process by which information or stimuli are received from the environment and transformed by psychological awareness (Van den Ban and Hawkins, 2000). According to De Joung (2010) perception of climate change refers to how people see and interpret their experiences of climate that lead to particular understanding. This includes their views on changes in climatic conditions and the impacts of these changes on their

environment. Rural peoples experience and interpretations, as well as scientific research, indicate that climate change seldom act in isolation, but interacts with other environmental and social factors (Jan and Anja, 2007). These interactions affect people's perception of change.

Scholars argue that individual perception of climate change is very important in shaping their adaptive responses including their understanding of and support for policies that aim to address the problem of climate change. Some policies responses indeed count on the active, behavioral involvement of individual for their success (Wolf and Moser, 2011). A growing body of research on climate change has accorded importance to peoples' perceptions on the phenomenon. This is because of the consensus amongst scholars that perceptions are an important factor that influences adoption of response measures such as adaptation. Smithers and Smit (2009) assert that environmental perceptions are among key elements influencing adoption of adaptation strategies. In this study perception therefore refers to how people perceive climate change as a result of their long term experiences with their biophysical as well as human environment.

2.2.3 Rural Communities

Rural areas are referred to as areas of open country and small settlements (IFAD, 2010). A rural settlement is a community where the inhabitants obtain their livelihood directly from the land (Bob-Duru, 2007). Rural areas, even after significant demographic shifts, still account for 3.3 billion people, or almost half (47.9%) of the world's total population (UN DESA Population Division, 2013). The overwhelming majority of the world's rural population (3.1 billion people, or 91.7% of the world's rural population, or 44.0% of the world's total population) live in less developed or least developed countries (UN DESA Population Division, 2013). Rural dwellers also account for about 70% of the

developing world's poor people. IFAD (2010) states that around 70% of the extreme poor in developing countries lived in rural areas in 2005. Ravallion *et al.* (2007), using 2002 data and poverty lines of US\$1.08 or US\$2.15, in each case with urban poverty lines adjusted upward to recognize additional non-food spending, give a figure of around 75% of people, under either poverty line, being rural. Rural areas are a spatial category, associated with certain patterns of human activity, but with those associations being subject to continuous change. Rural areas are largely defined in contradistinction to urban areas, but that distinction is increasingly seen as problematic. Rural populations have, and will have, a variety of income sources and occupations, within which agriculture and the exploitation of natural resources have privileged, but not necessarily predominant, positions.

According to Okafor (2007), up to 70% of the population of Nigeria is rural. They are noted for their role as producers of agricultural commodities. A rural area or community therefore refers to areas with low population density in which a large number of the inhabitants are relatively homogenous in their values attitudes and behavior and depend on their natural resources for their livelihood (Abaje and Giwa, 2010). Yusuf and Ukoje (2010) states that three types of criteria define rural community or settlement (1) The number of inhabitants in the community; (2). The ratio of people to open land; (3). The type of economic activities such as; agriculture fishing hunting and mining.

Different researchers also have defined rural areas based on the point of views of their discipline. For instance the sociologist sees rural area as social organization with emphasis on the ways of life of rural inhabitants. Demographers on the other hand emphasizes on population size as criteria for defining rural area similarly economist tend to emphasize on functional characteristics while geographers give more emphasis on the density of population (Okafor, 2007). In Nigeria as well as in some African countries low population density,

dependence on agriculture, as source of livelihood and poor infrastructural services are criteria for identifying rural communities (Yusuf and Ukoje, 2010).

2.2.4 Vulnerability

The Intergovernmental Panel on Climate Change, IPCC, (2007) defined vulnerability as the degree, to which a system is susceptible to, and unable to cope with, adverse effects of climate change including climate variability and extremes. Vulnerability 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. Fusel (2007), Kaspersen, Tunner, Hsiesh & Schiller (2010). The effect that an event may have on humans referred to as social vulnerability and, the risk that such an event may happen referred to as (exposure). Institutional stability and strength of public infrastructure (adaptive capacity) are crucial factors which determine extent of vulnerability (Ellis, 2000; Kurukulasuriya et al., 2006). A well-connected population with appropriate public infrastructure will be able to deal with a hazard effectively and reduce vulnerability. Such a society is said to have low social vulnerability. In an absence of institutional capacity in terms of knowledge about the event and ability to deal with it, then such high vulnerability is likely to ensure that biophysical risk turns into an impact on the human population.

In view of various conceptual renderings, the exposure, sensitivity and adaptive capacity of a system have been identified as the components of vulnerability. *Exposure* can be interpreted as the direct danger (the stressor), and the nature and extent of changes to a region's climate variables such as temperature, rainfall, extreme weather events. It reflects factors external to the system of interest such as changes in climate variability including extreme weather events or the rate of shifts in mean climate conditions (IPCC, 2007). *Sensitivity* describes the human–environmental conditions that can worsen the hazard,

ameliorate the hazard, or trigger an impact. It is given by the degree to which a system is modified or affected by an internal or external disturbance or set of disturbances (Gallop, 2003).

The poor have particularly limited access to such resources, hence are most vulnerable to negative impacts of climate change and least able to develop viable adaptation strategies. Consequently, different socioeconomic and biophysical indicators are classified into adaptive capacity, sensitivity, and exposure based on the IPCC definition of vulnerability. Vulnerability assessment is such a possible criterion for allocating resources for adaptation funding. Vulnerability indicators have been developed to assist policy makers and relevant stakeholders evaluate the need for new innovative technologies by assessing their current livelihood vulnerability in absence of adaptation International Crop Research Institute for Semi-Arid Tropics, (ICRISAT, 2010). A high vulnerability index indicates a greater susceptibility to extreme climate risk events. Vulnerability indicators (includes; food, water, health, landuse, habitat, hazard/risk) also serves as simple approach to support climate protection planning processes and help identify regions where development, donor funds and support aids should be more directed (ICRISAT, 2010).

2.2.5 Adaptation and Mitigation

Adaptation to the impact of climate change has been defined as the process through which people reduce the adverse effect of climate on their health and well-being, take advantage of the opportunity that their climatic environments provides (Smith., Burton., Klein, and Wandel, 2000) IPCC (2007), Dixon, Smith and Guill (2003). Adaptation to climate change is a process in which the people historically adapt to climatic stimuli in a dynamic environment (Füssel, 2007). In defining adaptation, two major schools of thought can be distinguished. The first sees adaptation as adjustment to reduce the negative impact of change. For instance, Smit & Wandel (2006) argue that “adaptation in the context of human

dimensions of global change usually refers to a process, action or outcome in a system (household, community, group, sector, region, country) in order for the system to better cope with, manage or adjust to some changing condition, stress, hazard, risk or opportunity". The second school refers to both the negative impact and opportunities in the term of adaptation. For example, Adger, Arnell and Tomkins (2005) claim that adaptation as an adjustment in ecological, social or economic systems in response to observed or expected changes in climatic stimuli and their effects and impact in order to alleviate adverse impact of change or take advantage of new opportunities. In addition to the term "adaptation", "coping" is also used to characterize responses of human in confronting with climate change impacts. The adaptation strategies undertaken by people differ considerably. These specific adaptation practices rely on a number of factors such as: social and economic endowments, ecological location, social network, institutional relationship, and access to resources (Agrawal, 2008). Each type of adaptation practice has its own characteristics. Nevertheless, there have been many efforts to categorize different adaptation strategies, in particular to be used as knowledge for the development of policy and planning.

According to USAID (2007), however, climate change produces globally both risks and opportunities. Moreover, according to Mendelsohn (2000), the forms of adaptation to climate change can represent both that of reducing damages and of taking advantage. Failure is an indispensable part of this process. The increase of damage from climate events in many areas proves that adaptation is not always effective, which eventually leads to maladaptive options. Maladaptation has been used to depict the extent to which adaptation fails (Klein & Maciver, 1999). Maladaptation includes avoidant reactions (denial of the threat, wishful thinking, and fatalism) and wrong adaptations that unintentionally increase the damage done through climate change (Grothmann & Patt, 2005).

Mitigation strategies on the other hand are procedures or activities that help prevent or minimize the process of climate change adaptation (Nyong *et al.*, 2007). Mitigation strategies can be grouped into two categories: those that represent mainly technological solutions; and those that involve changes in economic structure, societal organization, or individual behavior. African peoples employ mitigation strategies traditionally in form of natural resources conservation measures, but they generally serve the dual purposes of reducing the emission of GHG from anthropogenic sources, and enhancing carbon sink. Strategies aimed at reducing GHG emission emphasize cutbacks in the burning of fossil fuel through improved energy-efficiency, use of clean energy sources particularly solar and discontinuation of gas flaring. Carbon sink enhancement generally involves forestry programs that protect the forest and encourage afforestation in marginal areas including range lands (Adesina *et al.*, 1999). Ozor and Nnaji (2010) states that while mitigation is necessary to reduce the rate and magnitude of climate change, adaptation to the anticipated climate change is essential to reduce the damages from climate change that cannot be avoided. Therefore, adaptation is considered an important response option or strategy, along with mitigation (Kane and Shrogen 2000)

2.2.6 Adaptive Capacity

IPCC (2007) had noted that 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. Adaptive capacity is the ability to recover from shock, or the ability of communities and individuals to adjust to change, to take advantage of opportunities, or to cope with the consequences (Smith et al 2001). Successful adaptation depends critically on the capacity of human ability or system to adapt to stimuli. In order to depict this capacity, scholars use the term “adaptive capacity”. Adaptive capacity is the potential or ability of a system, region, or community to adapt to the

effects or impacts of climate change” (Smit, *et al*, 2001). According to Adger, *et al* (2004) the capacity of the community to adapt to climate change is a function of their access to resources; and the adaptive capacity of the community is a reflective of the resources and processes of the region which depends on the ability of the community to act collectively in the face of the threat posed by climate change (Adger, *et al* 2004). In this study adaptive capacity is therefore referred to a rural community’s ability to make adjustment in order to reduce climate change damages, take advantage of the opportunities, and cope with change.

2.2.7 Livelihood

Livelihood *is* defined as the means by which households obtain and maintain access to the resources necessary to ensure their immediate and long-term survival. These essential resources can be natural, physical, financial, social, human and political. Households use these assets to increase their ability to withstand shocks and to manage risks that threaten their wellbeing” (USAID, 2005). According to Department of International Development (DFID, 2000) a livelihood comprises the capabilities, assets and activities required for a means of living. The fact is also made explicit in (Scoones, 2009;) that they depend on access to natural, human, physical, financial, social, and cultural capital (assets); the social relations people draw upon to combine, transform, comprises and expand their assets; and the ways people deploy and enhance their capabilities to act and make lives meaningful. Livelihoods are dynamic and people adapt and change their livelihoods with internal and external stressors. Ultimately, successful livelihoods transform assets into income, dignity, and agency, to improve living conditions; a prerequisite for poverty alleviation (DFID, 2000).

Livelihoods are universal. Poor and rich people both pursue livelihoods to make a living. However, the adverse impacts of weather events and climate increasingly threaten and erode basic needs, capabilities, and rights, particularly among poor and disenfranchised people, (Adger 2010, Olson *et al* 2014). Some livelihoods are directly climate-sensitive, such

as rainfed smallholder agriculture, seasonal employment in agriculture (e.g. tea, coffee, and sugar), fishing, pastoralism, and tourism. Climate change also affects households dependent on informal livelihoods or wage labour in poor urban settlements, directly through unsafe settlement structures or indirectly through rises in food prices or migration. Better infrastructure and technology as well as diversification of assets, activities, and social support capabilities can boost livelihoods, spreading risks and broadening opportunities (Clot and Carter, 2009; Carr, 2013).

The sustainable livelihoods framework is widely used for identifying how specific strategies may lead to cycles of livelihood improvements or critical thresholds beyond which certain livelihoods are no longer sustainable (Sabates-Wheeler *et al.*, 2008). It emerged as a reaction to the predominantly structural views of poverty and “underdevelopment” in the 1970s and became adopted by many researchers and development agencies (Ellis and Biggs, 2001). With the neoliberal turn in the late 1980s, the livelihoods approach became associated with a more individualistic development agenda, stressing various forms of capital (Scoones, 2009). Consequently, it has been criticized for its analytical limitations, such as measuring capitals or assets, especially social capital, and for not sufficiently explaining wider structural processes (e.g., policies) and ecological impacts of livelihood decisions (Small, 2007; Scoones, 2009). An overemphasis on capitals also eclipses power dynamics and the position of households in class, race, and other dimensions of inequality (Van Dijk, 2011).

Climatic and other stressors affect livelihoods at different scales: spatial (e.g., village, nation) or temporal (e.g., annual, multi-annual). Both direct and indirect impacts are often amplified or weakened at different levels. Global or regional processes generate a variety of stressors, typically mediated by cross-level institutions, that result in locally experienced shocks (Reid and Vogel, 2006; Paavola, 2008; Pouliotte Smith & Westerhoff, 2009) Multiple stressors, simultaneous and in sequence, shape livelihood dynamics in distinct ways due to

inequalities and differential vulnerabilities between and within households. More affluent households may be able to capitalize on shocks and crises while poorer households with fewer options are forced to erode their assets. Limited ability to adapt and some coping strategies may result in adverse consequences. Such maladaptive actions undermine the long-term sustainability of livelihoods, resulting in downward trajectories, poverty traps, and exacerbated inequalities (Tanner and Mitchell, 2008; Barnett and O'Neill, 2010). Multiple stressors related to climate change, globalizations, and technological change interact with national and regional institutions to create shocks to place-based livelihoods (Reason, 2000).

There also now exists a well-developed body of work around the key concepts of vulnerability, resilience, and adaptation in the context of global environmental change (Janssen et al. 2006). This evidence suggest that climate change will stress existing livelihood options, and even more importantly, make them more unpredictable owing to increased volatility in climate impacts (Yohe and Tol 2002).The problem of increased volatility and risks owing to climate change is especially important. It means that many more vulnerable households can periodically be driven into destitution and hunger and find it difficult afterwards to recover (Barnett and O'Neill, 2010). This is because the incomes and livelihoods of poorer, more vulnerable households, by definition, are closer to the line separating an adequate subsistence from malnutrition and starvation. When variations in climate impacts and consequently in livelihoods increase, it is logically obvious that poorer households will more frequently face declines below subsistence levels. They will need to identify and rely on livelihoods sources that allow them therefore either to smooth consumption to survive through periods of scarcity, or to maintain livelihoods such that they do not dip below subsistence levels (Reason, 2000).

While several studies have been carried out on the impact of climate change on local livelihoods, there is very little dedicated literature to understanding the impact of climate

change on rural livelihood of communities; existing studies cannot be generalized to include the Zaria scenario due to several reasons. Firstly, livelihoods differ according to regions because they are ecologically dependent. Saarinen *et al.* (2012) argues that ‘Naturally, some regions and activities are more sensitive to climate change than others...’ Regional ecological variations mean that livelihood strategies and the impact of climate change on those strategies will differ. Secondly regional climatic variations also mean that the impact would be experienced differently in different regions. For example, it has been suggested that while sub-Saharan countries will bear the brunt of climate change, Arctic regions stand to gain positively from climate change with the warming of temperatures enabling longer periods for growing crops. This argument shows the need for local studies on the impact of climate change on local livelihoods.

2.3 LITERATURE REVIEW

2.3.1 Causes of climate change

Climate change is the long term change in regions weather events (UNEP, 2005). It has also been defined by the United Nations Framework Convention (UNFCCC) 2006, on climate change as a change of climate that is attributed directly or indirectly to human activity that alters the composition of global atmosphere and which in addition to natural variability is observed over a comparable time period. Climate change is attracting global concern as a result of its perceived threats to the earth, environment and humanity. According to Aluko *et al* (2008), climate changes over any particular place on the globe are caused by a host of interacting natural and man-made factors such as solar output, earth-sun geometry and interstellar dust all of which are extra-terrestrial in nature. However, internal factors, many of which are open to the influence of man include the land systems (comprising the latitudes, elevation, topography and vegetation), the atmosphere comprising its composition and prevailing winds and the oceans along with their associated currents. Over the past 30 years,

researchers have gathered evidence to show that the major change in climate is due to greenhouse gas emissions GHG (Akinbami et al, 2003).

Greenhouse gases are groups of naturally occurring gases that can trap heat near the earth's surface (Phillip & William, 2004). The major greenhouse gases are water vapor which causes 36 – 70% of the greenhouse effect, carbon dioxide (CO^2) which causes 9 – 26%, Methane (CH^4) which causes 4 – 9% and Ozone which causes 3 – 7% as well as a number of man-made ones such as sulphur hexafluoride (SF^6), fluorocarbons and hydro fluorocarbons (HFCs) (Phillip & William, 2004)

In Nigeria, climate change has been attributed to the oil and gas sector, especially in the Niger-Delta and offshore as a result of gas flaring, deforestation through tree cutting, firewood and expanding slash and burn agriculture as well as developmental projects (Pelemo & Olatoye, 2008). Other areas that contributed to climate change are exhaust from cars and trucks, generators and some similar exhaustive machines. Deforestation and land clearing activities emit about 1.7billion metric tons of carbon per year into the atmosphere (CBD, 2007). Also, about 266 million kg of firewood is consumed daily (The Guardian 2008). According to Steinfeld et al (2006), livestock is responsible for 18% of the world's greenhouse gas emission as measured in CO^2 equivalentents. This includes land use change, through deforestation so as to create grazing land. In addition to CO^2 emissions, livestock produces 65% of human – induced nitrous oxide (which has 23 times the global warming potential of CO^2 and 37% of human induced methane).

These activities lead to an increase in the carbon content in the atmosphere. Thus, accumulation of CO^2 alongside other trace gases such as methane and nitrous oxide also enhances the greenhouse gases effects and climate change. Research findings of the Intergovernmental panel on climate change (IPCC) confirmed that human activities are warming the earth and causing climate change.

Climate change is caused by both man and by nature. According to the summary of the intergovernmental panel on climate change (IPCC) fourth assessment report (IPCC, 2007), human actions are very likely the cause of global warming; meaning a 90% or greater probability is attributable to human actions. A comprehensive assessment by the IPCC of the scientific evidence suggests that human activities are contributing to climate change, and that there has been a discernable human influence on global climate. Climate changes by human activities, most importantly the burning of fossil fuel (coal, oil, and natural gas) and deforestation, are superimposed on and to some extent masked by natural climate fluctuations (Buba, 2004).

Climate change and global warming are caused by the build-up of greenhouse gasses (GHGs) such as carbon dioxide, nitro oxide, chlorofluorocarbons (CFCs) and methane in the atmosphere, as a result of human activities among them, the burning of fossil fuels, bush burning, use of machines that produce smoke, cooking etc. The planet (earth) is surrounded by atmosphere containing gasses that regulate temperature (Buba 2004; Odjugo, 2007; IPCC 2007 Odugbo 2010; Porbeni, 2004 Scott 2010 De Weerd 2007 and Jamila et al, 2009).

Various activities carried out by man have varying contributions to changes in the climate systems. The burning of coals oil and natural gas as well as deforestation and various agriculture and industrial practices are altering the composition of the atmosphere and contributing to climate change. These human activities have led to increased atmospheric concentrations of a number of greenhouse gasses. According to De Chavez and Tauli-Corpus (2008) GHGs are chemical compounds such as water vapor carbon dioxide, methane and nitro oxide found in atmosphere. These gasses are able to absorb and radiate heat. Many greenhouse gases occur naturally such as water vapor, carbon dioxide (CO₂) methane (CH₄), ozone (O₃) and Nitrous oxide. Other such as hydro fluorocarbon (HFCs) per fluorocarbon (PFC) results exclusively from human industrial processes. All of these gasses are responsible for the greenhouse effect, but water vapor and CO₂ contribute 90% of the total GHG emissions. In terms of direct contribution of these greenhouse gasses, CO₂ contributes 55% methane 15% CFCs 7% and CFCs (11 and 12) 175 and NO₂ 6%.

Carbon dioxide is produced when coal oil and natural gas (fossil fuels) are burnt to produce energy used for transportation manufacturing heating cooling electricity generation and other applications. Fossil fuel currently accounts for 80 to 85% of carbon dioxide being added to the atmosphere. Clearing land for logging ranching and agriculture also leads to carbon dioxide emissions. Land use changes are responsible for 15 to 20% of current carbon dioxide emissions. Methane natural gas is the second most abundant gasses that are found on the earth atmosphere resulting from human activities. It is produced by rice cultivation, cattle and sheep ranch and by decaying materials in landfills. Methane is also emitted during coal mining and oil drilling and by leaky gas pipeline

Nitro oxide is produced by various agricultural and industrial practices (<http://climate.jpl.nasa.gov/causes>). Chlorofluorocarbons (CFCs) have been used in refrigerators, air conditioning, and solvents. Ozone in the lower part of the atmosphere is another important greenhouse gas resulting from industrial activities. It is created naturally and also by reactions in the atmosphere involving gasses resulting from human activities, including nitrogen oxides from motor vehicles and power plants (De Chavez and Tauli-Corpus, 2008). On the other hand the following are natural causes of climate change; Among the natural causes of climate change, continental drift, volcanic eruptions and ocean current are outstanding. [These are examined;

Comment [b4]: delete

The continent were formed when the land mass began gradually drifting apart, millions of years back. It is noticeable that South America and Africa on the map of the world fit each other like pieces in jigsaw puzzle? About 200 million years they were joined together. Scientist believed that back the earth was not as it is today but the continent was all part of one large mass (Coney, 2009). This drift has an impact on climate change because it changed the physical features of the land mass, their position and the position of water bodies. The separation of the land mass changed the flow of the ocean currents and winds which affected the climate (Ayoade, 2003).

When a volcano erupts, it throws out large volume of sulphur dioxide (SO₂) water vapour dust and ashes into atmosphere. Although the volcanic activity may last only few days yet the large volume of gasses and ashe can influence climatic patterns for years. Millions of tons of sulphur dioxide gas can reach the upper level of atmosphere (called the stratosphere) from major eruption. The gas and dust particles partially block the incoming rays of the sun leading to cooling. Sulphur dioxide combines with water to form tiny droplets of sulfuric acid. These droplets are so small that many of them can stay aloft for several years. They are sufficient reflectors of sunlight, and screen the ground from some energy that it would ordinarily receive from the sun. This may eventually affect the climatic system of an area.

The earth makes one full orbit around the sun each year. It is tilted at an angle of 23.5° to the perpendicular plane of its orbital path. For one half of the year when it is summer, the northern hemisphere tilts towards the sun. In other half when it is winter, the earth tilts away from the sun. If there was no tilt there would not have been season. Changes in the tilt of the earth can affect severity of the seasons as more tilts means warmer summers and cold winters, less tilt means cooler summers and milder winters (Coney, 2009). The earth's orbit is somewhat elliptical, which means that the distance earth and the sun vary across the year. People usually think of the earth's axis as being fixed, after all, it always seems to point towards polaris (Pole Star and North Star). Actually it is not quite constant: the axis does move, at the rate of a little more than half-degree each century. So Polaris has not always been, and will not always be, the star pointing to the North. This gradual change in the direction of the earth's axis called precession is responsible for changes in the climate (De Chavez and Tauli-Corpus, 2008).

The oceans are major components of the climate system. They cover about 71% of the earth and absorb about twice as much of the suns radiation as the atmosphere or the land surface. Ocean current moves vast amount of heat across the planet –roughly the same amount as the atmosphere does. But the oceans are surrounded by landmass, so heat transport through the water is through channels. Oceans current have been known to change direction or slow down. Much of

the heat that escapes the ocean is in the form of water vapor, the most abundant greenhouse gas of the earth. Yet water vapor also contributes to the formation of clouds which shades the surface and has net cooling effects (NASA, 2012). Climate is basically defined in terms of 30 year means, and higher-order moments about those means. Climate can also be defined as the statistical description in terms of the mean and variability of meteorological variables such temperature, rainfall and wind over a period of time spanning from months to thousands or millions of years, but the classical period is 30 years, as defined by the World Meteorological Organization (WMO, 2017). Hengeveld et al (2005) provided criteria that can be applied to study evidence of climate change in a region. These includes: upward in temperature, rising evaporation, reduction in the quantity of rainfall in the continental interiors, rising rainfall in the coastal region, increasing changes in climate patterns and increasing rate and severity of extreme weather related events such as thunderstorms, lightning, floods, landslides, drought, unpredictable rainfall pattern, sea level rise, increase desertification and land degradation, evaporation, loss of forest cover and biological species which have been confirmed to exist in Nigeria. Moreover, the additional proof of climate change in Nigeria is the rise in rainfall quantity in the coastal areas since the 1970s, and a continuous decrease in precipitation amount and length in the continental interiors of the semiarid region of Nigeria. The rise in precipitation in the coastal areas could be the major cause of floods affecting the coastal cities of Warri, Lagos, Port Harcourt and Calabar as observed by Ogundebi, 2004; Ikhile, 2007; Nwafor, 2007; Umoh, 2007; Odjugo, 2010. Moreover, Odjugo (2005; 2007) also found that the number of rainy days has reduced by 53% in northeastern Nigeria and 14% in the Niger Delta coastal areas. These two changes in climate pattern are proof for the existence of changing climate in Nigeria.

2.3.2 Impacts of Climate Change

There is now significant scientific consensus about the significant adverse impacts of climate change on agricultural, food, water, social, and ecological systems (IPCC 2007a,

2007b). The IPCC Third Assessment Report, which assesses climate research up to 2001, concludes that global average temperature has increased by 0.6°C over the 20th century and is predicted to increase by 5.8°C between 1990 and 2100; and average precipitation has increased over tropical latitudes by about 2 to 3% throughout the 20th century, and on average has decreased by about 3% in the sub-tropics. These changes are leading to environmental impacts, such as global average sea level rise of 10 to 20cm over the last 100 years (expected to rise a further 10 to 90cm by 2100), and an increase in frequency and intensity of drought in parts of Asia and Africa in recent decades. The impacts of climate change are already being experienced across the globe. Climate change has even been described as a new security threat for Africa (Brown et al., 2008). While climate change will affect everyone; it is expected to have a disproportionate effect on those already suffering from poverty mostly in developing countries.

In Pakistan, the 2010 floods were described as the worst in the country's history, affecting about 20 million people. At the other extreme, Russia was locked in the worst heat wave and drought in its documented history, with hundreds of wildfires burning out of control, destroying a quarter of Russia's crops and prompting a ban in grain exports. Within the sub-Saharan region, Nigeria has to contend with the various environmental problems, particularly the encroaching desert from the north and coastal inundation (due to rising sea level) from the south (Okhumanhe, 2009). Drought induced famine and locusts and an increase in the number of extreme heat days affected Niger and northern Nigeria. These recent events highlight just how vulnerable we could be in the future with more frequent and severe weather events (Odjugo, 2010; FRN, 2010; BNRCC, 2011). Extreme heat events have become more frequent in the past four decades and this trend is continuous in Nigeria and world over which affects millions of people (IPCC, 2007). For example in 2010, Nigeria and many other parts of the world experienced devastating floods (BNRCC, 2011). Nigeria like many parts of the

world has been beset by a lot of climatic anomalies with serious consequences on the society (Odjugo, 2011).

These anomalies and their consequences are of great concern to the Nigerian people and have created considerable awareness and demonstrated the sensitivity of human welfare and nations socio economic planning and development to climatic events (Imo and Jackson, 2011). Eleven out of the thirty six states in the country referred to as the ‘frontline states’ are gradually being swallowed up by desertification, while sea level rise is slowly eating- away the eight coastal states (Okhumanhe, 2009; Abdulkarim, Balarabe and Oladipo, 2015). These are states where the impact of climate change is expected to be severe because it will exacerbate the existing environmental degradation. By 1985, deforestation claimed 1,544km of the nation’s forest land. Between 1983 and 1993 alone, Nigeria lost 20% of its forest and woodland areas (Okhumanhe, 2009).

In northern Nigeria, especially the sudano-sahelian region, where desertification is a key environmental problem, drought have been recurring for the past three decades thereby affecting food security and increasing cardio-respiratory health issues resulting from the increasing dust pollution (Eke and Onafalujo, 2011; Farauta, 2011). During the environmental summit that was held in 2008, the former late president Umaru Musa Yar’adua announced that the countrys annual losses stemming from environmental degradation (combating land degradation, deforestation, drought and desertification, loss of biodiversity, flooding, erosion, urban decay and municipal waste disposal and the adverse effect of climate change) adds up to approximately US\$5.1billion (Okhumanhe, 2009).

Consequences of extreme climatic events due to global warming have been so dramatic that there has been considerable and disturbing concern among the various government and people of the country Nigerian First National Communication (NEST) 2004; IPCC, 2007, Eke and Onafalujo, 2010). In particular with the variations and changes in climate since the

late 1960s and early 1970s, a lot of impacts have manifested on various environmental processes and human activities in various part of the country (Okeke, 2007; Oyetade, 2007; Abaje, Sawa and Ati, 2014). Evidence are bound that global mean surface increase in temperature has increased by about 0.3⁰C to 0.6⁰C since the 9th century (Odjugo, 2007; IPCC, 2007). Recent years, particularly since 1950s have been among the warmest since 1860 while evidence of warming at the regional level have been found in many parts of the world. Also significant is the rise in sea level by between 10 and 25cm over the past 100 years, and much of the rise may be related to the increase in global mean temperature NASA, 2012)

Available evidence shows that climate change will be global, likewise its impacts, but the biting effects will be felt more by the developing countries, especially those in Africa, due to their low level of coping capabilities (Nwafor, 2007; Jatap, 2007, Odjugo, 2010). Nigeria is one of the developing countries. Researchers have shown that Nigeria is already being plagued with diverse ecological problems, which have been directly linked to the ongoing climate change (Odugo, 2001; 2005; Odjugo, Odjugo, 2010). In more specific terms the Nigeria's first National Communication (NFNC, 2003, BNRCC, 2011) and other relevant reports (Federal republic of Nigeria (FRN), 2010; West Africa Research and Innovation Management (WARIMA), 2010). Nigeria's key vulnerability factors include the following.

- a) heavy dependence of the economy, and of individuals livelihoods on rain-fed agriculture that is highly susceptible to fluctuations in rainfall and water supply
- b) Exposure of northern Nigeria to accelerated desertification linked to increasing drought, with resulting impacts on local population and natural resource base.
- c) Exposure of the Nation's 850km coastline to the threats of accelerated sea level rise and an increased storm risk, which could impact communication,

infrastructure, coast oil installations, epidemic species of flora and fauna and spawning grounds for fish.

- d) Sensitivity of other sectors of the economy to climate variability (e.g Nigerias electrical supply is heavy dependent on hydropower which is affected by fluctuations in rainfall).
- e) The pressure of dramatic population growth in Nigeria, which reduces resilience to a range of climatic risk.
- f) A lack of defined policies, low political will, and limited financial resources to address the need for early action on climate change.
- g) Limited organizational and technical capacity to respond

These vulnerabilities make clear the urgent need to address the challenges of climate change in a comprehensive and systematic manner. The cost of inaction is enormous (WARIMA, 2010).

Climatic projections suggest that prolonged and more intense droughts are likely to cause the continent to become drier (Boko et al., 2007). Increasing mean annual temperatures will increase evapotranspiration losses resulting in a reduction in soil moisture content. Many of these changes have already led to multiple socio-economic manifestations such as changes in rainfall patterns, frequency and severity of drought flood, storms, sea level rise, and glacial melt. (IPCC, 2001).

Globally, climate change impacts are more severely felt by marginalized and resource challenged communities (Mwangi, 2012). The united nations report of 2010 MDGs highlighted some of the challenges facing the world in addressing the first goal-eradicating poverty and hunger the poverty target of having the proportion of people whose income is less than one dollar (1\$) a day between 1990 and 2015 is likely to be achieved, although some countries will meet the target (United Nations 2010; Nelson et al, 2010).

In Nigeria the MDGs 2013 report also stated that the eradication of extreme poverty and hunger is likely to be attained by 2015 (FRN, 2013). According to Thornton and Lipper (2014) climate change has serious consequences on agriculture in Nigeria, thereby affecting socioeconomic activities, environment and livelihood patterns of farmers in particular and Nigerians in general. Rainfall, being the most critical aspect of climate changes in Nigeria, has its amount and patterns affected by climate change (Adejuwon, 2004). This manifests in form of late onset of rain, late establishment, dry spells, excessively heavy downpours and untimely cessation. Huge spatial and temporal variations in rainfall result in flooding, drought, delayed wet season and erratic rainfall. Areas with hitherto optimum temperature experience excessive temperatures, while areas with high temperatures are further characterized by higher and unbearably excessive temperatures (Awotodunbo, 2012). Pests and diseases incidences and severity, competition for resources and biodiversity loss also increase due to climate change. All these and many other manifestations of climate change negatively affect crops, livestock and the farmer. Socioeconomically, impacts of climate change include decreasing crop and livestock yield, decreasing soil fertility and productivity, declining prices and fluctuating prices and diminishing gross domestic product (GDP) from agriculture.

Far reaching consequences of the phenomena above include food crises, worsening poverty, unemployment, social strife and unrest among others (Awotodunbo, 2012; Mwangi, 2012; and Onwualu and Ogunwusi, 2012). The trend of food insecurity in Nigeria is worrisome. The proportion of food insecure in Nigeria people was reported to be about 18% in 1996, over 40% in 2005 and over 65% in 2008 (Busayo, 2011; Mohammed, 2008). The United Nations (2007) define food security as “People having at all times, physical, social and economic access to sufficient, safe and nutritious food which meets their dietary needs and food preferences for an active and healthy life”. Hence, food security knows whether

they have “enough” or not (CARE / WFP, 2003). It encompasses availability, accessibility, consumer safety and preferences and biological utilization and stability of all the factors. Clearly, food security is about much more than just how much people have to eat. Yet, having “enough” food to eat is clearly the most important outcome of being food secure, and while physiological requirements differ, people largely. All these may be impacted by climate change.

IPCC (2007) report opines that deviations or rapid changes in climate will greatly impact forest distribution. Climate change is predicted to be largest at middle and high latitudes, the impacts of climate change in the tropics will also be significant and alter both the function and distribution of forest types. With regard to the degree of climate change and the sensitivity of forests, such changes will significantly impact upon biodiversity and on a variety of ecosystem services in terms of regional carbon balance, nutrient sequestration, water quality and crop yield. Boko et’ al. (2007) projected that climate change will reduce net crop revenues by 90% by 2100. This is likely to exacerbate poverty and underdevelopment in many countries (Sissoko et’ al., 2011) and lead to significant migration both within countries and internationally.

New evidence with respect to micro-climate change due to land-use changes such as swamp reclamation and deforestation suggest an increase spread of malaria to new areas (IPCC, 2007). Direct impacts include health problems induced by increasing incidences of heat waves. These could lead to more cases of cerebra-spinal meningitis (CSM), which today is found to correlate positively with the highest maximum temperature of the northern winter season, and inversely with absolute humidity to a lesser, although still significant, extent. The dryness has led to dry waterbeds and movement of people and their pasture to the southern regions thus causing tension and conflicts between the original inhabitants and the new comers.

2.3.3 Adaptation and Mitigation to Climate Change

Responses to climate change have been grouped into two main categories: *mitigation* which focuses on addressing causes and *adaptation* which addresses effects. Mitigation and adaptation are the two fundamental responses to the risk posed by climate change. The capacity to mitigate and adapt is dependent on socio-economic and environmental circumstances, and the availability of information (IPCC, 2007).

2.3.3.1 Mitigation to Climate Change

Mitigation strategies are procedures or activities that help prevent or minimize the process climate change. Mitigation strategies can group into two categories: technological solution and others involve changes in economic structure, societal organization, or individual behavior (Swart, Robinson and Cohen, 2003). Mitigation activities especially in Africa are traditionally employed as a natural resources conservation measures but they generally serve the dual purposes of reducing the emissions of GHGs from anthropogenic sources, and enhancing carbon sink''. Strategies aimed at reducing GHGs emission emphasize cutbacks in the burning of fossil fuel through improve energy efficiency, us of clean energy sources particularly solar and discontinuation of gas faring, carbon sink enhancement generally involves forestry programs that protect the forest and encourage afforestation in marginal areas including range lands (Fusel and Klein, 2006; Nyong, Adeshina and Elisha, 2007).

Mitigation presently focuses on measures to be taken to reduce the CO₂ levels due to emissions from fuel combustion and other human activities. Hence, mitigation through carbon sequestration is being advocated. Carbon sequestration is a natural or artificial process whereby carbon is absorbed by trees to reduce its hazardous effects on the environment. Forest and oceans are known to act as sinks for carbon dioxide. Trees act as a kind environmental 'buffer' for ecosystem they dominate. They help ameliorate the extremes of climate (heat, cold and wind) and create an environment where large land mammals including

people can live comfortably. Most means of mitigation appear effective only for preventing further warming, not at reversing existing warming.

Mitigation of climate change is of great concern because, if global warming is not minimized, it could lead to large-scale impairment in food supply in the future that the globe would be incapable of controlling it. Similarly, agricultural sector play role in releasing emissions and also a good contributor to emission reductions and carbon sequestration (FAO, 2008). Setting the international mitigation targets has been carried out by signing the Kyoto Protocol in 1997. The protocol compelled that by the period from 2008 to 2012, developed countries and economics in transition are engaged to decrease their GHG emissions by about 5% compared to their 1990 levels (Bruin, 2011). The Stern Review identifies several ways of mitigating climate change. These include reducing demand for emissions-intensive goods and services, increasing efficiency gains, increasing use and development of low-carbon technologies, and reducing fossil fuel emissions (Stern, 2006).

2.3.3.2 Adaptation to Climate Change

Many definition of the term adaption abound in literature, but perhaps the most quoted is that provided by the IPCC, third assessment report, which defined adaptation as ecological, social or economic systems in response to actual or expected stimuli and their effects or impacts. This term refers to changes in processes, practices or structures to moderate or offset potential damages or to take advantages of opportunities associated with changes in climate (IPCC, 2001). Understanding expected adaptations is essential to impact and vulnerability assessment and hence is fundamental to estimating the cost or risks of climate change (Pittock and Jones, 2000; Yohe and Strzepek, 2007). In other words even the most effective reductions in emissions, however, would not prevent further climate change impacts, making the need for adaptation unavoidable. Article 2 of the United Nations Framework Convention on Climate Change (UNFCCC) refers to “dangerous” human influences on climate change in terms of

whether they would “allow ecosystem to adapt, ensure food production is not threatened and enable economic development to proceed in a sustainable manner”.

Adaptation to climate change is therefore the process through which people reduce the negative effects of climate on their health and wellbeing and adjust their lifestyles to the new situation around them. In a nutshell adaptation is being better prepared or adapting to climate change, not fighting it, but learning to live with it. Climate change adaptation is especially important in developing countries since those countries are predicted to bear the brunt of the effects of climate change. That is, the capacity and potential for humans to adapt is unevenly distributed across different regions and populations, and developing countries generally have less capacity to adapt. Adaptive capacity is closely linked to social and economic development (IPCC, 2007). The economic costs of adaptation to climate change are likely to cost billions of dollars annually for the next several decades. As the potential significance of the resulting changes and the links with human causes have become clearer, demands for assistance for the most vulnerable/least resilient have become louder (Nelson et al, 2007) leading to adaptation moving up the agenda.

The main sectoral adaptation options and responses highlighted by developing countries to adapt to climate change in these different sectors are both reactive and anticipatory responses to climate change. Reactive responses are those which are implemented as a response to an already observed climate impact whereas anticipatory responses are those that aim to reduce exposure to future risks posed by climate change (UNFCCC, 2007). As shown by the national communications, the range of practices that can be used to adapt to climate change is diverse (NFNC, 2003). The effectiveness of a practice tends to depend on location and socio-economic situation, but that does not prevent practices from being shared, replicated and improved. Work on adaptation planning and practices has

highlighted a one way of grouping adaptation options is to identify whether they are sectorial, cross-sectorial or multi-sectorial.

Sectorial adaptation measures look at actions for individual sectors that could be affected by climate change. For example, in agriculture, reduced rainfall and higher evaporation may call for the extension of irrigation; and for coastal zones, sea level rise may necessitate improved coastal protection such as reforestation. Strengthening of the policy that already exists, emphasizing the importance of including long term climate change considerations along with existing local coping mechanisms and integrating them into national development plans. Multi-sectorial adaptation options relate to the management of natural resources which span sectors, for example, integrated management of water, river basins or coastal zones. Linking management measures for adaptation to climate change with management measures identified as necessary from the other Rio Conventions: the Convention on Biological Diversity and the United Nations Convention to Combat Desertification; could be a useful multi-sectorial approach which addresses a range of environmental stresses. Cross-sectorial measures also span several sectors and can include: improvements to systematic observation and communication systems; science, research and development and technological innovations such as the development of drought-resistant crop varieties or new technologies to combat saltwater intrusion; education and training to help build capacity among stakeholders; public awareness campaigns to improve stakeholder and public understanding on climate change and adaptation; strengthening or making changes in the fiscal sector such as new insurance options; and risk/disaster management measures such as emergency plans (UNFCCC, 2007). An example of a cross-sectorial adaptation project identifies the need for a forecasting and early warning system to provide seasonal forecasts for supporting agricultural production decisions and provide an early warning system and disaster management strategy for food security and emergency medicine to vulnerable

communities in the case of extreme events (Bhutan 2006). The previously overlooked interactions between mitigation and adaptation are also receiving greater attention, because of the potential synergies and trade-offs implied for policy decisions (IPCC, 2007).

2.3.4 Nigeria's Efforts towards Adaptation and Mitigation of Climate

The manifestation of climate change in Nigeria are evident in: excessive rain in eastern Nigeria resulting to gully erosion (Okeke, 2007); the north, advancement of the desert and drought (Ayoade, 2003; Abdulkarim, Balarabe and Abaje 2015) at the coastal regions, sea level is rising, threatening much settlement.

Nigeria has joined the League of Nations in their efforts towards mitigating climate change by ratifying the United Nations Framework Convention on Climate Change (UNFCCC) and the Kyoto protocol. The Federal Ministry of Environment was then given the responsibility for implementing the UNFCCC programs and Kyoto Protocol in the country. Within the Ministry a Special Climate Change Unit (SCCU) is presently created within the ministry to develop a short to long term national plan to enable Nigeria to respond to its obligation as specified by the UNFCCC and the Kyoto protocol to coordinate the activities of the Inter-Ministerial committee(IMCCC) on climate change (FRN, 2010).

Nigeria has also embarked on national environmental policy in 1989 in order to meet the challenges of addressing key environmental problems and land degradation (deforestation desertification and coastal and marine erosion) air and water pollution urban decay and municipal waste, as well as hazards of drought, floods and coastal surges. This policy was revised in 1999 to accommodate new and emerging environmental concerns. The goal of the revised policy was to achieve sustainable development in Nigeria and in particular to i) secure a quality of environment adequate for good health and wellbeing; ii) promote the sustainable use of natural resources; iii) restore and maintain the ecosystem and ecological

processes and preserve biodiversity; iv) raise public awareness and promote understanding of linkages between environment and development; and v) cooperate with government bodies and other countries including international organizations on environmental matters (FRN 2010b)

In addition also, Nigeria has resolved to provide positive incentives on issues relating to reducing emissions from deforestation and forest degradation. Nigeria recently received a boost by presidential directive which provides up to 60% of the national ecological funds for reforestation and afforestation programs (FRN, 2010). The federal government of Nigeria is setting an internal agenda to meet climate change challenges irrespective of how the negotiations at Copenhagen proceed (WARIMA, 2010). Whilst the process of developing internal mechanisms, programs and initiatives to deal with the devastating effect of climate change, like afforestation/reforestation efforts, integrated water management plans, and the promotion of alternative energy sources (FRN, 2010).

To date the government has put in place various policies and other socio-economic and political conditions to pave the way for international collaboration and corporation towards investment opportunities in the energy sector. Like other developing countries, Nigeria has not only evolved sound policies towards reduction of greenhouse gas emissions as part of its mitigation measures but has also embarked on the implementation of such policies. The country discovered that apart from polluting the environment, billions of naira is lost through flaring of petroleum associated gases. In an attempt to arrest the situation, the government has embarked on refining, piping, bottling and exporting refined gas products which could have been otherwise flared (FRN, 2010). The policy has therefore resulted in a win-to-win option for the environment and for the economic benefits of the country. The aim is to reach a zero flaring target, which is another laudable policy.

Another major policy goal of the government is to ensure sustainable use of our forest and also check desert encroachment. As such, the government has embarked on the elaboration of the national tropical forest action plan, launching extensive reforestation programs in the southern part of the country and afforestation programs in the northern part of the country. The programs include community-based tree planting programs, tighten the control of fuel wood stoves (FRN, 2010). Within the African context, Nigeria is involved in green-wall Sahara program of the African Union. The goal is not only to protect the sinks for carbon dioxide as one of the means of mitigating climate change, but also to safeguard its biological diversities and reverse the ecological status of the area to a more humane one (FRN, 2010)

To support national climate and mitigation response effort the country has also put in place specific policies and action plans such as;

National policy on drought and desertification; the policy recognize that climate change could intensify drought and desertification especially in the northern part of the country that are very prone to these environmental problems. The policy emphasize the need to equip relevant agencies, institutions and citizens adequately to collect, analyses and use climate data effectively to ameliorate and combat drought and desertification.

National forest policy: this policy is geared towards ensuring sustainable forest management, promoting participatory process of development, facilitating private sector – forestry development and adopting integrated approach to forestry development. Government is currently embarking on a number of afforestation programs such as “Green Wall Initiative” in which a “greenwall” of trees will be planted across the Sudano-Sahelian zone of the country.

National biodiversity strategy and action plan; this policy is to devep appropriate framework and program instrumrnts for the conservation of Nigeria’s biological diversity and to enhance

it sustainability by integrating biodiversity considerations in national planning policy and decision making processes.

National erosion and flood control policy; to ensure coordinated and systematic measures in the management and control of the climate related hazards and risk of erosion and floods to reduce their impact on the people and the environment.

Environmental laws and regulations: this serve as a means of inducing responsible attitudes and behavior towards the environment (Mogo, 2014). In addition to the national environmental policy, Nigeria has many laws and regulatory measures to promote sustainable environmental management in many sectors of the economy. This include;

-National Park Service Act- retained as CAP N65, LFN 2004: (for conservation and protection of natural resources(wildlife and plants) in national parks.

-Endangered Species (Control of International Trade Traffic) Act. Retained as CAP E9, LFN 2004: (conservation of wild life and protection of threatened endangered species).

-Land Use Act, 1978 (CAP 202, LFN 2004): the right of all Nigerians to use and enjoy land and the natural fruit thereof in sufficient quantity to enable them to provide for the sustenance of themselves and their families should be assured protected and preserved.

-Exclusive economic zone Act, CAP E11, LFN 2004: This act is to make it illegal to explore or exploit natural resources within the exclusive zone without lawful authority.

-Nuclear Safety and Radiation Protection Act, CAP N142, LFN 2000: concerned with the regulations of the use of radioactive substances and equipment emitting and generating ionizing radiation.

-Water Resource Act, CAP W₂, LFN 2004: the water resource at is targeted at developing and improving the quality and quantity of water resources.

Forest Law CAP 55, 1994: prohibit any act that may lead to the destruction of or cause injury to any forest produce, forest growth or forestry property in Nigeria.

River Basin Development Authority Act: CAP R9, LFN 2004: concerned with the development of water resources for domestic, industrial and other uses and the control of floods and erosion.

The National Adaptation Strategy and Plan of Action on Climate Change for Nigeria (NASPA-CAP) document that was prepared by BNRCC project (2011) also recommended policies, programs and measures at the Federal State and Local Government. The recommendations, when acted upon will increase the resilience of local communities and of Nigeria as a whole to the impacts of climate change.

CHAPTER THREE

STUDY AREA AND METHODOLOGY

3.1 INTRODUCTION

This chapter deals with the physiography of the study area on one hand which encompasses location, climate, geology, topography, drainage, soils, landuse, vegetation and population and it deals with the methodology of the study on the other hand.

3.2 THE STUDY AREA

3.2.1 Location and Extent

The study area is located between Latitudes 11°01'30"N and 11°12'00"N and Longitudes 7°36'00"E and 7°46'30"E (See Figure 3.1). The total area covered is about 2638.20Km² with an altitude of about 762 metres above sea level (Ogunleye, 2006). Zaria lies in the Northern part of Kaduna State. It is a historical, ancient and traditional centre of the north with its administrative capital situated at Birnin Zazzau (Zaria City). It remains a strategic political centre of the north with authority vested solely in hands of the Emir of Zazzau) (Mortimore, 1970).

Essentially, Zaria metropolis comprises two Local Government Area (LGA), namely, Zaria and Sabon-Gari LGAs. The study area is bounded to the south by Igabi LGA, to the north by Kudan LGA, to the east Soba LGA and to the west Giwa LGA. Zaria is 156km south-west of Kano, 84km north-east of Kaduna. Zaria is about 698km north of the Atlantic Ocean. Zaria is the second largest city in Kaduna covering a total landmass of about 61km² making it a nodal point in terms of road and rail transport because of location factors (Jatau, 1999).

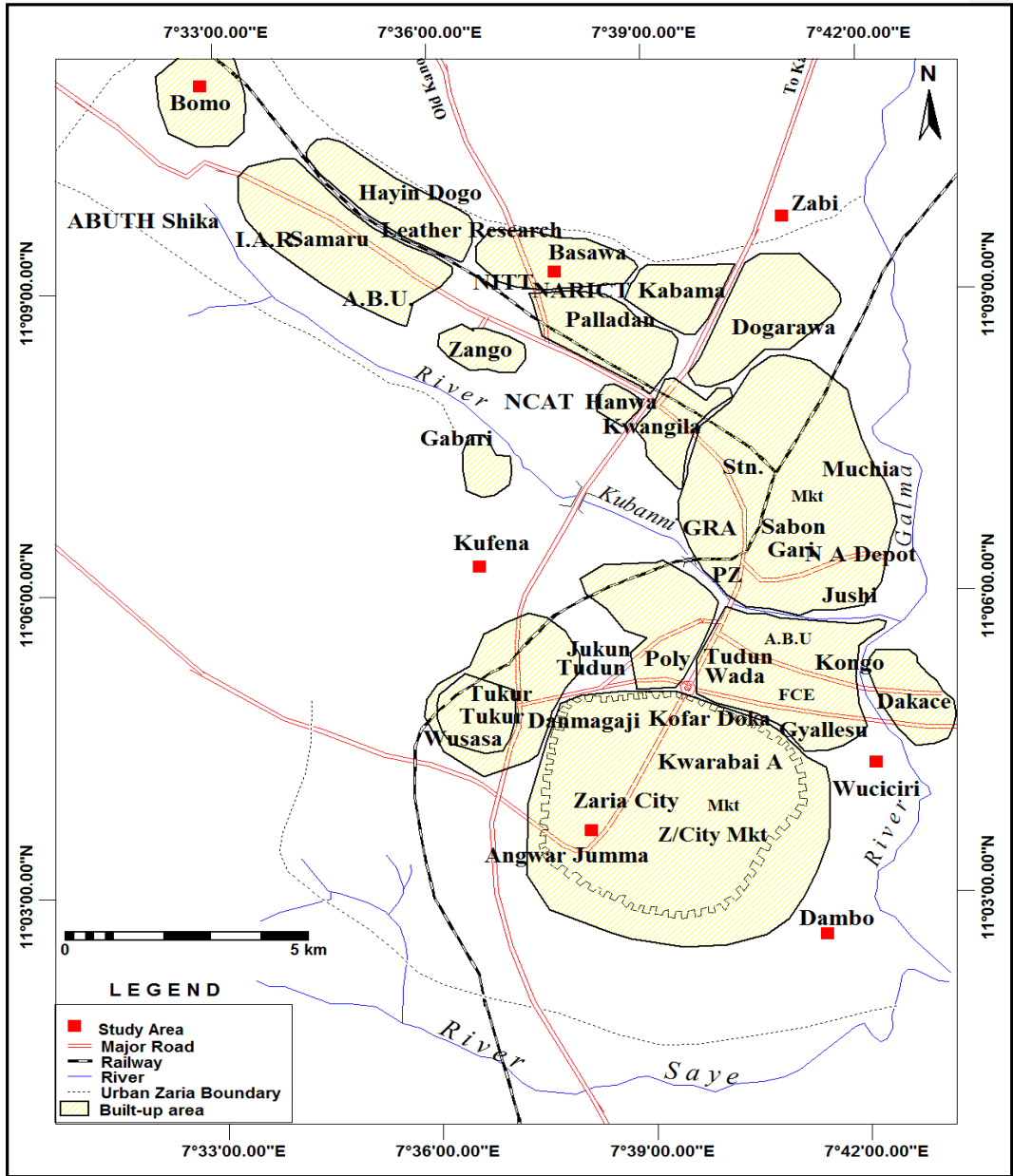


Fig 2.1: Map of zaria showing study area
 Sources: Modified from administrative map of kaduna state

3.2.2 Brief History of the Study Area

The history of Hausa states dates back to Bayajida from Daura. But over the years, evolution of settlement has caused a serious spread of the Hausa people to cover areas or states like Katsina, Kano, Sokoto, Zamfara, Kaduna, Kwara and Zaria inclusive. By the beginning of the 15th century permanent settlement had been established in Zaria, and this has led to the expansion of its kingdom during the reign of Muhammadu Yan Hazo (1671-1684) (Mortimore, 1970). Old Zaria city is 83 kilometers to the north Kaduna, and is the second largest city in Kaduna state. It covers a total area of about 6,000 hectares and totally it has some of the amount of agricultural and craft activities (Urquhart, 1976).

3.2.3 Geology

The Zaria area is a dissected portion of the Zaria-Kano plains, an extensive peneplain developed on crystalline metamorphic rocks of the Nigerian Basement complex (Wright and McCurry, 1970). Russ (1957), described the Basement complex as composing of older high grade metamorphosed gneiss interspersed by belts of younger metasediment of mainly quartzite and schist oriented in the north – south direction. In the south-eastern corner, younger granites and batholiths are evident. Deep chemical weathering and fluvial erosion, influenced by the bioclimatic nature of the environment, have produced the characteristic high undulating plains with subdued interfluves (Mortimore, 1970). According to Ike (1988), the older granite outcropping of Zaria is exposures of a syntectonic to late tectonic granite batholiths which intruded a crystalline gneissic basement during the Pan-African Orogeny. In some places, the interfluves are capped by high grade lateritic ironstone especially in the Northwest. Egbeifo

(1978), in his work on Kubanni Basin in general listed the different basement rocks found in the area viz:

- i. Coarse perphyritic – biotite granite which is distinctly foliated and aligned.
- ii. Medium – coarse grained biotite granite gneiss.
- iii. Aplite granite, pegmatites and quartz veins intrude most of the bodies; and
- iv. Weathered basement. This is about 14% of the basin's total area and formed a storage aquifer.

The surface of the older granite basement is overlain by a deposit of older laterite, young laterite, older alluvium and younger alluvium; the last two being quaternary deposits. The thickness of this zone varies from place to place, especially along stream valleys. There are frequently older granites exposed on the surface. They exist either in the form of domed hills (inselbergs), or as low outcrops (whaleback), (Wright and McCurry, 1970).

3.2.4 Relief/Geology

In general, over much of Zaria area, relative relief (the height range between interfluvial crests and the valley bottom) is less than 20m. Similarly, the average slope (average inclination of the landscape from the horizontal) really exceeds 6 degree (a slope value which is still quite satisfactory for a wide range of land use) and is very rarely more than 10degree. Average slope is predominantly 3 degree. Taking the relative relief and the average slope together, the terrain can be characterize as gently rolling to undulating, studded with residual hills of various shapes and sizes.

The plain area is stunted by a large number of mostly small residual hills, either as isolated features or grouped together, including:

- (i) **low ridges** on quartz and pegmatite veins, rising less than 10m above the surrounding terrain
- (ii) **low whalebacks** on migmatite, granite-gneiss and granite; the inhabitants of the area use these as drying, grinding and pounding surfaces and often build their granaries on them, safe from the fierce.
- (iii) **Inselbergs** - more commonly occurs, perhaps, on granites and migmatites. Occurring often as impressive, steep-sided domes, they are also found as elongated and assymetrical features. They may be relatively free of boulders, but more commonly carry boulders of various sizes on their tops and on fairly gentle side slopes.
- (v) **Broken rocky hills** - these rise abruptly (many as much as 200m) from the gently-sloping plains surrounding them which also differ by carrying weathered and transported regolith of various depths.

The valleys are shallow but wide, stretching several tens of kilometres into the headwater areas with gentle sloping valley sides; imperceptibly grading into flat moist to marshy alluviated bottomlands or floodplains, called "fadamas" in Hausa. Although stream valley incisions and dissections of the high plains are evident in several areas, especially in the Zaria, they are due to more anthropogenic influences and climatic factors than regional geologic instability (Abdulraheem, 2011).

3.2.5 Drainage

The drainage system of Zaria area on the River Galma, a major tributary to River Kaduna. It flows North while Kubanni River flows Eastwards The confluence of Galma and Kubanni is about 1.2km at the North-Eastern direction. Galma and Kubanni rivers carry water throughout the year (Thorp, 1970). Stream flow in the area strongly reflects the climatic

environment and, in particular, the seasonal and torrential nature of the rainfall. Three main types of stream flow pattern have been recognized in the area.

- i. Perennial flows: low dry season discharges; flash floods superimposed on high rainy season discharges. This flow pattern occurs on the largest stream;
- ii. Seasonal flow: zero dry season flow; flash floods superimposed on rainy season flow which may be high or low depending on catchment area;
- iii. Flash flow only that is, there is flowing water in the stream channel only during rainy season and for a short while after runoff producing storm.

Flow patterns range from being radial, dendritic to trellised and deranged depending on weather the rivers are consequent/obsequent or subsequent.

3.2.6 Soils

Zaria soils falls within the ferruginous tropical soils. The soils are deeply weathered with fine particles up to 50m deep (Jackson, 1958). A typical soil profile of the study area shows that the lower part of the underlying soil shows the presence of mineral materials from the weathered gneisses and still has some pieces of quartz and mica. The upper layer is a mixture of some materials together with blown (wind-blown) particles. The profile also indicates and accumulation of clay between a depth of 36cm and 119cm (Jaiyeoba, 1986).

According to Jaiyeoba (1986), below the horizon of clay accumulation, there exists another horizon which is of iron deposit. This is signified by the red or brown coloration; lower down is also found hard iron concentration. Though the soils of Zaria belong to the ferruginous group, those at the fadama (flood plains) belong to the hydromorphic type of soil which has high

water retention capacity (Wright and McCurry, 1970). The upland fadama soils provide basis for farming and other livelihood options in rural part of Zaria.

3.2.7 Vegetation

Zaria lie within Northern Guinea Savannah which has been modified by continues cultivation, grass burning and grazing activities. Within the radius of about 12km around Zaria almost all available lands are used for agricultural and another radius 19km to 24km is a belt, in which these patches of wood land appear with short grasses. Agricultural activities have resulted in the evolution of the thorny shrubs interspersed with short annual grasses. The dominant species of shrubs *Isobertina doka*, which has an average of about 0.8m other less common shrubs are *Butryo_spermum spp*, *Piliostigma spp*, *Vitex daniana spp*, *Terminalia spp*, *Dachrostacys spp* etc (Oluyori, 1999).

In the immediate vicinity of settlement, and over otherwise intensively farmed areas, is man-made parkland or tree savannah. The community is a peculiar derived vegetation type, which is the mark of many settlements in northern Nigeria. It consists of remarkably uniform immature trees of economic value that are scattered throughout a mosaic of cultivated fields and short-term fallows covered with mostly annual grasses. Such grasses may include *Rhynchelytrumrepens*, *Panicumkerstingii*, *Setariapallide-fusca*, *Aristida spp.* and *Hackelochloa granularia*.

The trees are largely indigenous and represent either the few surviving species of once-dense tree savannah woodland, which formally covered the whole area, or trees deliberately planted by man. Prominent among such trees are *Ceiba pentandra*, *Tamarindus indica*, *Adansonia digitata* and *Mangifera indica*. Others are *Vitex doniana*, *Vitaleria paradoxa*,

Comment [b5]: delete

Borassus aethiopum, Afzelia africana, Acacia albida, Khaya senegalensis, Parkia bigloboza, Daniella oliveri, Ficus sycomorus, Ptero carpus erinaceus Abdurraheem, (2011).

3.2.8 Climate

Owing to its interior location of about 698km north of the Atlantic Ocean, Zaria experiences a Tropical Continental Climate characterized by distinct wet and dry seasons subject to the movement of the Inter Tropical Discontinuity (ITD) associated with Tropical Continental and Tropical Maritime air masses. The former airmass originates from the Sahara desert and therefore dry, bringing dusty and hazy conditions known as 'harmattan' to the region in the dry season while the latter air mass originates from the Atlantic Ocean and hence moist and rain-bearing (Kowal and Knabe, 1972).

The region experiences convectional rainfall type with single maximum and a long-term average of about 1100mm per annum. Of great importance is the seasonal character of the rainfall. About 90% of the rains fall between April and October with the heaviest recorded in July and August. Monthly total can vary as well as the annual (Adejuwon, Adejuwon and Balogun, 1989). However, the mean annual rainfall of Zaria is 800mm (Ojo, 1982).

Onset of the rainy season is highly variable and unpredictable; although long-term average appears to be first week of May (Owonubi and Olorunju, 1985). Variability in the cessation date of the rainy season has also been observed. Akintola (1986), for example, reported that the expected mean cessation date of the rainy season is October 8th with an upper limit of October 23rd. The North East Trade wind (Tropical Continental Air mass) characterized by hazy to dusty conditions lowers temperatures to as low as 10^oC at night. In the afternoons, up to 42^oC is sometimes recorded. As a result of the large inter- annual variability of rainfall and high

temperature evapotranspiration will be high leading to water shortage especially in the dry season, the study area is prone to drought or flooding which can impose serious socio-economic constraints (Oladipo, 1993; FRN, 2000)

Based on the effect of climate controls and the temperature conditions according to (Oladipo and Balarabe, 2014) four seasons can be identified:

Comment [b6]: incomplete

- i. The dry and cool season (kaka): this season is known as harmattan period and the last from end of November to the end of February. This period is characterized by cool, dry and dusty weather conditions. Sometimes the air becomes so dusty that the visibility becomes very poor. The wind originates from the faya largeau birma region near the Ahaggar and the Tibesti massifs. The ITD lies south of the state during this period and the prevailing winds are the northeast trades.
- ii. The Dry Hot Season (Bazara): This is the very short season that follows the harmattan period. Its length in a particular year is determined by the onset of the rains. On the average, it last from March to April and may extend to mid-May at northern extreme parts of the state. This is the hottest period of the year and mid-day temperatures ranges from about 36°C in the southern part of the state to about 38°C in the northern part or even more in some cases. This period is characterized by the occurrence of sandstorm which originates from the Sahara desert with local surplus of sand as the ITD begins to move northwards. The dominant winds are still the northeast trades. The sandstorm normally signifies the end of dry season and the beginning of the rainy season.
- iii. The Wet and Warm Season (Damina): This period is the period when the ITD runs through the state and moves southwards also. The period begins around May and ends in mid-October. Over 90% of the annual rainfall of the state is recorded during this period,

and has the lowest diurnal and monthly ranges in temperature. The cessation of rains starts from the extreme north around ending of September moving southwards, reaching the southern tips of the study area in mid-October or end of October in wet years.

- iv. The Dry and Warm Season (Rani): this period starts at the end of the rains, and ends about mid-November with the onset of the harmattan. It is the second hottest period, winds are very variable and the season records of the highest number of calms in the year.

3.2.9 Socio-Economic and Livelihood Activities

Zaria comprises of six (6) traditional districts, Birni Da Kewaye (Zaria town and its environs), Dutsen-Abba, Gyallesu, Tudun Wada, Tukur-Tukur, and Wuchiri. They all lie within the farmlands of the monotonous plains which make up most of the area occupied by the Hausa speaking farmers and craftsmen of Zaria (Urquhart, 1977). Zaria is a cosmopolitan city with tribal nationalities from all parts of Nigeria and other West African countries co-existing harmoniously in the midst of the warm receptive traditional values and norms of the people of Zazzau. The main Ethnic groups are Hausa and Fulani and they are predominantly Muslims.

The pattern of settlement is tied to the historical, political and socioeconomic forces the area has been subjected to from the precolonial to post-colonial period. Prior to the advent of the British occupation, the basic unit of human settlement was the extended family compound. The impact of the historical and cultural developments and the agrarian nature of the rural economy (agrarian), makes them vulnerable to climate change impacts.

In recent times, the rate of population has been astronomical due to high birth rate and immigration. The population of Zaria, as put together by the population and housing census of 2006, is 1, 364,942 people.

Two types of lands are found in the study area; Gona or upland fields which support crops such as maize, millet, sorghum and groundnut during the wet season, and Fadama or lowland fields which support crops such as sugarcane, onion, tomatoes, pepper, spinach and other garden vegetables throughout the year. There is a relative buffering by the addition of organic manure and fertilizer application. Sand mining is also conspicuous with their left overs as holes, pit, gullies etc. used as material for moulding bricks and building of mud houses for both residential and animal shelter and in road construction. Minor fishing activities usually take place especially during the dry season both for commercial and subsistence purposes consumption scales.

3.3 RESERCH METHODOLOGY

3.3.1 Reconnaissance Survey

A reconnaissance survey was carried out by the researcher as a site survey to observe the characteristics of the landscape, cultural and social set-up of the study area. It also facilitated the identification of the economic and biophysical conditions of some of the communities within the study area as well as the people.

Comment [b7]: Vague. Please re-cast

3.3.2 Types and Sources of Data Used

In order to achieve the aim and objectives, the following types of data were obtained from both primary and secondary sources. Both primary and secondary data were collected for this study using different methods including questionnaire, observations, Focus Group Discussions (FGDs) and field observations.

3.3.2.1 Primary Sources of Data

The researcher employed the use of questionnaire and focus group discussions to obtain information for the research. The questionnaire contains relevant and well-structured questions aimed at eliciting responses that aid the understanding of socio-economic characteristics of the respondents, climate change and adaptation on livelihood of rural communities in Zaria (see appendix I). The questionnaire contains both closed and open ended questions. Seven (7) Focus group discussions were held in each of the selected study area consisting (8) people each comprising both male and female participants drawn from the community based-organizations (CBOs), elders and village heads. The aim was to gather more information as related to observed changes in recent years, past climate related disasters and how climate change impact their livelihood and the adaptive capacity of the communities.

3.3.2.2 Secondary data source

Secondary data was obtained from existing which include literatures from journals, magazines, internet materials, articles among others that are relevant to be used for literature review.

3.3.3 Sample Size and Sampling Technique

A total of twenty four (24) wards make up the study area. In this research, the unit of observation is the ward. In this study, purposive sampling technique was used at different points for the purpose of this study. This method is characterised by the use of personal judgement and deliberate attempt to obtain representative sample by including presumable typical areas or groups in the sample (Abiola, 2007). Zaria is made up of two LGAs. From each of the LGAs, respondents were selected from the rural area which is the major focus in this study. The Yamane (1976) method of determining sample size was employed based on the formula

$$\frac{N}{1 + N(e)^2}$$

Where N = Number of population under study area.

e= proportion of population given as (0.05%)

Due to non-availability of population figures of locality in the last 2006 census published, the population data for registered voters by INEC (2011) for each ward available to the researcher was used to select respondents. The INEC (2011) report on the number of voters registered for the selected wards was projected using exponential formula giving a total population of selected ward registered to be 129,679. (Table 3.1). Using the Yamane (1976) formula for determining sample size, 399 respondents was sampled for this study. The utilization of voter's record is justifiable since only adults are expected to provide reliable information on climate change issues.

Table 3.1: List of Selected Wards and Sampled Population

| Local Government | Wards | Population | Projected Population | Sampled Population | |
|-------------------------|--------------|-------------------|-----------------------------|---------------------------|--|
| Sabon Gari | *Bomo | 18,457 | 20,810 | 64 | |
| | *Bassawa | 19,751 | 22,066 | 68 | |
| | *Zabi | 16,698 | 18,827 | 58 | |
| | Chikaji | 16,978 | | | |
| | Dogarawa | 15,466 | | | |
| | Gyallesu | 21,866 | | | |
| | Hanwa | 23,650 | | | |
| | Samaru | 11,965 | | | |
| | Jamaa | 19,070 | | | |
| | Jushinwaje | 20,432 | | | |
| | Muchia | 27,294 | | | |
| | Zaria | Kwarabai I | 23,977 | | |
| | | Kwarabai II | 27,562 | | |
| Kaura | | 24,608 | | | |
| Limankona | | 26,626 | | | |
| *AngwanJuma | | 17,235 | 19,432 | 60 | |
| Tudunwada | | 33,760 | | | |
| Tukur-tukur | 22,797 | | | | |

| | | | |
|--------------|--------|----------------|------------|
| UgwanGabas | 17,700 | | |
| UgawanFatika | 15,646 | | |
| *Dambo | 17,011 | 19,180 | 59 |
| Dutsenabba | 22,239 | | |
| *Kufena | 13,921 | 15,696 | 48 |
| *Wucciri | 12,122 | 13,668 | 42 |
| Total | | 129,679 | 399 |

Source: Computed from INEC (2011) records by the author

*: Represent Sampled Areas.

The wards were arranged systematically and seven (7) wards were selected purposively as a representative of the sample of the population of the rural people in the study area. These are; Bassawa, Danbo, Wuciciri, Bomo, Kufena, Zabi, and Ungwan Juma. The basis for this selection was to gather information from respondents who have had experiences in climate variability and change over the years and are more concerned and conscious about the imminent impacts of these changes on their environment. This was to ensure spatial coverage in the administration of questionnaire. Only respondents who are willing and interested were administered questionnaire since majority are farmers they were mostly approached in their settlement in the evening after retiring from their farms. To determine the proportion of the respondent, Yamane (1976) sampling method for determining proportion of respondents was used to i.e.

$$\frac{n \times 399}{N}$$

Where:

n= Population of each area selected in each LGA.

N=Total population of selected areas in the selected L.G.As.

3.3.4. Data Collection Procedure

Both closed and open ended questions (items) were used to elicit data from respondents (see Appendix 1). The closed ended questions were in the form of Likert Scale (LS) and fixed question format. The questionnaire has five (5) sections. Section A sought information on demographic characteristics of respondents (gender, age, educational status among others). Section B sought information on the perception of respondents on climate change, Section C sought information on the vulnerability of the rural people (Section D) focussed on information on the adaptive strategies of the rural people. And the last (Section E) sought information on risk and hazards. The questionnaire were purposively administered to sampled households heads who have resided in the community for the last 30years. This is to enable the gathering of information from respondents who are experienced on the impact of climate change.

Focus Group Discussions questions however, were focused on the climate change issues, adaptive capacity and community and organizations and institutional efforts in addressing these problems. Focus group discussions were in the evening. Altogether the number of trained field assistance that were used for the data collection were four (4).

3.3.5 Method of Data Analysis

Descriptive statistics was used to analyse the data for this study. All statistical analysis was carried out using SPSS version 20 statistical programme and Microsoft Excel 2007. The analytical techniques used in achieving the objectives of the study were as follows:

- i. **Objective I:** The analysis and presentation on source of climate change information was done by means of descriptive statistics. The data were summarized and presented using percentages, tables and charts.

- ii. **Objective II:** To determine the perception of respondents on climate change, responses was analyzed and each response was coded and ranked 1, 2, 3... in that order according to their average means score. Result was presented in tables.
- iii. **Objectives I11, IV and V:** These objectives were achieved using descriptive statistics. The data was summarized and presented in forms of tables, percentages and charts.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.2 Introduction

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4.3 This chapter presents the findings from the study which includes information on the socio-economic characteristics of the respondents their perception of changes, vulnerability and th adaptation strategies. The results were discussed and presented according to the objectives set for this study.

4.2 Socio-Economic Characteristics of Respondents

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Socio-demographic characteristics of respondents such as sex, age, length of stay, highest level of education and occupation were examined as shown in Tables 4.1 and 4.2.

Table 4.1: Sex, Age and Length of Stay of Respondents

| Sex | Frequency | Percentage (%) |
|-----------------------|------------------|-----------------------|
| Male | 269 | 67.4 |
| Female | 130 | 32.6 |
| Total | 399 | 100.0 |
| Age | | |
| 19-29years | 44 | 11.0 |
| 30-39years | 149 | 37.3 |
| 40-49years | 58 | 14.6 |
| 50-59years | 81 | 20.3 |
| 60 and above | 67 | 16.8 |
| Total | 399 | 100.0 |
| Length of stay | | |
| 30years and above | 257 | 64.4 |
| 20-29years | 76 | 19.1 |
| 10-19years | 38 | 9.5 |
| Below 10years | 28 | 7.0 |
| Total | 399 | 100.0 |

Source: Field Survey, (2016)

Table 4.1 shows the distribution of respondents according to sex, age and length of stay in the area. It reveals that more than two-third of the respondents were male and in the case of age, most of the respondents were within the age of 30-39 years (37.3%) although observable was majority of them were of 40years age bracket and above. Table 4.1 further reveals that for the duration of stay in the study area, respondents that have stayed for over 30years were the majority (64.4%). This is followed by 19% who have stayed for 20-29years while a few (7%) have stayed for less than 10years. It is believed that the residents possess adequate knowledge of the climatic conditions of the area given that most have stayed over 30years. This confirms the findings of Abaje, et' al (2013) that the longer the period over which a respondent has been living in a community the better his/her understanding of the physical environment.

Table 4.2: Highest Educational Level and Occupation of Respondents

| Educational Level | Frequency | Percentage (%) |
|------------------------------|------------------|-----------------------|
| Degree | 65 | 16.3 |
| NCE/OND | 88 | 22.1 |
| Secondary School Certificate | 45 | 25.3 |
| Primary School | 47 | 12.8 |
| Non Formal Education | 74 | 18.5 |
| Others | 80 | 5.0 |
| Total | 399 | 100.0 |
| Occupation | | |
| Civil service | 156 | 29.1 |
| Studying | 26 | 6.5 |
| Farming | 159 | 49.8 |
| Trading | 44 | 11.0 |
| Others | 14 | 3.5 |
| Total | 399 | 100.0 |

Source: Field Survey, (2016)

Table 4.2 shows the distribution of respondents based on their highest educational level and occupation. It shows that more than two-third of the respondents possess one form of formal education or the other. This is supported by findings of Cutler et al (2003) that an educated person is more able to process information and use it to inform decisions, in addition to enabling that individual to perform tasks more efficiently, whereas lower education constrains the ability to understand warning information and access to recovery information. The result also shows that most of the respondents were farmers (49.8%) while few about (11.0) are into trading a handful of 3.5%, were however involved in other forms of occupation studying, artisans, business, labourer's work and so on. The reason for this diverse secondary occupation in the study area is owing to proximity of major urban centres such as Samaru, Sabon gari and Zaria city which allows rural dwellers acquire western education and get employment in the civil service. Thus notwithstanding most of them engage in farming as their primary activities alongside other activities. This high percentage of respondents engaging in farming reflects the characteristics that is common to rural dwellers (Abaje and Giwa 2010). This result indicates the diverse source of livelihood of the people which could be affected differently by climate change.

4.3 Source of Information on Climate Change

The several media of information on climate change were television, radio, print materials as well as friends as identified by the respondents. The responses are presented in Figure 4.1

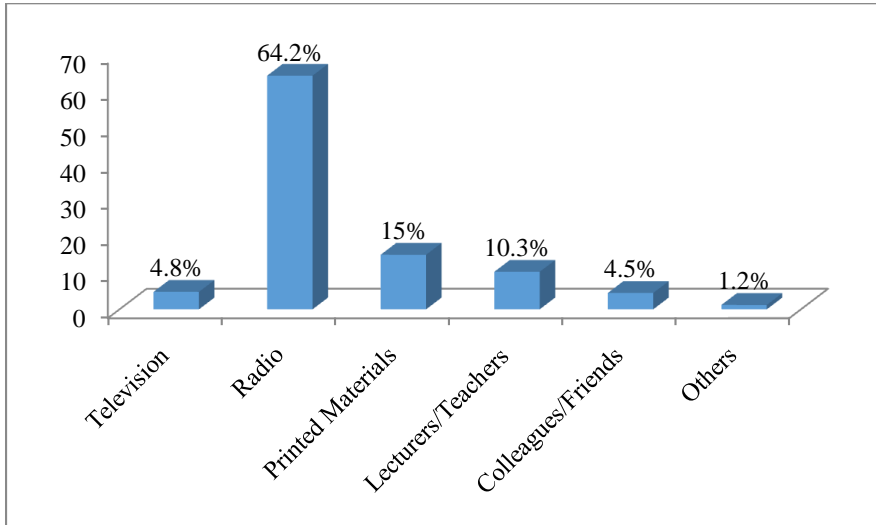


Figure 4.1: Sources of Information on Climate Change

Source: Field Survey, (2016)

Figure 4.1 shows the distribution of respondents based on various sources of information on climate change. It shows that majority of the respondents (64.2%) got to know about climate change through radio. This is followed by a few who knew through other sources such as pamphlets, flyers and so on. But to a handful, they knew about climate change through television, printed materials, lectures/teachers and colleagues/friends. This finding reveals that the mass media especially radio and televisions were the main medium through which the respondents sourced information on climate change. This agrees with Isife and Ofuoku (2008) Oladipo Balarabe and Abdulkarim (2015) Abdulkarim and Sarki (2013), who documented that radio, has the highest audience and strength of reaching large population especially rural dwellers faster than other means of communication.

Table 4.3 reveals climate change as perceived by the rural people in the study areas. Result shows, the most perceived impact of climate change as perceived by respondent includes

environment is suffering from excessive devegetation which is the reason for it being (ranked 1) followed by other perceived impact such as fuel scarcity (ranked 2), cost of food crops are increasing (ranked 3), crop infestation are increasing(ranked 4), hamattan /wind is stronger(ranked 5), yearly rains not supporting crop production(ranked 6), rainfall is increasing (ranked 7), temperature is decreasing (ranked 8), and drought is increasing (ranked 9) and flooding which is the least and is (ranked 10). These findings are in agreement with the perceived impact of climate change in Manyatsi et al (2010), Ozor and Nnaji (2011), Abaje et al (2014). This result suggests that most of the respondents seem to perceive climate change based on the changes in weather events as listed above.

4.4 Communities' Perception of Climate Change

The impact of climate change as perceived by respondents is presented in Table 4.3

Table 4.3: Respondents' Perception of Climate Change

| S/N | Response | Mean Scores | | | | | | | | Rank |
|-----|--|-------------|------|-------|------|-------|--------|-----------|---------|------|
| | | Kufena | Zabi | Jushi | Bomo | Dambo | Basawa | Ung. Juma | Average | |
| 1 | Temperature Decrease | 3.68 | 2.91 | 2.96 | 3.09 | 3.61 | 2.47 | 3.86 | 3.23* | 8 |
| 2 | Rainfall Increase | 4.37 | 4.23 | 2.68 | 4.72 | 4.00 | 3.23 | 2.89 | 3.73* | 7 |
| 3 | Harmatan/wind is Stronger | 4.65 | 4.02 | 4.44 | 4.61 | 3.88 | 3.14 | 4.58 | 4.19* | 5 |
| 4 | Yearly Rain not supporting crop production | 4.41 | 3.33 | 3.18 | 4.16 | 3.96 | 3.14 | 4.14 | 3.76* | 6 |
| 5 | Crop Infestation and diseases are increasing | 4.58 | 4.42 | 4.30 | 4.40 | 4.49 | 4.14 | 4.63 | 4.42* | 4 |
| 6 | Cost Food Crops are increasing | 4.89 | 4.42 | 4.58 | 4.71 | 5.00 | 4.30 | 4.39 | 4.61* | 3 |
| 7 | Environment Suffer from De vegetation | 4.47 | 4.86 | 4.60 | 4.74 | 5.00 | 5.00 | 4.09 | 4.68* | 1 |
| 8 | Fuel Scarcity | 4.47 | 4.88 | 4.79 | 4.82 | 5.00 | 4.16 | 4.33 | 4.64* | 2 |
| 9 | Flood Incidence | 1.00 | 3.96 | 2.30 | 1.38 | 1.79 | 1.63 | 3.02 | 2.15 | 10 |
| 10 | Drought Increase | 1.42 | 3.71 | 3.19 | 3.00 | 2.49 | 3.51 | 3.67 | 3.00* | 9 |

Source: Field Survey, (2016)

*: Represent Highest Average Mean Score.

4.6 Types of Climate-Induced Vulnerabilities in the Communities

Areas of threat and reasons for vulnerability to Climate Change are shown in Table 4.6. A cumulative perception of the community based responses.

Table 4.4: Types of Vulnerabilities and Areas of threat to the Communities.

| Groups | Frequency | Percentage (%) |
|--|------------------|-----------------------|
| Farmers | 334 | 83.7 |
| Civil service | 25 | 6.3 |
| Trading | 18 | 4.5 |
| Others | 22 | 5.5 |
| Total | 399 | 100.0 |
| Area of Threat | | |
| Health | 183 | 45.9 |
| Food supply | 155 | 38.8 |
| Fuel wood availability | 30 | 7.5 |
| Water supply | 12 | 3.0 |
| Others | 19 | 4.8 |
| Total | 399 | 100 |
| Reasons for Vulnerability | | |
| Low income status | 245 | 61.4 |
| Poor farming practices | 74 | 18.6 |
| Inadequate knowledge on climate change | 76 | 19.0 |
| Others | 4 | 1.0 |
| Total | 399 | 100 |

Source: Field Survey, (2016)

Table 4.4 shows the distribution of respondents based on group affected mostly by climate change, the perceived threat and reasons for being vulnerable. It reveals that climate change affected farmers (83.7%) mostly in the area. The result further reveals that threat of climate change was mostly on health and food supply. This agrees with Manyatsi *et al.* (2010) that the most susceptible sectors of human life which are sensitive to climate variability and change, hence highly at risk are water resources, agriculture, tourism,

natural resources and biodiversity, health and food supply and security. This is supported by FGDs on group affected. One participant noted that;

the farmers are the group mostly affected by climate change because they rely on the weather which is no longer stable unlike the past years. Some years we may experience flooding or drought depends on the magnitude, while unset and ceasation of rains is no longer predictable sometimes strong wind can affect our produce. (Manir Suleiman, Bassawa)

Table 4.4 shows that majority of respondents (45.9% and 38.8) saw the threat of climate change more on health and food supply. It further reveals that majority of respondents (61.4%) saw low income as the major reason for being vulnerable to threat of climate change. While a few were of the view that inadequate knowledge, lack of loans, absence of extension worker, poverty, lack of assistance from government ,among others makes the people vulnerable. In support of threat on health and food supply by climate change, another participant from the Focus Group Discussions noted that:

in the past the rains were predictable but now the unpredictable rainfall patterns have led to some villagers not planting at all in some seasons because they would have waited for the right rains until it was too late to plant (Mal. Yau a, Bomo)

While another was of the view that;

the incidence of flooding as well as increase heat has led to pollution and has increased incidence of diseases such as malaria typhoid and cholera whose recent outbreak led to the death of my son (Halima Abubakar, Dambo)

Types of hazards and period of occurrence in the study area were also summarised as indicators of vulnerability in the communities as shown in Table 4.5. It reveals that Hazards related to climate change can be naturally triggered and or humanly induced.

However it occurs, it create impact on one or more forms of rural livelihood owing to the intricate between physical environmental based and key rural livelihood activities

Table 4.5: Hazard Type Experienced and Occurrences

| Types of Hazards | Frequency | Percentage (%) |
|-------------------------------------|------------|----------------|
| Drought | 88 | 22.1 |
| Flood | 114 | 31.1 |
| Bush/wild fire | 15 | 3.8 |
| Invasive species | 103 | 25.8 |
| Erosion | 49 | 12.3 |
| Others | 20 | 5.0 |
| Total | 399 | 100.0 |
| Period of Hazard occurrences | | |
| <i>Bazara</i> (dry and hot season) | 80 | 20.1 |
| <i>Kaka</i> (dry and cool season) | 19 | 4.8 |
| <i>Rani</i> (dry and warm season) | 31 | 7.8 |
| <i>Damina</i> (Wet and warm season) | 269 | 67.4 |
| Total | 399 | 100.0 |

Compiled by the Researcher (2016)

Source: Adapted from Abdulkarim, Oladipo and Balarabe, (2015)

Table 4.5 reveals that hazards of different magnitude occur in the study area among which flood has a record of (31.1%) usually in wet season, followed by invasive species (25.8%), drought (22.1%) and erosion (12.3%) while bush/ wild fire and others account for 3.8 and 5.0 respectively. This indicates that the study area is at risk of hazard related to climate change. This is in line with the research finding of related study that through the season one or more hazard occurs thereby impacting directly or indirectly on the environment (Abdulkarim, Oladipo and Balarabe, 2015). Participant among the FGDs confirm the above statement that;

hazards affects us in the community but usually occurs with interval of 3-5 years depending on the severity. Flooding is one among the hazards that we experience most commonly and it

usually affects us directly or indirectly. Directly is due to increase rainfall while indirectly is erosion (zaizayar ruwa), pollution, sicknesses and diseases (Mai Gona, Bomo)

4.7 Impact of Climate Change Vulnerability on Community Livelihoods

Figure 4.6 shows the respondents perception on impact of climate change on their source of livelihood. The approach also indicate the level of agreement of the respondents on perception of change on their livelihood options.

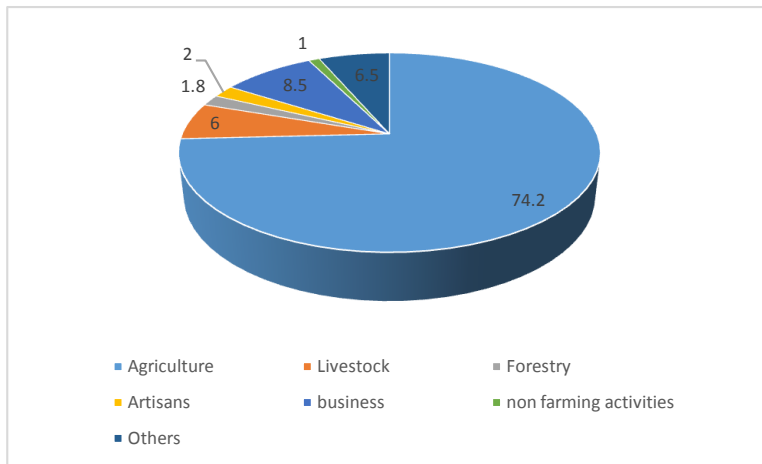


Figure 4.2: Distribution of Respondents based on Source of Livelihood

Source: Field Survey, 2015

Figure 4.2 shows the distribution of respondents based on the source of livelihood. It reveals that for majority of respondents, their source of livelihood in the area is agriculture which account for (74.2%). While other sources of livelihood such business, livestock rearing, artisan, non-farming activities and others such as casual work and labour account for the remaining (36.8%). This result indicates that respondents have diverse sources of livelihood but agriculture is the most common sources of livelihood. This

corroborates (Abaje and Giwa, 2010) that this high percentage of respondents engaged in farming reflects the characteristics that is common to rural dwellers.

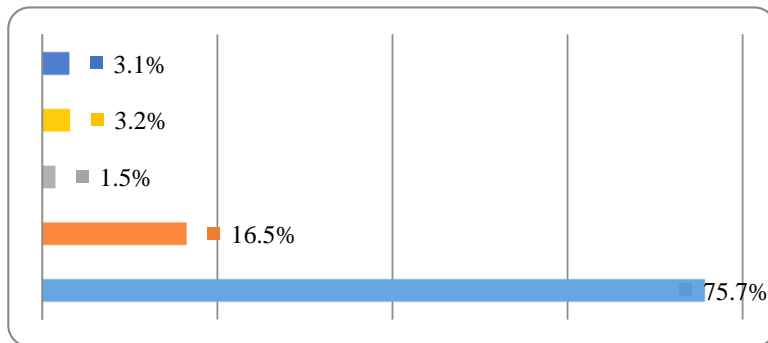


Figure 4.3: Perception of Changes on Source of Livelihood
Source: Field Survey, (2016)

Figure 4.3 reveals the perception of changes on sources of livelihood of respondents. Results revealed that majority of respondents (75.7%) agreed that their sources livelihood has change which is responsible for their diversified livelihood options.

In support to this, a discussant during one of the FGD conducted stated that:

“Climate change affects the livelihood of an average rural inhabitant because most of us depends on activities that are climate sensitive like farming and because of the variability in weather condition crop yields have not been stable i.e. either we experience increase or decrease, depending on the changes this is affecting us a lot because the farming can no longer support us we have to find other means to survive (Mal. Sirajo, Gangare Zabi)”.

Another respondent also reaffirms the earlier statement that,

Although I am farmer I also double as a civil servant, this I have to do in order to augment my income because the farm produce is no longer sufficient to carter for my family and the income generated is not enough, there’s also need to buy fertilizers and other farm

facilities so we need to engage in other livelihood sources to generate more income (Alh. Shehu, Bassawa).

4.7.1 Impact of Climate Change on Source of Water and Availability.

Table 4.6 indicates the respondent's response on the impact of climate change on water availability.

Table 4.6: Impact on Source of Water and Availability

| Sources of water | Frequency | Percentage (%) |
|--|------------|----------------|
| Borehole | 73 | 18.3 |
| Well | 317 | 79.4 |
| Others | 5 | 1.3 |
| Total | 399 | 100.0 |
| Impact of Climate Change on Water Source | | |
| Yes | 105 | 51.4 |
| No | 194 | 48.6 |
| Total | 399 | 100.0 |
| Experience of Water Scarcity | | |
| Yes | 262 | 65.7 |
| No | 137 | 34.3 |
| Total | 399 | 100.0 |

Source: Field Survey, (2016)

Table 4.6 shows the distribution of respondents on impact of climate change on source of water and availability. It reveals that majority of the respondents source their water from the well (79.4%), followed by those who source water from borehole while a handful source water from other sources such as water vendors, tap, rivers, streams. Also little above half of the respondents were of the view that climate change have impact on their water sources thereby resulting in scarcity as agree by majority of respondents (67.7%). The impact of climate change on water sources as revealed by the respondents cannot be unconnected with the increase in temperature and decrease in rainfall and

variability as observed by the researcher. The implication of these is low soil moisture, high level of water scarcity and increase in cost of food production. This affirms the view of USAID (2008) that change in rainfall has had an impact on water sources and availability, as well as agricultural production resulting to overall increased vulnerability in food and water security, with direct impacts to health (mainly nutrition and water-borne illness) and poverty. The findings corroborates the FGDs.

A participant during the FGDs was of the view that:

we use to have water in our wells in the past even in dry season but recently the wells gets dry as we approach the dry season which eventually leads to scarcity of water thus, we usually experience long queue, or resort to buy from water vendors as an alternative or to add to the little we get from few wells around. This times are usually very tough for us. (Hajia Binta, Ungwan Juma, 2016)

A farmer further explains that;

water scarcity is usually high in dry season because of high evapotranspiration due to high temperature as a result of climate change impact. Most of our well dries up while people queue for the available one which is not enough.. Even our farms are supported by irrigation farming these days (Mal. Rilwanu, Zabi).

4.7.2 Impact of Climate Change on Agricultural

The impact of climate change on agricultural and the reason is exemplified in Table 4.8.

Table 4.7: Impact of Climate Change on Agricultural Productivity

| Impact on Agricultural Productivity | Frequency | Percentage (%) |
|-------------------------------------|------------|----------------|
| Increase | 64 | 16.0 |
| Decrease | 335 | 84.0 |
| Total | 399 | 100.0 |
| <u>Reason</u> | | |
| decrease in temperature | 4 | 1.0 |
| Decrease in rainfall | 161 | 40.4 |
| Incidence of disease | 51 | 12.8 |
| Flooding | 86 | 21.6 |
| Drought | 19 | 15.8 |
| Others | 78 | 8.4 |
| Total | 399 | 100.0 |

Source: Field Survey, (2016)

Table 4.7 reveals that majority of the respondents (84.0%) agreed to the fact that agricultural productivity have decreased as a result of climate change impact. This might be attributed to the unpredictability of rainfall which has made agricultural production the main source of income, difficult and undependable. It further reveals that most respondents (40.4%) saw decrease in rainfall to be the reason for the decrease in agricultural productivity while a few see flooding (21.6%) as responsible for the change and so on. The implication of this is food insecurity. This finding agrees with the view of Jones and Thornton (2002) that crop yield in Africa may fall by 10-20% by 2050 or even up to 50% due to climate change. Supported by FGDs, an elderly respondent noted that;

in the last 30 years I usually harvest over 100 -200 bags of my produce yearly but the story has change now , I can barely get up

to 50 -80 bags of all due to uncertainty associated with rainfall which affect our planting period. (Baba Lado, Bassawa).

Another participant among the village head said;

even the ground is hard to till and the soil now requires more nutrient to produce more yield. This has affected production to a large extent, consequently we have to put more fertilizer to get the desired yield which is affecting us a lot because we can't afford to buy more than our earnings.

4.7.3 Impact of Climate Change on Land Use

Table 4.8 shows the impact of climate change on landuse. Results revealed that majority of the respondents which account for (68.9%) opined that climate change have impact on their landuse while the remaining few (31.1) agreed less. The implication is that it will give rise to social effect like loss of dignity and social values. The consequence of this is increase spate of communal clashes among herdsmen and famers. This is in confirmation with the resulted that increase in spate of communal clashes has led to the death of 180 people in six northern state of Nigeria between 1998 and 2006 (Yugunda 2002). This is because farming is a basic rural livelihood option that requires land. Also livestock rearing requires land and competition can result, especially in a rural community with traditional or customary land tenure system.

Table 4.8: Impact of climate change on Landuse

| Land Clash Experience | Frequency | Percentage (%) |
|-----------------------|------------|----------------|
| Yes | 124 | 31.1 |
| No | 275 | 68.9 |
| Total | 399 | 100.0 |
| Period of Land Clash | | |
| Wet period | 78 | 61.2 |
| Dry period | 38 | 33.1 |
| Both | 8 | 5.7 |
| Total | 124 | 100.0 |

Source: Field Survey, (2016)

The reason for the wet period experiences of land clashes is attributed to the view of an elderly man during the FGDs:

crises from landuse in this part of the north usually arise in wet season as a result of conflict arising from land scarcity. Since most of the land have been converted to other use other than farming the few lands left for agriculture is being compete for either by nomadic (herdsmen), farmers or residents. (Mal. Nasiru, Dambo).

4.7.4 Impact of climate Change on Source Domestic Fuel

Table 4.9 show the source of domestic fuel of the respondents and how climate change has impact on forest resources.

Table 4.9: Impact of Climate Change on Sources of Fuel

| Source of Domestic Fuel | Frequency | Percentage (%) |
|-----------------------------------|------------|----------------|
| Kerosene | 45 | 11.3 |
| Wood | 332 | 83.2 |
| Others | 22 | 5.5 |
| Total | 399 | 100.0 |
| Impact on Forest Resources | | |
| Yes | 354 | 88.7 |
| No | 45 | 11.3 |
| Total | 399 | 100.0 |

Source: Field Survey, (2016)

Table 4.9 reveals that majority (83.2%) of respondent sources of domestic fuel is fuelwood. This indicates the overdependence of the rural dwellers on forest resources for domestic energy. In line with (Hertberg et al., 2000). fuelwood used from the forested areas is the most important source of domestic energy for the developing world, Majority of the respondents (88.7%) agreed that source of domestic fuel have affected the forest growth in the study area. The implication of these is that it can lead to deforestation since

the trees that are fell down are not replaced which means loss of forest reserves and biodiversity thereby causing increasing incidence of erosion/ flooding which may have far reaching effect on lives and property. This corroborates findings that demands for fuelwood by subsistence agricultural household may be the leading cause of world deforestation loss of biodiversity associated with climate change will affect this source. NEST (2004) and Ayuba et al. (2007) Abdulkarim, Balarabe and Oladipo, (2015) in like manner, deforestation has numerous harmful consequences such as loss of biodiversity and soil erosion (Heltberg et al., 2000). A participant in the FGD confirm the statement thus;

From time memorial we have been depending on the forest resource for our domestic energy, reason is because the kerosene or gas is not readily available, likewise we can't afford to buy this product since we have large family size. (Hassan Wuciciri, 2016

Another participant also said;

of a truth the forest resource have depleted due to increase falling of trees for domestic use as well as for business, this place usually use to be a thick forest but now it has gradually become a field and you can even see the end from where one is standing (Haj, Maryam Nasiru, Kufena)

4.8 Adaptation Strategies to the Impact of Climate Change on Livelihoods

Climate change will impact on different aspect of human survival and existence. These aspects that are connected with livelihood are water scarcity, land quality and access to firewood. These three are specifically selected because of their significant relationship with rural basic needs. The strategies are presented in different subsections thus:

4.8.1 Adaptive Strategies to mitigation Impact of Climate Change to Water

Availability

The various adaptive strategies employed by the community reduce the impact of climate change to availability of water is shown in Table 4.10.

Table 4.10: Adaptation Strategies to Mitigate Water Scarcity

| Practice | Frequency | Percentage (%) |
|-------------------------------------|------------|----------------|
| Construction of boreholes and wells | 256 | 64.1 |
| Provision of pipe-borne water | 12 | 3.0 |
| Improve water harvesting techniques | 21 | 5.3 |
| Conservation of water casement | 16 | 4.0 |
| Others | 94 | 23.6 |
| Total | 399 | 100.0 |

Source: Field Survey, (2016)

Table 4.10 reveals that for more than half about (64.1%) of respondents agreed, that construction of boreholes and wells was the major adaptive strategy to reduce the impact of climate change on water availability in the study area, But for a handful, the adaptive strategies includes provision of pipe-borne water, improvement on water harvesting techniques and conservation of water casement (3.0, 5.3, and 4.0) respectively. While for others buying from vendors, digging the wells deeper among others were strategies used to reduce the impact of climate change on availability of water .this support FGDs that;

our community usually source for help from philanthropist as well as government to provide borehole. In case of water scarcity response sometimes appears positive like you can see this boreholes were built by government, we even have water casement which they also built for us in order to conserve water in the case

of scarcity but not adequate to sustain our population. (Mal. Zuwaira, Zabi 2016)

In like manner another participant is of the view;

were the response from stakeholders is negative we engage community effort to dig our wells deeper when they are getting dry or build general wells which are dug more deeper than the individual wells we have in our houses as an alternative. In extreme cases were the well are not sufficient or dry we have to buy from vendors or get from nearby streams (Abdullahi Garba, Anguwan jumma).

4.8.2 Adaptive Strategies to Mitigate Landuse Related Problems

Table 4.11 shows the distribution of respondents based on the strategies to mitigate problems associated with land use.

Table 4.11: Respondent strategies to Mitigate Land Use Related Problems

| Strategy | Frequency | Percentage (%) |
|---------------------------------|------------|----------------|
| Diversify land use | 150 | 37.5 |
| Cultivating different crops | 81 | 20.3 |
| Shorting group season | 15 | 10.0 |
| Training extension workers | 17 | 3.7 |
| Use of modern technologies | 19 | 4.7 |
| Improve food storage | 61 | 15.3 |
| Modern farming techniques | 28 | 3.5 |
| Provision of government subsidy | 14 | 3.0 |
| Others | 28 | 2.0 |
| Total | 399 | 100.0 |

Source: Field Survey, (2016)

Table 4.11 results shows that most respondents agreed that diversification (37.5%) is the best strategy to mitigate landuse problems. This agrees with Odjugo's (2010) view that due to increasing temperature and decreasing rainfall amount occasioned by climate change, farmers have resorted to shift in crops cultivated in northern Nigeria. Also

improvement on food storage and shortening cropping season as a remedy were identified whereas only a few respondents used provision of government subsidy, modern farming techniques, training by extension workers and use of modern technologies. Some of these findings are in support of strategies put forward by First National Communication (2003) and Canada-Nigeria Climate Change Capacity Development Project reports (2004) which emphasized the need for diversification to new plant species and varieties that would have higher resistance to anticipated temperature increase and reduced rainfall, adoption of zero/minimum tillage and other appropriate technologies to reduce soil erosion and loss of organic nutrients, but increase soil moisture availability and reduce weed and pest infestation. According to an FGD participant who is a farmer said that;

government has done well to provide improve variety of seeds as well as short seasoning crops. For instance some agricultural researchers(NAERLS/IAR) has set up some of their research site in our locality and has enlightened us on diversified landuse practices as well as the use of short season and improve variety of crops to boost our production. (Mal Abdullahi, 2016)

4.8.3 Adaptive Strategies to Mitigate Fuel Scarcity

Table 4.12 shows the distribution of respondents based strategies to reduce fuel scarcity.

Table 4.12: Strategies to Mitigate Fuel Scarcity

| Practice | Frequency | Percentage (%) |
|--|------------|----------------|
| Use of low-cost charcoal cooker | 78 | 49.5 |
| Public enlightenment on dangers of deforestation | 54 | 23.5 |
| Stop bush burning | 57 | 14.3 |
| Reduction in use of wood for cooking | 27 | 6.8 |
| Others | 183 | 5.9 |
| Total | 399 | 100.0 |

Source: Field Survey, (2016)

Table 4.12 show that the highest number of respondents (49.5%) agree to have used low-cost charcoal cooker as their most effective strategy to mitigate fuelwood consumption for domestic use, while the least of responses agree that reduction of wood for domestic fuel (6.8%) is their most effective strategies. This indicates that respondents are making effort by applying their traditional strategies to mitigate the impact climate change on their sources of domestic energy.

This idea was emphasised by another participant that;

we store cornstalk during harvest and use them instead of firewood. Because of our large families many of us that can't afford buy modern cooking equipment. However, we can afford to use low cost cookers like the ones that uses coal as a substitute (Alh.Sambo, Ungwan Juma, 2016).

4.8.4 Adaptive Strategies to Mitigate Hazards

Figure 4.4 shows the distribution of respondents according to their opinion on strategies to reduce hazard.

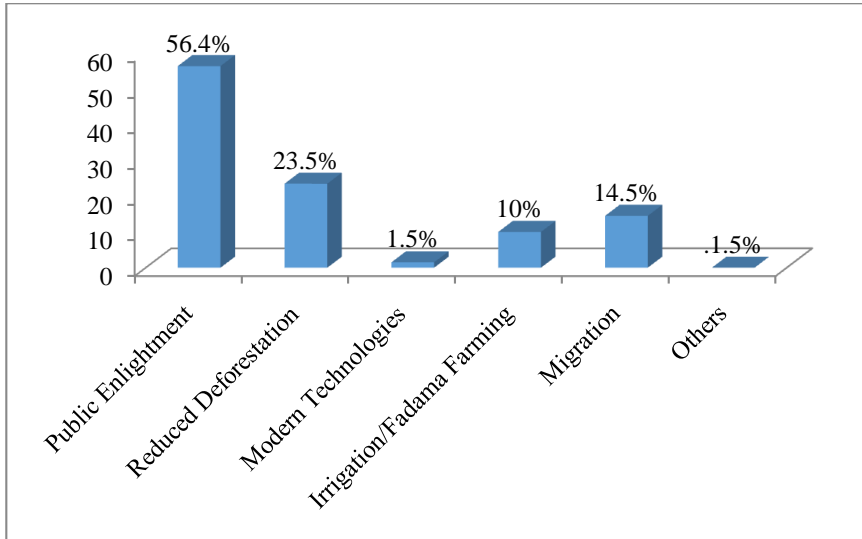


Figure 4.4: Strategies to Mitigate Hazards

Source: Field Survey, (2016)

Results in figure 4.4 reveals that more than half of the respondents about (56.4%) agreed that public enlightenment is the most effective strategies to reduce hazards, while a few are of the opinion that modern technologies and migration will reduce hazards .Others (1.5%) however sees prayers, proper implementation of environmental laws, government interventions, aids from non-governmental organisations, community assisted projects amongst others as the best strategies to reduce hazards. In support of the findings above a participant opined that

In case of hazards call for prayers to avert the evil menace and enlightenment through radio or TV programs in their local dialects goes a long way to reduce hazards from impact of climate change in our communities. (Jamil Garba, 2016)

In like manner another participant from Dambo and Zabi expressed that

Irrigation farming is an alternative to delay in the onset of rains. As put by him, we also encourage ourselves through community effort in afforestation in order to reduce deforestation or replace cutting down of trees (Muktar and Isah Dambo and Zabi, 2016).

4.9 MAJOR FINDINGS

Base on the research objectives;

1. The general perception of the people on climate change shows that the people in the study area have perceived climate change as changes in weather conditions over the last 30years.
2. The sources of livelihood which is very common to the study area is agriculture and communities have however experienced changes in their livelihood options as a result of low adaptive capacity.
3. On the aspect of vulnerability to climate change, the most disadvantaged groups are the farmers reasons is attributed the fact that the rural people depend on climate sensitive livelihood strategies and have low capacity.
4. Vulnerability to climate change is more on health and food supply.
5. The most common hazards that affects the study area flooding and drought
6. The most effective adaptive strategies to mitigate hazards is public enlightenment.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.2 Summary

- i. The study assessed the adaptation strategies to climate change on livelihood of rural communities in Zaria Kaduna State. Findings from the study reveal that more than half of the respondents were males, within the age of 30-39years, high level of literacy level was revealed and most residents have stayed in the area for over 30years.
- ii. The study found that majority of the people have a good knowledge of changes in climatic conditions and perceived climate change as changes in weather events such as increase in temperature, decrease in rainfall, decreased crop yield among others over the last 30years in the study area. This affirmed responses from the participants during the FGDs who also confirms that temperature has increased and rainfall has decreased with variability over the last 30years.
- iii. Based on obtained result obtain from the rural communities on vulnerability to climate change, the most disadvantaged groups are the farmers which is obvious owing to their over dependence on climate sensitive livelihood option (e.g. farming) and low adaptive capacity.
- iv. Climate change was discovered however to pose more threat on the health of the people and food supply in the area.
- v. Among many hazards that affect the community in the last thirty years flooding most common however, usually in wet season.
- vi. Rural community's engagement in adaptation strategies is through their traditional experiences of managing extreme weather events, for example Construction of boreholes

and wells were the major adaptive strategies for water scarcity in the area while diversifying land use as a remedy for land conflict and public enlightenment was suggested for hazard coping strategies in the area. Although modern technologies are available the adaptive capacity is low which is a major constrain to an effective adaptation in the study area.

5.2 Conclusion

This study has assessed the adaptation strategies to climate change on livelihood of rural community in Zaria, Kaduna State. From the study, it was observed that the people in the study have knowledge on climate change and they perceived climate change as changes in weather related event. The findings further reveals that the most vulnerable groups are the farmers and climate change have significant impact on their livelihood by compromising their health and food supply. Although, the people, based on individual efforts, have put various adaptation measures in place but much still need to be done. Zaria area is an urban centre with adjoining rural settlements with people pursuing diverse ecological and non-ecological dependent livelihood which make the community vulnerable because they lack adequate capacities to adapt. Consequently, the adverse impact of climate change will continue to erode their basic assets and needs and they will experience inexplicable changes in their livelihood options such as; health, security, biodiversity, social interactions, food and water which is why this study is carried out. Unless the effective adaptation strategies of the rural people in the study area is documented and inculcated into policy formulation on climate change the threat of climate change will continue to pose a threat to their environment.

5.3 Recommendations

In view of this findings on assessment of adaptation strategies to climate change on livelihood of rural communities in Zaria, Kaduna state. The following recommendations are made:

- i. More intensive but careful awareness creation should be embarked upon in the study area this can be made effective through mass media (television, newspapers and radio) this information which will provide a link between the people's traditional practices which will in turn enhance the rural peoples resilience to climate change vulnerability such as environmental degradation and the changing climate whose impacts they have begun to experience.
- ii. Integration of traditional practices into formal climate change mitigation and adaptation strategies will help the rural people to strengthen their adaptation strategies.
- iii. Extensive use of low cost charcoal cookers and other alternatives instead of wood burning devices should be encouraged which will limit the current pressure on the fastly disappearing forest.
- iv. To reduce vulnerability to climate change effect; there is need to promote practices such as, water harvesting, Afforestation programmes, planting of disease resistance crops, strategic irrigation farming, and improvement of early warning and communication systems should be embarked upon by the government to assist the rural people. These measures will both reduce the effects of climate change on humans and ecosystems to the barest minimum and strengthen the adaptive capacities and resources to withstand pressure from climate change.

- v. Rural dwellers should be encouraged toward intensification and diversification as a policy for rural development. Their livelihood sources can be improved through acquisition of skills needed for other livelihood option sources such local crafting, blacksmithing, trading, artisans, retail services civil service etc. which will further enhance rural peoples traditional adaptation strategies and strengthen their adaptive capacity to climate change effect.
- vi. Nigeria should partner with international agencies that can help build capacities in relevant government agencies at all levels (national, state, local) in order to develop and implement strategies and plans that would reduce her vulnerability to the impact of climate change
- vii. Government should ensure that appropriate policy on adaptation and mitigation are enacted and indigenous people (rural people) should be carried along in the design and formulation of policies on climate change.

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**APPENDIX I
DEPARTMENT OF GEOGRAPHY
AHMADU BELLO UNIVERSTY, ZARIA
KADUNA STATE.**

Dear respondent, I am a student of the above named university, carrying out research on “ASSESSMENT OF ADAPTATION TO STRATEGIES TO CLIMATE CHANGE ON LIVELIHOODS OF RURAL COMMUNITIES IN ZARIA, KADUNA STATE”. Please fill this questionnaire sincerely and be rest assured that all information will be treated with confidence and used only for academic purpose.

SECTION A

Biodata

Please (Tick (✓))

Gender: (a) Male () (b) Female ()

Age bracket (a) 19- 29 () (b) 30 –39 () (c) 40 – 49 () (d) 50-59 () (e) 60+ ()

Length of stay in the community

Above 30 years ()

20 – 29 ()

10 – 19 ()

Below 10 ()

Educational status of respondent

a) University ()

b) NCE/OND ()

c) School certificate ()

d) Primary school ()

e) Non formal education ()

f) Others specify _____

Occupation

(a) civil servant ()

(b) student ()

(c) farming ()

(d) trading ()

(e) others (specify) _____

Sources of information on climate change

Comment [b10]:

- TV ()
- Radio ()
- Printed materials ()
- Lectures/Teachers ()
- Colleagues/Friends ()
- Others (specify) _____

SECTION B

PERCEPTION ON CLIMATE CHANGE Please choose the options below to answer questions in the table to indicate your level of agreement.

Comment [b11]: Bold and cap

SA (Strongly Agreed) A (agree) UN (Undecided) D (Disagree)
SD (Strongly Disagree)

| | SA | A | UN | D | SD |
|--|----|---|----|---|----|
| 1. Temperature is decreasing | | | | | |
| 2. Rainfall is increasing | | | | | |
| 3. Harmatan/wind is stronger | | | | | |
| 4. Yearly rains are not supporting crop production | | | | | |
| 5. Crop infestation and diseases are increasing | | | | | |
| 6. Cost of food crops are increasing | | | | | |
| 7. Environment is suffering from excessive e de-vegetation | | | | | |
| 8. There is increase in fuel scarcity | | | | | |
| 9. flooding incidence is increasing | | | | | |
| 10. drought is increasing | | | | | |

13. What are the sources of livelihood in your household?

- (a) agriculture () (b) livestock () (c) forestry () (d) artisans () (e) business () non farming activities () others _____

SECTION C

Vulnerability Assessment Tick (✓)

14. Who are the people affected by climate change a. Farmers () b. artisans () c. civil servants () d. livestock keepers () e. Biomass resource users ()
15. The threat of climate change is felt more on
a. health () b. Food supply () c fuelwood availability () d. Business () e. Instigating disaster () f. biodiversity quality and sustainability ()
16. The incidence of climate change will affect the sustainability of our environment?
Yes () No ()
17. What is the reason for vulnerability?
a. low income b. Poor practices c. inadequate knowledge (d) others specify _____

SECTION D

Vulnerability and Adaptations Tick options (✓)

Water

18. What are the sources of domestic water supply in the community?
(a) borehole () (b) well () (c) tap () (d) others
19. Have sources of water change over the last 30 years?
Yes () No () if yes to what? _____
If yes specify the reason _____
20. Has your community been experiencing water scarcity over the past 30 years?
Yes () No ()
21. If yes, what are the reasons? _____
22. Does your community experience conflict arising from water scarcity?
Yes () No ()
23. What period of the year does conflict get critical?
(a) wet season () (b) dry season () (c) both seasons ()
24. What coping strategies is the community adopting against water scarcity?
(a) Construct boreholes and wells () (b) provision of pipe borne water () (c) improve water harvesting techniques () (d) conservation of H₂O casement () (e) others specify----
25. Which coping strategy is more effective? specify _____

Food Security

26. What types of agricultural activities do you engage in?
(a) crop production () (b) Animal production () (c) fisheries () (d) others specify _____
27. Any increases/decreases experienced in the last 30 years on crop and animal production?
Yes () No () state reasons _____
29. What are the reason for the increase/decrease?
(a) increase in temperature () (b) increase rainfall () (c) incidence of disease () (d) flooding () (e) drought () (f) others specify _____
30. Does community experience any clashes as a result of landuse?
Yes () No ()
31. What period of the year do these clashes get critical?
(a) wet period () (b) dry periods () (c) both periods ()
32. What are the coping strategies the communities adopt to remedy these problems
(a) Diversify land use () (b) cultivating different crops () (c) shorting group season () (d) training extension workers () (e) use of modern technologies () (f) improve food storage () (g) modern farming techniques () (h) provision of government subsidies () others specify _____
33. Which is strategy is more effective? specify _____

Energy

34. What are the sources of fuel for domestic use?
Kerosene () wood () others specify _____

35. Has communities experienced changes in source of fuel over the past 30 years?
Yes () No ()
36. Changes has led to decline in forest resources Yes () No ()
37. The environment suffers excessive de-vegetation due to climate change.
Yes () No ()
38. Communities experiencing fuel related conflict as result of difficulty in access
Yes () No ()
39. At what periods of the year do such conflicts get critical?
Wet season () dry seasons ()
40. How do communities solve these conflicts?
(a) Use of low cost solar energy cookers () (b) public enlightenment () (c) stop bush burning () (d) reduce use of wood for cooking furniture and roofing () (e) others specify_____
41. Which strategy is more effective? Specify_____

Section E

Exposure (risk and hazards)

42. What hazards affect your livelihood?
Drought () flood () bush/wild fire () invasive species () erosion () others (specify)

43. How often do communities experience these hazards?
Frequently () less frequently () more frequently
44. Which period of the year are the hazards severe?
Bazara () kaka () rani () damina ()
45. How does the hazards affect livelihood of the community?
(a) low () (b) moderate () (c) high ()
46. How do communities recover from the hazard or risk?
(a) very slowly () (b) slowly () (c) fast ()
47. What are the coping strategies adopted against these hazards?
Public enlighten () reduce deforestation () stop pollution () acquire modern technologies () old of improved seeds () irrigation/fadama faring () migration () other (specify)
48. Which strategy is more effective is the coping strategy? Specify_____

APPENDIX II

FOCUS GROUP DISCUSSION GUIDE ASSESSMENT AND ADAPTATION STRATEGIES TO CLIMATE CHANGE ON LIVELIHOOD OF RURAL COMMUNITIES IN ZARIA, KADUNA STATE.

| S/NO | General questions | Probe for |
|-------------|--|---|
| 1 | Are you aware of Climate? | How do you know about it? |
| 2 | Do you think climate is changing? | What is your reason |
| 3 | What are your source of livelihood? | Why the choice of this livelihood |
| 4 | What do you think are the factors affecting your livelihood choice? | Problems associative with the choice of livelihood |
| 5 | Which season usually do you experience climate change Hazards most? | What season in the year |
| 6 | What are the problems associate with effect of change in climate? | Issues regarding health, water, vegetation etc. |
| 7 | How do you cope with these issues with respect to your source of livelihood? | Adaptation strategies |
| 8 | How do you cope in respect of your environment? | Adaptation strategies use |
| 9 | Are there any form of help form country or other stakeholder? | Government, individual, NGO efforts at mitigating climate change. |
| 10 | Suggest ways of improving adaptation strategies and livelihood options. | Benefits |