Reports of Research Projects on Impacts and Adaptation -- Climate Change in Nigeria

A Compendium of Reports

Commissioned by Building Nigeria's Response to Climate Change (BNRCC) Project

Coordinated by
Nigerian Environmental Study/Action Team (NEST)
1 Oluokun Street, Off Awolowo Avenue
Bodija, UI-PO Box 22025
Ibadan, Oyo State, Nigeria

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Preface and Acknowledgements

The heightened impacts of climate change in Nigeria and other developing countries, which are likely to intensify in the coming years, have overwhelmed local and traditional knowledge and technologies, leaving many people with inadequate information and little means to deal with the challenges. In addition, there are too few government policies and strategies to address climate change impacts. To tackle these issues, the 'Building Nigeria's Response to Climate Change' (BNRCC) project was implemented between 2007 and 2011 by the consortium of ICF Marbek, CUSO-VSO and by the Nigerian Environmental Study/Action Team (NEST), with financial support from the Canadian International Development Agency (CIDA).

The BNRCC project components included research and pilot projects, policy development, communication and outreach as well as youth and gender initiatives. The research projects involved community-level socio-economic and future climate scenario studies, while the pilot projects engaged partners and communities in all of Nigeria's ecological zones.

Mainstreaming gender equality was integrated throughout all components, and communications activities built awareness at all levels, from the communities to government agencies. Lessons and knowledge generated from the project components fed into the development of the National Adaptation Strategy and Plan of Action on Climate Change for Nigeria (NASPA-CCN), which was prepared in partnership with the Special Climate Change Unit (SCCU) of the Federal Ministry of Environment, and other partners.

Publications that have emerged from the BNRCC Project include: the *National Adaptation Strategy and Plan of Action on Climate Change for Nigeria* (NASPA-CCN); the *Climate Change Adaptation Strategy Technical Reports* (CCASTR), which is a precursor to the NASPA-CCN; *Climate Change Scenarios for Nigeria: Understanding Biophysical Impacts; Gender and Climate Change Adaptation: Tools for Community-level Action in Nigeria; and Learning from Experience – Community-based Adaptation to Climate Change in Nigeria*, a practitioners' guide to climate change adaptation based on BNRCC's experience with pilot projects in vulnerable communities. In addition, BNRCC produced two documentary films on climate change in Nigeria: *Water Runs Deep* and *In the Red Zone*. All publications and films are available on-line at www.nigeriaclimatechange.org and www.nestinteractive.org.

Primary contributors to this document are three BNRCC's research partners who implemented the research projects in nine states (Rivers, Ondo, Akwa Ibom, Bayelsa, Delta, Enugu, Imo, Abia, and Anambra States) of Nigeria. All three partners, Rural Linkage Network (RULIN), the University of Uyo (UNIUYO) and Women and Children Development Initiative (WACDI), were committed to climate change adaptation research, focusing mainly on the socio-economic impacts of climate change hazards as well as community vulnerability and adaptation options. Also the researchers integrated the gender implications of climate change impacts and vulnerability because climate change affects men and women differently. The hard work and dedication of the researchers, along with community contributions of time and knowledge, certainly contributed to their success in adding to the growing body of literature on climate change in Nigeria. In addition, we want to thank all the respondents, discussants, and interviewees who dedicated their time, interest, materials and labour to provide all relevant information to BNRCC research partners. It is also important to acknowledge the commitment to the projects by the Research Project Advisory Group (RAG) members: Dr Austin Nnaji (Chair), Prof. Aloysius Nwosu, Dr.

Emmanuel Nzegbule and Dr. Appolonia Okhimamhe. Thank you also goes to Dr. Mrs. Ibidun Adelekan who served as the Pioneer BNRCC Research Projects Programme Officer. A very big thank you to Prof. Eric Eboh who acted as an external reviewer to the draft of these research reports. Finally, thanks to NEST staff who did the in-house review of these research reports including Robert Onyeneke (Research Officer), Dr. Ellen Woodley, Christian Ichite, Emily Bullock, Dr. Brent Tegler and Prof. Chinedum Nwajiuba.

BNRCC appreciates the contributions and commitment by members of the Project Steering Committee (PSC) and the Advisory Groups for the research, pilot projects and communications activities. All of these members served as volunteers. Also deeply appreciated are those people in the public and private sectors, including NGO representatives, who assisted in various capacities during the five years of the BNRCC project. All of these efforts – and sacrifices – and the resources expended will enhance Nigeria's capacity to adapt to climate change and we expect they will be of benefit to humanity.

BNRCC is pleased to publish this compendium of research project reports, in order to encourage knowledge sharing, discussion and action on climate change adaptation. Although BNRCC has edited the reports for publication, in all cases responsibility for the content rests with the authors.

Introduction

The world's climate is changing and changing fast, bringing about new threats and opportunities. Climate change is defined by the Intergovernmental Panel on Climate Change (IPCC) as a variation in the mean state of the climate, persisting for an extended period of time (typically decades or longer). The United Nations Framework Convention on Climate Change (UNFCCC) defines climate change as a change of climate which is attributed directly or indirectly to human activity, that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods. In April 2007, the IPCC concluded that Africa is one of the continents that is most vulnerable to climate change owing to "multiple stresses and low adaptive capacity", and despite the fact that some adaptation is taking place "this may be insufficient for future changes in climate".

Nigeria is vulnerable to the impacts of climate change largely because about 70% of Nigerians are engaged in small holder rain-fed agriculture. For Nigeria, agriculture is important because about 42% of the country's GDP comes from agriculture and related activities. The impact of climate change is very visible in most communities in Nigeria, from the Sahel in the north to the rainforest and coastal zone in the south. The high population coupled with high poverty levels and rapid economic growth, are making huge demands on Nigeria's natural resources. Climate change impacts compound existing pressures on these resources.

Drought in the north, for example, has led to poor crop yields, water scarcity and forced migration. In the south, sea level rise increases the risk of flooding, salt water intrusion and displacement of people and livestock. Erosion associated with heavy rainfall and flooding is now a frequent threat in most ecological zones in Nigeria, especially in the rainforest where mudslides can occur. Loss of biodiversity is now a common trend in all ecological zones of Nigeria and this trend only makes natural resource-dependent communities more vulnerable.

This document is a compendium of reports on research projects, which were implemented by three partners as a part of the Building Nigeria's Response to Climate Change (BNRCC) project. The researchers focused mainly on the socio-economics of climate change hazards, impacts, vulnerability and adaptation. Each of the three reports, written by BNRCC's partners, outlines the introduction, literature review, methodology, results and discussions and conclusions and recommendations from their research.

The research projects assisted in achieving the BNRCC goal of building informed responses to climate change in Nigeria by enhancing capacity at the community, state, and national levels to implement effective adaptation strategies, policies and actions. The project partners were selected through a competitive process with clear selection criteria, starting with an Expression of Interest (EOI) and followed by the call for proposals. The BNRCC project facilitated the implementation of the research by supporting the three partners in conducting research that generated gender disaggregated socio-economic data on climate change

The selected partners were mainly researchers in Nigerian Universities. The research project partners and the states that they worked in are: i) Rural Linkage Network (RULIN), an NGO based in Asaba, Delta State. RULIN is composed by a team of researchers at the Delta State University, Asaba. RULIN conducted an Assessment of Impacts, Vulnerability, Adaptive Capacity and Adaptation to Climate Change in the Niger-Delta Region, Nigeria; ii) A team of researchers at the University of Uyo in Uyo (UNIUYO), in Akwa Ibom State, who analysed

Adaptation to Climate Change and Variability by Farming Households in the Niger Delta Region; and iii) Women and Children Development Initiative (WACDI), an NGO based in Umuahia, Abia State, composed of a team of researchers from the Michael Okpara University of Agriculture Umudike, Abia State, Nigeria. WACDI analysed Gender Dimensions and Indigenous Knowledge for Adaptation to Climate Change in South East Nigeria.

While appreciable progress has been made in generating gender-disaggregated information on climate change hazards, impacts, vulnerability and adaptation in the nine selected states in Nigeria, much more research of this kind needs to be done in other states, especially in northern Nigeria. It is hoped that findings of these research projects will be meaningful to all stakeholders, including policy-makers. The huge gap in knowledge on the socio-economics of climate change in Nigeria has been partially filled by the empirical findings provided by these research projects.

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Nigerian Environmental Study/Action Team - NEST
Ibadan
October 2011

REPORT 1: ADAPTATION TO CLIMATE CHANGE AND VARIABILITY BY FARMING HOUSEHOLDS IN THE NIGER DELTA REGION, NIGERIA

A Research Report by the Department of Agricultural Economics & Extension, University of Uyo (UNIUYO), Uyo, Akwa Ibom State

ADAPTATION TO CLIMATE CHANGE AND VARIABILITY BY FARMING HOUSEHOLDS IN THE NIGER DELTA REGION

Research Report
University of Uyo (UNIUYO)

MARCH 2011

Prepared For:
Building Nigeria's Response to Climate Change (BNRCC) project
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Thirdly, we thank the authorities of the University of Uyo for granting to the team the use of its facilities for some aspects of research. Thanks are due our enumerators and numerous respondents, discussants and key informants, across the communities of Akwa Ibom, Ondo and Rivers States who volunteered their time and information.

Fourthly, we also wish to thank Dr. Solomon Lanride of the University of Port Harcourt who had to be drafted in to assist in data collection in Rivers State. Our warmest thanks go to Frank Namso, a Ph.D student in the Department of Agricultural Economics and Extension, University of Uyo who worked tirelessly with the team even beyond work hours, including weekends. We are also grateful Ms. Glory Umanah for painstakingly coding the data in the computer and typing the research report.

Finally, we owe a debt of gratitude to members of the Research Advisory Group for their helpful comments on our reports at the various stages of the research. Their inputs have really helped give the study itself and the final report both focus and quality.

EXECUTIVE SUMMARY

The Niger Delta is a complex and fragile environment. Almost all oil production activities in Nigeria take place in the region, which spans from upland areas to the deep sea. Oil exploration in the region brings with it environmental degradation of monumental dimensions. The Niger Delta is located in the Atlantic Coast of southern Nigeria where the River Niger divides into numerous tributaries. The Niger Delta is made up of nine states, namely Abia, Akwa Ibom, Bayelsa, Cross River, Delta, Edo, Imo, Rivers and Ondo. It has a total population of 27,696,577 (National Population Commission, 2006).

Climate variability and long term change has assumed importance in international and national discourse due to its impacts on all facets of human life. Changes in climate could interact with other forms of stress associated with agricultural production and affect crop yields and productivity in different ways, depending on the types of agricultural practices and system in place. In Niger Delta, the main direct effects are through changes in temperature, precipitation, length of growing season, and timing of extreme or critical threshold events relative to crop development. Availability of climate information to households, understanding household vulnerability to the impact of climate change and the ways climate change and variability impacts on households as well as household adaptation to these impacts is becoming increasingly important for sustainable adaptation. This paper summarizes findings on these processes in the Niger Delta. Research was conducted in three states (Akwa Ibom, Ondo and Rivers) out of the nine states in the region.

Trends in and variation in climate

Trends analyses indicate that both rainfall and temperature have been on the increase in the Niger Delta Region. The trend lines for rainfall and temperature are found to be positive for the three states studied except rainfall in Rivers State. The trend for rainfall in Rivers State is negative indicating that rainfall amount has been on the decline over the years. The observations of the respondents across the states and agro-ecological systems also indicate a lack of pattern or uniformity of either temperature or rainfall amount. Most respondents however, reported an increase in rainfall amount but its onset, cessation and duration are variable. Respondents also reported higher than normal temperatures, which is supported by the scientific literature.

Climate information sources, accessibility, availability and perceptions

There are no formal institutional sources of information available to farmers and fisher folk. General weather information is received from the mass media mainly television (NTA), radio and newspapers. Accessibility of climate information sources is inadequate. Even though there are institutions with the mandate to supply tailor-made information to farmers and fisher folk, they have no access to information. Weather stations reported that most users of climate information are institutions such as airlines, companies and researchers. Climate information is supplied on demand and therefore not available to the farmers and fisher folk. Farmers and fisher folk consider climate information received through mass media sources as not regularly available and inappropriate for their livelihood activities.

Awareness, knowledge level and understanding of local forcings

Farmers have general but limited understanding of climate change. They simply have heard that the climate is changing. Their understanding of local forcings of climate variability and long-term change (i.e. local actions that contribute to climate change) is low. In some of the communities studied, certain individuals possess indigenous knowledge (IK), however, very few own up to having this knowledge due to negative perception of community members towards persons with this skill.

Vulnerability of households to climate variability and long-term change

Both male and female-headed households in all the uplands, wetlands and fishing communities are vulnerable to flooding, windstorms, erosion and drying of streams. People in the fishing communities are more vulnerable to sea level rise. Respondents feel that these hazards may continue in the communities in the future and that mudslides and landslides could occur in their communities due to the current climatic situation. Those factors considered to make households vulnerable to the climate hazards are: low agricultural output and income, non-availability of irrigation facilities, insufficient farm labour, lack of storage facilities and inadequate transport.

Except in Rivers State, farming and fishing households tend to spend less on food during disasters. This suggests that there is a lack of income to buy food. Most households lack the technical capacity to adapt to climate change and variability. There is high level of dependence on agriculture, and households are located to areas susceptible to the impact of climate hazards and are thus vulnerable to climate change impacts.

Impacts of climate variability and change

Both men and women have been adversely affected by the impacts of climate variability and change. Both men and women in farming and fishing households have lost properties due to floods, sea level rise and erosion; have lost income; have had poor crop yields; and experience health problems. The male respondents in the fishing communities also suffer from low fish catch, which affects everyone in the communities dependent on fish as a food source and as income.

Adaptation measures

Households adopt a number of measures to adapt to the impacts of climate variability and change. Upland and wetland farmers use hand irrigation, plant on mounds, use soil augmenting technologies such as fertilizers, and plant shade trees. In the fishing communities, women fish close to the shore while men fish further ashore. The men now equip their boats with deep freezers to preserve their catch. Adaptive capacity depends on income, farm size, community type and household size.

Conclusions

Communities in the Niger Delta are vulnerable and have limited adaptation measures to climate change-related events and extremes. Communities with different livelihoods experience different types of climate risks. For instance, the communities along the coastline are confronted with the risk of ocean surge and sea level rise, while the wetland communities are faced with the risk of pests and flooding. More studies that focus on the community-specific risks such as ocean surge and sea level rise are needed in the Niger Delta region. There exists a vast indigenous and traditional knowledge of weather/climate and climate variability and change which could be tapped for sustainable adaptation to climate variability and long term climate change. To draw on this body of knowledge would require more research time than the present study permitted. Indigenous knowledge on climate and climate variability and long term change is being lost due the negative perception of those who possess this knowledge by other members of the community.

Policy implications and recommendations

The examination of adaptation to climate change and variability by farming and fishing households in the Niger Delta provides lessons that can help improve the design of policies for climate change adaptation. The relevant Nigerian and global institutions are making efforts to make policies that will enhance communities', households' and individuals' adaptation to climate change. Yet one important finding of this study is that a large percentage of the Niger Delta population lacks science-based knowledge of climate change. Therefore, rigorous awareness creation using science-based information should be the starting point for policy aimed at effective adaptation. It is evident that the Niger Delta people are deeply religious. Thus, it could be suggested that religious institutions become involved, together with other means to disseminate climate change information. This is already being done with HIV/AIDS, polio, immunization and "Roll Back Malaria" programmes.

The second policy-related finding of this study is that available weather information gathering institutions do not make weather/climate information available to the public. Climate information from the media is not addressed to the particular needs of the farmers and fisher folk. Therefore, policy is required that will make relevant climate information available to the different end-users on time. It is recommended that the mandates of existing weather stations be modified to include dissemination of climate information to resource-dependent people and communities. Community-based weather/climate information stations should be established. School-based geographical gardens should be established with a qualified official, preferably a school teacher with background in geography and allied subject. The study reveals that indigenous knowledge of climate is not preserved or widely appreciated in the communities. This knowledge may be facing the danger of extinction. The use of IK should be promoted through patronizing the services of custodians of this knowledge, followed by a comprehensive study on the existence of this knowledge and integration of this knowledge into the climate change information system.

The third important policy-related finding of this study is that the local people have limited ways of adapting to the impact of climate variability and long term climate change. This poses immediate challenges to policy makers as well as development agencies. IPCC (2007) noted that much more extensive adaptation than is currently occurring is required to reduce vulnerability to climate change. Policies that could enhance the capacity of communities are required. It is recommended that a climate change component be introduced into the annual Tree Planting Campaign. The campaign should include management of shade trees so that they are maintained and valued. The Community Climate Change and Environmental Workers (CCEW) programme should be established so that technical workers in this scheme work with the communities to establish and manage the trees in avenues and parks.

The result of the study indicates that the upland and wetland farming households are vulnerable to flooding, windstorms, and drying up of streams, erosion and other water bodies.

The wetland and fishing communities are also exposed to sea level rise. Several factors are rated as “very important” in exposing the farmers and fisher folk to the impacts of climate hazards. These are low agricultural output, non-availability of irrigation facilities, insufficient farm labour, and lack of agricultural commodities/food storage facilities, low income and inadequate means of transportation, particularly in the fishing communities. Besides the current climate-related hazards, farmers and fisher folk report that mudslides and landslides can occur in their communities. To assist the communities adapt to these hazards and impacts, it is recommended that an early warning system for extreme climate events be established. Without this warning, such events could destroy crops or kill livestock that farmers and fisher folk rely on for livelihood. Emergency evacuation systems should be established to evacuate farmers and fisher folk in cases of imminent risk.

Climate variability and change has impacted on the communities in many ways. Chief among these are loss of income, poor crop yield, loss of property and health problems (skin rashes, etc.). These affect men and women alike. In addition, the fisher folk experience low fish catch. These impacts lead to increasing poverty of farming and fishing households. Therefore, programmes that will reduce the vulnerability the farmers and fisher folk’s livelihoods to climate change impact are imperative. Income opportunities, income-support programmes and capacity building on enterprise development and management are recommended. This will enable farmers and fisher folk to diversify their income sources in order to reduce their vulnerability to climate variability and change.

Farming and fishing households have already implemented a few adaptation options to reduce the impacts of climate variability and long-term change, which include using hand irrigation, land management (e.g. fertilizers), planting on mounds and also planting shade trees to reduce the effect of extreme heat. These in-place cultural practices should be improved upon and scaled up. Irrigation schemes should be also established to make water available for farming.

The “ordered probit analysis” used for determining the factors shaping the adaptive capacity of the farmers shows that household size negatively impacted on the adaptive capacity of households. To improve this situation, the implementation of national policy on family size should be re-initiated. In the absence of any existing policy, one should be formulated and implemented. Such a policy, if effectively implemented, could control household size and thus release household resources to take care of other needs such as adaptation strategies.

1. INTRODUCTION

Background of the Study

The Niger Delta is a complex and fragile environment. Almost all the oil production activities in Nigeria take place in the region, which spans through the uplands to the deep sea. Oil explorations in the region bring with them environmental degradation of monumental dimensions. Of particular concern has been enormous and consistent gas flaring which has taken place in the Niger Delta since the inception of oil production in the region. According to Okoh (2001), gas flaring has become a dominant feature of the upstream activity in the petroleum industry in the Nigerian economy. The report states that of the 285,306.95 million tonnes of natural gas produced between 1961 and 1998, 82 % was flared. Similarly, an estimate by Ibeanu (2000) indicates that between 1982 and 1983, 13,361,783,851 cubic metres of gas was flared and by 1991, Nigeria exceeded the world average for natural gas flaring by 72%. The International Finance Corporation (IFC) and the World Bank estimated the percentage of gas flared in Nigeria at 76% (IFC/World Bank, 1993). The Constitutional Rights Project (1999) also reports that at the time of writing its report in 1999, Nigeria flared about 75% of all the gas occurring in the course of crude oil production. They concluded that this constituted a major source of air pollution, emitting huge amounts of smoke, carbon dioxide, methane from over 100 flow stations. Environmentalists and communities allege that they have been experiencing acid rain, with dire consequences for the ecology, particularly agricultural land and water resources. Ibeanu (*op cit*) concluded that apart from the large amounts of greenhouse gas that gas flaring puts into the atmosphere, constant flares also affect both wildlife and human beings negatively.

Traditionally, agriculture (crop farming and livestock rearing) and fishing are important livelihoods in the Niger Delta. Both the uplands (dry land) as well as wetlands are cultivated. Studies (Umoh, 2000; 2008) have shown that farmers, particularly wetland farmers, operate between two extreme conditions- flooding and drought, conditions that are associated with changes in climate in the region. Data from the National Bureau of Statistics (NBS - Nigerian data gathering agency) indicate variation in such climatic elements as rainfall and temperature. For example, the mean annual rainfall in Akwa Ibom, Ondo and Rivers States was as high as 2,618.6mm, 1,699.5mm and 1,644.8mm respectively in 1994. This decreased to 180.2mm, 121.2 and 203.1mm respectively in 2004 (NBS, 2005; 2007). It is obvious from the foregoing that both local and global actions exert negative consequences on the climatic conditions of the Niger Delta region, which particularly affect the agricultural sector.

Many studies (IPCC, 2001; Nhemachena & Hassan, 2007) on climate change argue that it is necessary to focus on current problems and adaptation to climate change in order to develop strategies that will adequately respond to anticipated changes in climatic conditions. The IPCC (2001) for example, maintains that adaptation to current climate variability and extremes often produces benefits as well as forms a basis for coping with future climate change. The study is focused on filling the gaps in empirical data and information on how vulnerable households, particularly farming and fishing households are impacted by climate change and variability and how they adapt to these variations in climate. It is hoped that the outputs from this study can assist in informed policy decisions on climate change, vulnerability and adaptation.

Rationale for the Study

Agriculture was the mainstay of the Nigerian economy before the discovery and subsequent production of petroleum (oil) in commercial quantities. Despite the dominance of oil as a foreign exchange earner, agriculture has continued to play pivotal role in the growth and sustenance of the

Nigerian economy. Records (National Bureau of Statistics, 1997; Central Bank of Nigeria, 2006) reveal that not less than 70% of the Nigerian population depends on agriculture for its livelihood. Agriculture provides food and fibre for human use. Agriculture in Nigeria is largely rain-fed. Crop cultivation as well as livestock production depends on rainfall. Nigeria's agriculture is therefore strongly influenced by annual and inter-annual variations in rainfall and other climatic factors and highly sensitive to the vagaries of weather, especially variability in rainfall. According to Zabbey (2007), about 80% of the total rainfall over Nigeria occurs in the five months between May and September. While drought is a recurring problem in the northern part of the country, floods cause serious damage to livelihoods and agriculture in the south (NEST, 2004). Climate variability and long-term climate change may pose serious threats to agricultural production and to the livelihoods of 98 million people in Nigeria, with considerable social and economic consequences where about 70% of the population is engaged in agriculture (Zabbey, 2007). However, vulnerability to climate change is not evenly distributed across regions, social groups and livelihoods in Nigeria. Information on adaptation to climate change at the local level and particularly among those who form a greater proportion of the agricultural workforce in Nigeria - women - is rather scanty.

According to a report by the Intergovernmental Panel on Climate Change (IPCC) (2001a), rainfall in southern Nigeria, where the Niger Delta is located, is expected to increase, accompanied by an increase in cloudiness and rainfall intensity, particularly during severe storms. This was also expected to result in shifts in geographical patterns of precipitation and changes in the sustainability of the environment and management of resources. The inter-annual variability index for Nigeria indicates variation in the amount of precipitation recorded over a 40 year period (NEST, 2004). The study also reported a distinct increase in precipitation over the years in Akwa Ibom and Ondo State but a decrease in Rivers State indicating change in climate over the region.

Changes in climate will interact with other forms of stress associated with agricultural production and affect crop yields and productivity in different ways, depending on the types of agricultural practices in place (Watson et. al, 1997). In the Niger Delta, the main direct effects will be through changes in temperature, precipitation, length of growing season, and timing of extreme or critical threshold events relative to crop development (Oyekale, 2008).

Farming is practised in two slightly different agricultural ecosystems in the Niger Delta: upland and wetland. Each could be impacted upon differently by climate change. For example, studies (e.g. Gwarry, 1995; Kolawole, 1997; Umoh, 2000) have revealed that wetland farmers operate between two extreme weather conditions – flood and drought. According to Kolawole, "fadama" (wetland) farming is faced with the management of risks, which include the fluctuation of the water table, and the attendant dangers of flooding, especially during the rainy season. The second risk is the danger of inadequate water supply at the end of the dry season. Caught within the two extremes, farmers have had to strike a delicate balance between water stress on the one hand, and flooding on the other. Therefore, the vulnerability of wetlands farmers to climate change and variability may not be the same as that of upland or dryland farmers.

To date, there are few comprehensive studies aimed at improving adaptation strategies to climate change in Nigeria. Adejuwon (2004) suggested that the links between climate change and declining agricultural productivity in Nigeria will remain a subject of research for a long time. There exists a wide knowledge gap in the subject matter of impact of climate change and variability on agriculture in Nigeria. Research on the dynamics of adaptation in households, the processes of adaptation decision making and the conditions that influence adaptation is require. It is a strongly-held opinion that any assessment at the national level must take account of regional patterns of vulnerability within the country and the distribution of vulnerability within the national community (Adger, et al., 2004). This study addresses this concern from three perspectives.

First, the study focuses on the Niger Delta region, a region of global importance as far as environmental degradation and indeed climate change and variability is concerned. This region presents itself as a good subject for studies on climate change.

Second, it has been asserted that it is less meaningful to aggregate vulnerability across scales since the causes of vulnerability are different at each scale (Adger, 2004). Also, vulnerability differs by sector, as it is clear that the activities and operations taking place in the industrial sector are not the same as those in agriculture or mining. Therefore, it is important to develop our understanding of vulnerability and adaptation to climate change by examining each sector separately. Several authorities (IPCC, 2001b; Nwosu, 2008; Speranza, 2010) have reported that agriculture is the most vulnerable of all sectors, particularly in developing countries.

Third, there is dearth of empirical information on adaptation to climate change.

Studies on climate change adaptation in sub-Saharan Africa are recent and include those by Nhemachena & Hassan (2007); Deressa et al. (2008); and Speranza (2010). Nhemachena & Hassan (2007) examine farmers' adaptation strategies to climate change in three Southern African countries (South Africa, Zambia and Zimbabwe) using cross-sectional data. The study found access to credit and extension and awareness to climate change as some of the important determinants of farm – level adaptation. Deressa (*op cit*) investigated the major methods used by farmers to adapt to climate change in the Nile Basin of Ethiopia, the factors that affect their choice of method, and the barriers to adaptation. The methods identified include use of different crop varieties, tree planting, soil conservation, early and late planting, and irrigation. Results from the discrete choice model employed indicate that the level of education, gender, age, and wealth of the head of household; access to extension and credit; information on climate, social capital, agro-ecological settings, and temperature all influence farmers' choices. The main barriers include lack of information on adaptation methods and financial constraints. The study further reveals that age of the household head, wealth, and information on climate change, social capital, and agro ecological settings have significant effects on farmers' perceptions of climate change. Speranza (2010) analyzed how resilient adaptation of smallholder agriculture in Africa can be achieved. This study focused on testing adaptation tools to assess the resilience of sub-Saharan agriculture to climate change.

In Nigeria, a handful of studies are emerging on climate change adaptation. Onyeneke & Nwajiuba (2010) investigated socioeconomic effects of crop farmers' adaptation measures to climate change in the south eastern rainforest zone of Nigeria using multinomial logit model. The study found that the socioeconomic characteristics of farmers significantly affect the uptake of adaptation measures to counteract the negative effects of climate change. Umoh & Eketekpe (2010) used the "production function approach" to measure the impact of adaptation on crop outputs. The study found that labour and the level of education of the farmers were important determinants of the impact of adaptation on crop output. These studies used cross-sectional data in their analysis.

In spite of the global concern and the obvious vulnerability of the Niger Delta region to climate change given its long coast line and related industrial activities, the empirical investigation of climate variability and long term change, particularly households' vulnerability and their adaptation strategies, have not been given sufficient attention. This study analyzed vulnerability and adaptation from two broad perspectives: a gender perspective and an agro-ecosystem perspective. It also analyzed the trends in important climatic elements that affect agriculture in the Niger Delta in particular and Nigeria in general. In this way, inferences are drawn across gender and agricultural ecosystems. By agricultural ecosystem the definition provided by Ritter (2006) is used: a functioning agro-entity of all the organisms in a biological system generally in equilibrium with the inputs and outputs of energy and materials in a particular environment. In this study, three of such systems are focussed on: i) upland/dryland; ii) wetland/lowland (both for crop farming); and iii) fishing communities.

Given the lack of empirical information on adaptation to climate change, the output of this study contributes to bridging this information gap. This may be useful to provide input to informed policy on sustainable adaptation to climate change, not only in the Niger Delta region and Nigeria, but other regions with similar attributes as the study area.

Objectives of the Study

The goal of the study was to assess the impact of climate change on farming and fishing households in the Niger Delta and to examine how households have adapted to climate change. The specific objectives of the study are to:

1. Analyze trends in climate elements in the Niger Delta region;
2. Identify climate information sources, their availability, accessibility to male and female wetland and upland farming and fishing households and their perceptions of the available sources in the Niger Delta Region;
3. Determine male and female wetland and upland farming and fishing households' awareness of climate change, level of knowledge of climate change and understanding the key drivers of climate change;
4. Assess the vulnerability of male and female upland and wetland farming and fishing households to climate change in the study area;
5. Examine the impact of climate change on male and female-headed farming and fishing households in the study area;
6. Assess male and female-headed upland and wetland farming household's adaptation/coping strategies to climate change; and
7. Based on the findings of the study, make recommendations to enhance farming and fishing households' resilience and response to climate change and associated risks.

Scope of the Study

This study focuses on the Niger Delta region, which comprises nine of the thirty six states of Nigeria. A region-wide study using representative states (Akwa, Ondo and Rivers States) of the region was conducted. The study covered several aspects of climate change, which include vulnerability, impact, and adaptation to climate change as well as their gender dimensions. The study also focused on three agro-ecosystems that are predominant in the region: upland and wetland ecologies as well as fishing communities. This focus was to address micro-differences in environmental factors which might influence adaptation to climate change.

2. LITERATURE REVIEW

Since global attention was drawn to the phenomenon of climate variability and long term climate change, several empirical assessments have been carried out. However, early assessment studies tended to ignore adaptation (Tol et al., 1998 cited in IPCC, 2001c). This gave rise to the so-called "dumb farmer" scenarios, which are based on the assumption that farming communities will not anticipate or respond to changes in climate (Rosenberg, 1992; Easterling et al., 1993; Smit et al., 1996 cited in IPCC, 2001c). Recent climate change impact studies have attempted to incorporate adaptation in their modelling. Such studies include Nicholls & Leaterman (1995) for coastal zones; Mendelshon et al. (1994) and Rosenzweig & Parry (1994) for agriculture. These studies show the importance of adaptation measures in decreasing potentially adverse impacts of climate change and leveraging the benefits, if any, associated with changes in climate. Rosenzweig & Parry (1994) showed that there is great potential to increase food production under climate change in many regions of the world if adaptation is taken into consideration. A similar conclusion was arrived at by Downing (1991) who reported that adaptation has the potential to reduce food deficits in Africa from 50% to 20%. Mendelsohn & Dinar (1999 cited in IPCC, 2001c) also found that adaptation was estimated to reduce the potential damages from climate change from 25% to 15-23 % in Indian agriculture.

Some studies have investigated the potential of certain adaptation measures in mitigating the impact of climate change on agriculture. Bradshaw et al. (2004) assessed the adoption of crop diversification in Canadian prairie agriculture for the period 1994-2002, reflecting upon its strengths and limitations for managing risks, including climatic ones. Results showed that individual farmers have become more specialized in their cropping patterns since 1994 and this trend was unlikely to change in the immediate future, notwithstanding anticipated climate change and known risk-reducing benefits of crop diversification.

On adaptation measures, Speranza (2010) found that adaptation is a continuum of practices which ranges from activities that are predominantly for development to those that focus on reducing climate change. The study concluded that no single measure is sufficient to adapt to climate change. Rather, a mix of measures is required which targets the various farm variables – water, soil, micro-climate, seeds and crops as well as labour and capital. At the level of farm management, the study highlighted the close link between climate change adaptation and mitigation in the agricultural sector. It submitted that many of the adaptation practices such as mix cropping, green manure, agro-forestry and improved range land management sequester carbon, thereby reducing greenhouse concentrations in the atmosphere. The study recommended that good land management practices have potential for poverty reduction, environment and climate protection. It further asserted that for adaptation to be sustainable, local knowledge should be combined with other knowledge systems.

Several studies have taken a broader look at the impact of natural disasters. For example, Auffret (2003) studied the impact of natural disasters in 16 countries in Latin America and the Caribbean. The study found the impact to be so significant that the volatility of consumption in the Caribbean was higher than any other region in the world. The study also found that higher volatility was a result of a significant decrease in investment and production shocks. Other studies have focused on the impact of disasters on growth. There, however, seems to be certain degree of conflicting evidence in this case, in particular, on long term growth. While Benson & Clay (2003) argued that the impact of natural disasters on long-term growth is negative, Skidmore & Toya (2002) are of the view that disaster may positively impact on long-term growth as the effect of a natural disaster may be to reduce the return on physical capital thereby increasing the relative return to human capital. This may consequently induce growth in general.

Taking a more comprehensive assessment of the impacts for a larger group of economies in the Caribbean region, Rasmussen (2004) reported that a short-term impact of disaster is an immediate contraction in output as well as a significant worsening of external balances, resulting from higher expenditure and lower receipts. Heger et al. (2008) analyzed the impacts of natural hazards in small islands economies using the Caribbean as a case study. The study concluded that the high vulnerability of the region is due to a combination of a high frequency and intensity of natural hazards.

Many efforts have been made to measure the economic impact of climate change on agriculture focusing mainly on developed countries (Adams, 1989; Rosenzweig, 1989; Kaiser et al., 1993; Mendelsohn et al., 1994). Few studies have been conducted on agricultural systems in developing countries. Studies by Winter et al., (1996); Dinnar et al., (1998); Kumar & Parikh, (1998); Mendelsohn et al., (2000) have looked at issues in developing countries. In Nigeria, such efforts have been very recent and are few in number. Attempts in this area have been by Atairet (2010), Umoh & Eketekpe (2010).

Atairet (2010) estimated the correlation between climate elements and crop outputs as well as the impact of variation in climate on agricultural output. The study found a positive relationship between mean annual rainfall and output of millet and groundnut while outputs of oil palm, cassava, yam, cocoa and maize were inversely related to rainfall volume. Temperature, on the other hand was found to be inversely related to outputs of all the aforementioned crops. The two climate elements, rainfall and temperature, were found to be significant determinants of crop outputs. While some of the studies focus on the agricultural sector as a whole, others analyse the impact of climate change on specific crops. For instance, while Schulze, (1993) and Du Toit et al., (2001) analyzed the impact of climate change on maize production, Kiker, 2002 and Kiker et al., 2002 studied the impact of climate change on sugarcane farming in South Africa. These studies adopted the production function approach which excluded farmers' adaptations. This shortcoming was addressed by Deressa, et al. (2005) who employed a Ricardian model that captured farmers' adaptation to analyze the impact of climate change on South African sugarcane production under irrigation and dryland conditions. The result showed that climate change has significant nonlinear impacts on net revenue per hectare of sugarcane with higher sensitivity to future increases in temperature than precipitation.

Mendelsohn & Dinar (2003) and Kuruklasuriya and Mendelsohn (2006a), explored the importance of water availability in the Ricardian model by estimating the role of irrigation as an adaptation measure against unfavourable climatic conditions. The studies showed that irrigation is an important adaptation measure that can significantly help reduce the negative impacts associated with changes in climate. Kuruklasuriya & Mendelsohn (2006b) and Seo & Mendelsohn (2006) both used multinomial logit models to analyze crop and livestock choice options, respectively. The study on crop choice showed that it is climate-sensitive, meaning that farmers adapt to changes in climate by switching crops. The results from choice models from livestock study showed that farmers in warmer temperatures tend to choose goats and sheep as opposed to beef, cattle and chicken.

Madison (2006) reported on perceptions of climate change in 11 African countries and showed that a significant number of farmers believe that temperature has already increased and that precipitation has declined. Farmers with the greatest experience were more likely to notice changes in climatic conditions which, according to the author, is consistent with farmers engaging in Bayesian-updating of their prior beliefs. The study also reported that farmers' experience, access to free extension services and markets are important determinants of adaptation. In a study of the determinants of farmers' choice of adaptation methods and perceptions of climate change in the Nile Basin of Ethiopia by Deressa, et al. (2008), age of the household head, wealth, information on climate change, social capital, and agro- ecological settings were found to have significant effects on farmers' perceptions of climate change.

Nhemachena & Hassan (2007) conducted micro-level analysis of farmers' adaptation to climate change in Southern Africa. The study reported that most farmers perceived that long-term temperatures are increasing and that the region is getting drier with pronounced changes in the timing of rains and frequency of droughts. The results also showed that less than 40% of the farmers studied did not adopt any adaptation strategies. Similarly, Deressa et al. (2008) investigated the major methods used by farmers to adapt to climate change in the Nile Basin of Ethiopia, the factors that affect their choice of method, and the barriers to adaptation. The methods identified include use of different crop varieties, tree planting, soil conservation, early and late planting, and irrigation. Results from the discrete choice model employed indicate that the level of education, gender, age, and wealth of the head of household; access to extension and credit; information on climate, social capital, agro-ecological settings and temperature all influence farmers' choices.

According to IPCC (2000d), vulnerable populations to climate change include small holder agriculturalists with inadequate resources, pastoralists, rural landless labourers, and urban poor. Reduced food supplies and high prices immediately affect landless labourers who have little savings. The effect on agriculturalists and pastoralists depends on how much surplus they produce and the relative terms of trade (IPCC, 2001d).

The effects of drought are cross-cutting, with several direct impacts on agriculture, water resources, and natural vegetation and indirect effects on health, the economy, and institutions. The impacts of drought are confounded by environmental degradation, including soil erosion, water pollution, and deforestation.

The ecological dimension has also featured in vulnerability studies. According to Watson et al. (1996), people who live on arid or semi-arid lands, in low-lying coastal areas, in water-limited or flood-prone areas, or on small islands are particularly vulnerable to climate change.
Similarly, IPCC (2001e) stated that climate change will, in many parts of the world, adversely affect socio-economic sectors, including water resources, agriculture, forestry, fisheries and human settlements, ecological systems, and human health, with developing countries being the most vulnerable. Developing countries have less capacity to adapt and are more vulnerable to climate change damage, just as they are to other stresses. This condition is most extreme among the poorest people (IPCC, 2001e).

Small-island developing states (SIDS) are thought to be very vulnerable to climate change in general and sea-level rise in particular (Watson et al. 1998). The economic vulnerability of many South Pacific small-island countries is, according to Watson, et al. (op cit), related to the increasing reliance on imported food products and a relatively narrow resource base. Resource degradation appears to be contributing to increasing vulnerability among these countries. Sea-level rise represents the most significant impact of climate change for SIDs, as many important economic activities tend to be concentrated in their coastal areas. Sea-level rise may result in accelerated coastal erosion, salt-water intrusion of fresh water reservoirs and increasing reach of storm waves, in addition to the possibility of actual submerging of some low-lying islands. Countries that have considerable low-lying coastal areas are also particularly threatened by sea-level rise.

A number of studies have shown that small islands and deltaic areas are particularly vulnerable to sea-level rise (IPCC, 2000a, Heger et al., 2008). IPCC projections reveal that in the absence of mitigation actions, land losses could range from 1% for Egypt to 17.5% for Bangladesh, and about

80% for the Marshall Islands, displacing tens of millions of people, and in the case of low-lying SIDs, resulting in the possible loss of whole cultures. Heger et al. (op cit) attribute the vulnerability of SIDs to natural and environmental disasters to their dependence on agriculture and tourism. The high vulnerability of the region is due to a combination of high frequency and intensity of natural hazards. This implies that the nearer a community is to the coast, the more likely it will experience disasters which make it vulnerable. Thus, the location of a community can predispose it to climate variability and long-term change disasters.

According to the IPCC report on the regional impacts of climate change cited by Watson et al. (1998), "Africa is the continent most vulnerable to the impacts of projected changes because widespread poverty limits adaptation capabilities". According to the report, the importance of agricultural activities for the economies of most African countries, combined with the farming sector's reliance on the quality of rains during the rainy season, make countries in the region particularly vulnerable to climate change. Thus, from the point of view of food security, the increasing incidence of drought represents a very serious threat. It has been argued that, in Africa, drought hazard and vulnerability "…are likely to be the most damaging locus of impacts of climate change" (Downing et al., 1997). According to Ribot (1996), inequality and marginalization are among the most important determinants of vulnerability.

Empirical studies of the gender dimensions of climate change vulnerability and adaptation at the community and household levels seems to be at early stages. A few available studies are based on inter-household and inter-community analysis. For instance, Shewmake (2008) investigated the vulnerability and the impact of climate change in South Africa's Limpopo River Basin and found differences in vulnerability across ethnic groups. Most discussions on the gender dimensions of climate change impacts, vulnerability and adaptations seem to be inferences drawn from women's well known disadvantaged position in the society. For example, Tshikata & Awumbula (2004) found that in Ghana, women's livelihoods are dependent on all areas that are vulnerable to impacts of climate change and since about one third of women are already below the poverty line, climate change will adversely impact them. The Nigerian Environmental Study/Action Team (NEST, 2004) also paints a similar picture of the gender dimension of climate change vulnerability, impacts and adaption in Nigeria. Citing examples of water and water-related impacts, NEST points out that when water crises sets in, women and young girls will be the most vulnerable in view of their roles in daily water collection. It concluded that women continue to be the most affected by climate change.

Conceptual Framework

Adaptation, according to Galvin et al. (2001) is a concept derived from evolutionary biology. In its strict biological sense, adaptation refers to the ability of organisms to pass on their genetic material to the next generation. It is measured through genetic fitness. In a broader view, adaptation refers to the ability of individuals or groups to respond to changes in their environment. These concepts in biology have been carried over to address issues of adaptation and adaptive capacity in human populations coping with variability. People, societies and cultures must adapt to reduce vulnerability.

Adaptive capacity is the ability to cope with the impacts of climate variability and change, which is the ability to make adjustments (Smit & Pilifosova, 2001). Capacity varies among individuals, communities, socioeconomic groups and regions. Those with the least capacity to adapt are generally the most vulnerable to the negative impacts of climate variability and change. Issues of policy, growing populations and low agricultural and livestock production contribute to adaptive capacity and ultimately, vulnerability (Finan & Nelson, 2001). Developing countries with growing populations and lower technological capabilities generally have lower adaptive capacity (Downing, et al., 1997). This is especially true for small-scale farmers who are resource-dependent and also dependent on the seasons for their livelihoods. Also, pastoral people, who inhabit the arid and semi-arid regions with high climate variability, are especially vulnerable. Most adaptations to climate variability are socio-cultural and usually involve a series of reactive responses to a climate event such as drought (Galvin et al., 2001; Little et al., 2001).

But how is capacity assessed? It has to do with flexibility and choices. Those individuals and communities who can be flexible in their responses and have a range of choices usually have a greater capacity to deal with change. For a myriad of reasons, people are vulnerable (the risk of negative outcomes as a result of climatic changes that overwhelm the adaptations they have in place) to environmental changes due to changes in frequency or duration of those changes or because they are constrained economically, socially or politically from responding adequately to those changes. Thus, human derived and ecological processes as well as historical contexts can determine coping ability. Galvin et al. (2001) state that in areas of high climate variability where the future is intrinsically unpredictable, households are doing two things: they are trying to maintain their livelihoods in such a way as to be able to deal with unpredictability. Thus, livestock owners may sell or move their livestock, or provide inputs into their livestock management system as needed. These management strategies are institutionalized into the culture. Secondly, they also try to reduce the effect of climate variability through diversification of livelihood strategies in ways that are, again, institutionalized for that society. Both of these strategies are important and they work as long as the system is not subject to significant changes such as a large-scale disturbance.

Household decision-making under uncertain conditions functions within a complex system of human-environment interactions with many socio-economic, policy and institutional forces also playing an important role (Figure 1). At the core are households and communities who make decisions based on environmental conditions and a number of other socio-economic factors which derive from several levels of social organization (local, regional and beyond). The decision-making process is also influenced by specific land uses and household goals and is conducted under different forms of severity, duration and form of the climate perturbation. All of these factors determine when, how and in what capacity. Through time, some or all of these processes may apply, depending on initial conditions at the household (e.g., wealth, social networks, etc.) and the nature of the climatic event (Galvin et al., 2008).

Processes and feedbacks involved in household decision-making evolve over long time periods, constrained by environmental and socio-economic factors. At a given point in time, these processes and feedbacks may be viewed as initial conditions of households. Adaptive management of livelihoods may ameliorate effects of climate change (including increased variation in climatic factors) over time, so that households adapt to climatic uncertainty in an incremental way, diverging from initial conditions slowly. Such adaptation may be less effective or absent when change is rapid.

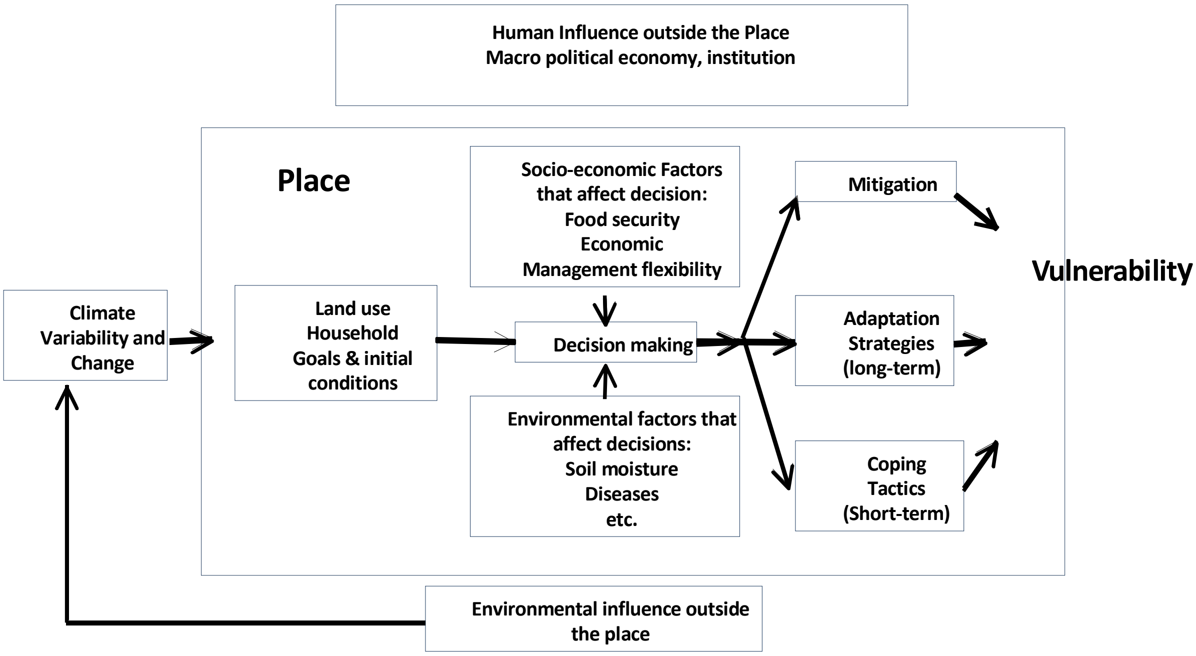

Figure 1. Adaptation to climate variability and climate change
Source: Adopted from Galvin et al. (2008).

Some of the concepts commonly used in this study are defined as:

Adaptation: Adaptation from a climate change perspective is regarded as changes in policies and practices designed to deal with climate threats and risks. It can refer to changes that protect livelihoods, prevent loss of lives or protect economic assets and the environment.

Forcing: Forcing refers to changes to the climate system that are caused by natural or human-caused factors (such as greenhouse gas emissions).

Vulnerability: The term vulnerability is central in climate change discussions and there are many definitions. According to McKeown & Gardner (2009), vulnerability is the degree to which an ecosystem or society faces survival risks due to adverse climate changes. Vulnerability includes susceptibility as well as the ability to adapt. The level of vulnerability determines whether an ecosystem or society can be resilient in the face of climate change. The Intergovernmental Panel on Climate Change (IPCC, 2001) defined vulnerability to climate change as the “degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and extremes. Vulnerability is therefore a function of the character, magnitude, and rate of climate variation to which a system is exposed, its sensitivity, and its adaptive capacity”

Climate Variability: Climate variability refers to variations in the mean state and other statistics (such as standard deviations, statistics of extremes, etc.) of the climate on all temporal and spatial scales beyond that of individual weather events. Variability may be due to natural internal processes within the climate system (internal variability), or to variations in natural or anthropogenic external forcing (external variability) (IPCC, 2007)

Climate Change*:* Climate change refers to any change in climate over time, whether due to natural variability or as a result of human activity (IPCC, 2007). According to the United Nations Framework Convention on Climate Change (UNFCCC) climate change is “a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods."

Coping: Coping is a short-term measure to protect livelihoods, prevent loss of lives or protect economic assets and the environment. The difference between coping and adaptation lies in the time horizon of the effect of the measure taken. While adaptation addresses impacts in the long term and are considered more sustainable, coping is considered short-term and unsustainable.

Hazard: Also referred to as a "climate event" and refers to a physical manifestation of climatic variability or change such as a drought, flood, storm, episode of heavy rainfall, a long-term change in the mean value of climatic variable, a potential future shift in a climatic regime, etc. (Adger et al., 2004). Climate hazards may be defined in terms of absolute values or departures from the mean of variables such as rainfall, temperature, wind speed or water level, perhaps combined with factors such as speed of onset, duration and spatial extent. The Adger et al. (op cit) concept of climate hazard is applied in this study.

Disaster: This is defined as a hazard that is measured in human terms i.e. lives lost, people affected and economic losses. It is, therefore, the outcome of a hazard, mediated by the properties of the human system that is exposed to and affected by the hazard.

Household: A household comprises a number of persons living together under one roof. In the study area, a household was found to be headed by a man or a woman (in both cases, with or without a spouse), children and or relations staying together, usually in the same building or apartment with the head providing for the needs of all the members in terms of food, education and other welfare needs. In some cases, there are single person households, made up only one person.

Upland: This refers to dry land areas that are usually employed in dry season farming.

Wetlands: These comprise a wide range of coastal and inland habitats such as estuaries, flood plains, freshwater marsh, peatlands, swamp forests, open coasts and lakes with water depths not exceeding 6m at low tide (NEST, 2004).

Analytical Framework

Analysis of an individual's actions during adaptation to climate change is founded upon utility theory. In a given economic environment, an individual or economic entity or household is assumed to make decisions to maximize utility. A household or individual can be assumed to make rational choices in order to maximize utility. Under threat of climate change impacts, a household or individual has different choices to make. However, the person will only choose the one that maximizes utility under the given conditions. If the available options are categorized into two types which the household has to choose, then this can be considered as choice alternative facing the households. The choice to adapt and what adaptation option to use is a function of the perceived utility which derives from the type of action, which in turn depends on number of factors which could be exogenous or endogenous to the households or the individual. In this way, the dependent variable is a qualitative choice variable that is discrete. In this study, the probit model lends itself to the phenomenon of household adaptation to climate change, and is thus used in the analysis. It is based on the utility theory. The advantage of the probit model is that it permits the analysis of decisions across more than two categories, allowing the determination of choice probabilities for different categories.

In this model, it is assumed that the decision of the ith household to adapt to climate change or not depends on an unobservable utility index I_i, that is determined by one or more explanatory variables, say Xi, in such a way that the larger the value of the index *Ii*, the greater the probability of a household adapting to climate change.

This index *Ii* is expressed as

$$Ii = \beta_1 + \beta_2 X_i \qquad (1)$$

Where Xi is a vector of household ith characteristics.
The question is: How is the (unobservable) index related to the actual decision to adapt to climate change? This question is answered as follows:
Let Y = 1 if the household adapt to climate change and Y = 0 if it does not. It assumed that there is a critical or threshold level of the index, which is designated as I^*_i , such that if *Ii* exceeds I^*_i , the household will adapt to climate change, otherwise it will not. The threshold I^*_i like *Ii*, is not observable, but if it is assumed that it is normally distributed with the same mean and variance, it is possible not only to estimate the parameters of the index given in (1), but also to get some information about the unobservable index itself.

Given the assumption of normality, Gujarati & Sangetha (2007) assured that the probability the I^*_i is less than or equal to Ii can be computed from the standardized normal cumulative distribution function as:

$$Pi = P(Y =1/X) \ P(I^*_i \ ? \ Ii) = P(Zi \ ? \ \beta_1 + \beta_2 X_i) = F(\beta_1 + \beta_2 X_i) \qquad (2)$$

Where P(Y =1/X) means the probability the an event occurs given the value(s) of the X, or explanatory, variable(s) and where Zi is the standard normal variable (i.e. Z ? N(0, δ^2). F is the standard normal cumulative distribution function (CDF) which can be written explicitly as:

$$F(Ii) = 1/?2\pi \ ?^{Ii}{}_{-8} \ e\text{-}z2/2dz$$

$$= 1/?2\pi \ ? \ \beta_1 + \beta_2 X_{i\ -8} \ e\text{-}z2/2dz \qquad (3)$$

P is the probability that an event will occur, in this case the probability that a household will adapt to climate change, it is measured by the area of the standard normal curve from - 8 to Ii.
To obtain information on Ii, the utility index, as well as on β_1 and $\beta_{2,}$ the inverse of (3) is taken to obtain:

$$Ii = F^{-1}(Ii) \ F^{-1}(Pi) \qquad (4)$$

$$= \beta_1 + \beta_2 X_i$$

Where F^{-1} is the inverse of the normal CDF.

In our study, the response variable is not restricted to only two outcomes (yes or no), but has more than two outcomes which are ordinal in nature. Gujarati & Sagetha (2007), Snodker, et al. (2002) and Torres-Reyna (2000) recommend the use of ordered logit or ordered probit model for such analysis. Thus, our probit model is extended to take account of multiple ranked categories.
Ordered Probit model has the form:

Probit (p1) ? Prob(p1/1-p1) = $\beta_1 + \beta?X$
Probit (p1+p2) ? Prob(p1+p2/1-p1-p2) = $\beta2 + \beta?X$

Qualitative data analysis is anchored on the "discovering patterns" analytical framework, first suggested by John & Lofland (1995). In using this framework, six different ways are used to look for patterns in a particular research topic.

These are:

- Frequencies: How often does a climate event or hazard occur?
- Magnitudes: What are the levels of climate variability, vulnerability and impact?
- Structures: What are the different types of impacts- economic, health, environmental, nutritional, etc.?
- Processes: Is there any order among the elements of the structure?
- Causes: What are the local forcings of climate variability and climate change? Is it more common in a particular agricultural ecosystem?
- Consequences: How does climate variability and climate change affect the victims (farmers), in both the short and long term? What changes does it cause to vulnerable households?

In examining the data, patterns that appeared across several observations that typically represent different case studies were examined. Huberman & Miles (1994) offer two strategies for cross-case analysis. These are variable-oriented and case-oriented analyses. Under variable-oriented analysis, variables of importance to the study are considered. These include such variables as gender, socioeconomic characteristics, location, climate elements, climate events and hazards, adaptation options, etc. The focus of the analysis is the interrelations among variables, and the people and locations observed are primarily the carriers of those variables. In variable-oriented analysis, the aim is to achieve a partial, overall explanation using a relatively few number of variables. There is no pretence that every individual's adaptation behaviour can be predicted or even explain any one person's motivation in full.

3. DESCRIPTION OF THE STUDY AREA

The Niger Delta is located between latitude 04^o 49? 60?? ? N and longitude 06^o 00? 00? ? E, along the Atlantic Coast of southern Nigeria where the River Niger divides into numerous tributaries (Figure 2). The Niger Delta is an area of over 70,000 square kilometres and among the three largest wetlands in the world as well as the largest mangrove swamp in Africa (Ikporikpo, 1998; Constitutional Right Project, 1999). The mangrove swamps spans about 1900 square kilometres. The Niger Delta has a coastline spanning about 450 kilometres, terminating at the Imo River entrance (Uyigue & Agbo, 2009). About 2,370 square kilometres of the Niger Delta area consists of rivers, creeks and estuaries, while stagnant swamp covers about 8600 square kilometres (Constitutional Rights Project, 1999).

The region falls within the tropical rain forest zone. The ecosystem of the area is highly diverse and supportive of numerous species of terrestrial and aquatic flora and fauna and human life. The region is divided into four ecological zones: (i) coastal inland zone; (ii) mangrove swamp zone; (iii) freshwater zone; and (iv) lowland rain forest zone.

The Niger Delta is made up of nine states: Abia, Akwa Ibom, Bayelsa, Cross River, Delta, Edo, Imo, Rivers and Ondo (Table 1). It has a total population of 27,696,577 (National Population Commission, 2006). Imo State has the highest population density of 759 persons per square kilometer while Cross River has the least (134 persons per square kilometre). Inhabitants of the Niger Delta fit into five major linguistic groups, described in terms of their Ijaw, Yoruba, Edo, Igbo, Ibibio and other Cross River origins such as Ibeno, Oron. There are over 20 different ethnic groups in the Niger Delta area. The upland areas are more densely populated, while the mangrove swamps have scattered settlements, because the fishing communities that inhabit these areas live a nomadic life, moving from place to place in the course of their traditional economic activities (Constitutional Right Project, 1999).

Table 1. Land Area, Population Density of the States of the Niger Delta

State	Land Area (Km^2)	State Population	Population Density
Abia	4902.24	2,833,999	578
Akwa Ibom	6,674	3,920,208	587
Bayelsa	9,416	1,703,358	181
Cross River	21,637	2,888,966	134
Delta	6421	4,098,391	238
Edo	19,819	3,218,332	162
Imo	5,183	3,934,899	759
Ondo	15,194	3,441,024	226
Rivers	10,432	5,185,400	497
Total	**99,678.24**	**27,696,577**	

Source: National Population Commission, Census Results, 2006

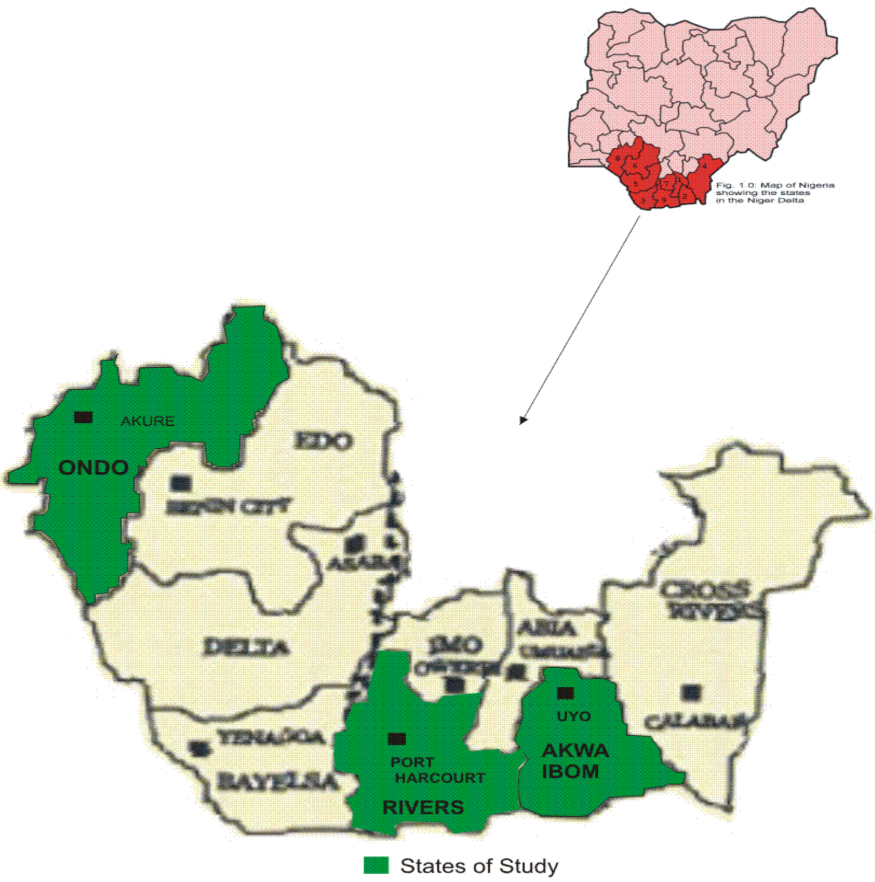

Fig. 2: Map of Niger Delta Showing States of Study
Source: Niger Delta Environmental Survey (NDES, 1997)

Climatic Characteristics: The Niger Delta is characterized by two seasons: dry and rainy. The area experiences long periods of high rainfall, high radiation and high relative humidity. The rainy season stretches from March to October and rainfall could be as high as 3800mm to 4500mm. Relative humidity is above 60% on the average. The rainfall causes flooding, leading to the loss of valuable property including crops and livestock. Loss of lives has also been recorded in some flood incidences. The dry season occurs for a few months in some coastal sections of the region. Intense petroleum exploration and production in the Niger Delta region have resulted in gas flaring with adverse effects on the environment (Ibeanu, 2000).

Natural Resources: The Niger Delta is endowed with mineral-rich sedimentary formations which yield petroleum, clay, glass sands, marble and limestone. The exploitation of petroleum accounts for over 90% of the federal government export revenue (Ibeanu, 2000). The soils support a variety of food and cash crop production. Aquatic resources such as fish, shrimps, crabs, etc. are in abundance in the region. The region has been judged to be the largest shrimp ground in West Africa. Forest resources include timber, medicinal plants, fruits, nuts and fuelwood (Ikporukpo, 1998).

Socio-economic Activities: Crop farming, livestock rearing, fishing and petty trading are important livelihoods of the people of the Niger Delta. Men and women engage in several productive and income-generating activities to ensure their household needs are met. It is common for one person to be involved in more than one economic activity, which may include different types of agricultural activities as well as non-agricultural activities. Many of such activities are seasonal and small-scale.

Food crops such as cassava, yam, cocoyam, rice, plantain and vegetables are cultivated. Important cash crops grown include oil palm, *raphia* palm, coconut, cocoa and rubber. Compound farms dominated by semi-domesticated trees such as African pear (*Dacryodes edulis*), bush mango (*Irvingia gabonensis*), Africa oil bean tree (*Treculia africana*) are a common feature of land use in the Niger Delta region.

Livestock rearing is also carried out by residents of the region, although on a small scale. Common livestock kept are goats, sheep, dwarf cattle and poultry (improved breeds as well as native fowl). Fishing is an important occupation in the region and can be a full time activity for both subsistence and commercial ventures.

Extraction of mineral resources is an equally important primary activity in the region. Crude oil extraction for petroleum products as well as associated natural gas is very important in all the States of the Niger Delta. Limestone is extracted in Cross River. Manufacturing industries are common in the urban centres of the region.

Petty trading is mainly an adjunct to farming. Local and imported goods and foodstuffs are exchanged for cash in the market place. Lumbering is also an important economic activity, especially in the high forests of Cross River, Akwa Ibom, Rivers and Bayelsa.

4. METHODOLOGY

Three States of the Niger Delta –Akwa Ibom, Ondo and Rivers State were selected for study.

Development of Data collection Instruments

Three questionnaires and two discussion guides were developed for use. The questionnaires were the household questionnaire, the weather stations/climate institutions questionnaire and the vulnerability questionnaire.

Establishing the Validity of the Questionnaire:

Having developed the questionnaires, the next step was to establish their validity. Validity is the amount of systematic or built-in error in measurement (Norland, 1990). Validity was established using a panel of experts and a field test. Our focus was on the content, construct, criterion, and face validity. The following questions were addressed:

- Are the questionnaires valid? That is, do the questionnaires measure what they were intended to measure?
- Do they represent the contents?
- Are they appropriate for the sample/population?
- Are the questionnaires comprehensive enough to collect all the information needed to address the purpose and goals of the study?
- Do the instruments look like questionnaires?

A reliability test was also conducted to enhance the questionnaire validity. This was done through a pilot test. This was carried out by administering the questionnaire on 20 respondents in Nung Ukim, Ikono in Akwa Ibom State. Two Focus Group Discussions (FGDs) were conducted, one for men and another for women group. In addition, in-depth interviews (IDIs) of key informants (one male and one female) were conducted. These were intended to determine the reliability of the FGD and IDI guides. The data collected with the questionnaires were analysed using Statistical Package for Social Sciences (SPSS). Two key information pieces were obtained: a “correlation matrix” and “view alpha if item deleted”. Statements and items were deleted until the reliability of the instruments was substantially improved up to a reliability coefficient of .90. This was considered good enough since Radhakrishna (2007) recommends that a reliability coefficient (alpha) of .70 or higher is considered an acceptable reliability.

Sampling Technique

A multi-stage sampling procedure was employed in the study. The first stage involved the random selection of states to be studied. This was done through simple random sampling method. A sampling frame comprising the nine states of the Niger Delta was made. It was considered that one-third of the states formed a large enough sample to be sufficiently representative of the states of the Niger Delta. Having decided on the number of states to be studied, the balloting method was used to select the three states for detailed study. This was done by writing the name of nine states each on a card and the cards placed in a bowl. One card was drawn at a time from the bowl without replacement until three states were selected. The states selected are Akwa Ibom, Rivers and Ondo.

In the second stage, five communities were selected from each state: two upland farming, two wetland farming and one fishing communities. Obtaining the list with an accurate number of upland and wetlands farming communities as well as fishing communities in each state was problematic.

However, the knowledge of the researchers and officials of the Agricultural Development Project (ADP) and State Ministries of Agriculture in each of the selected states was relied upon to select communities with concentration of farming and fishing activities respectively. Emphasis was placed on selecting communities with intense farming and fishing activities by the majority of the population. Thus, the five communities were selected purposively.

The third and last stage of sampling was the selection of farming and fishing households for detailed study. Again, the lack of household listings in the communities was a serious challenge to the study. Therefore, the principle of *disproportionate sampling* (Rubin & Babbie, 2005) was used in selecting households in the communities. The initial approach was to select an equal number of male and female households from each upland and wetland community and ten male-headed households and ten female-headed households from each fishing community. However, investigation revealed disproportionate distribution of male and female households, roughly in the ratio of 4:1.The ratio was even more disproportionate in the fishing communities. This is as expected as it is the men who go out to settle in the fishing settlements to engage in fishing activities. Under this circumstance, more male-headed household could be expected. In line with the skewed distribution of households, the proportion of households sampled was adjusted to 15 male headed and five female-headed per community. A total of 40 households were selected from upland and wetland communities in each state and 20 fishing households were selected per state. In all, a total of 180 respondents per state and a total sample size of 540 were used for the analysis.

Data Collection

A combination of quantitative and qualitative data collection techniques were employed in the study. These were: (i) administration of a set of (a) household and (b) institutional questionnaire (quantitative data collection) to collect cross sectional data; (ii) administration of a vulnerability questionnaire using Cost Route Method. Data were collected from a panel of five households from each of the study community on a fortnightly basis for six months (December 2009 to May 2010); and (iii) Focus Group Discussions (FGDs) and In-Depth –Interviews (IDIs): two FGDs and two IDIs were conducted in each community. The FGD groups included a male group and a female group. One male and one female key informant were also interviewed in each community. Social Analysis System (SAS) tools such time-line, gender analysis, etc. were employed during the FGDs and IDIs.

The Study Sites

Akwa Ibom State

Five communities were used for in-depth study in Akwa Ibom State. These comprised two upland communities – Ikot Ebom Itam, Ifiayong Usuk; 2 wetland communities – Ayadehe and Eyehedia; and one fishing community – Ibaka. A brief description of each of these communities is given below:

Ikot Ebom Itam: Ikot Ebom is a peri-urban but farming community in Itu Local Government Area (LGA) of Akwa Ibom State. It is a fragile community whose livelihoods are threatened by urbanization and an advancing ravine, the Ikpa River Basin. The major livelihood in the community is crop farming which takes place in both the upland and bottom valley. Crops cultivated include yam, cocoyam, plantain and banana, vegetables and cash crops such as oil palm trees and African pear. The population of the community has been increasing due to the influx of people from Uyo, the capital city. The community has clay deposits which necessitated the sitting of a ceramic company (Quality Ceramic) in the community.

Ifiayong Usuk: Ifiayong Usuk is an erosion-prone farming community located along Uyo-Nwaniba Road in Uruan LGA of Akwa Ibom State. It belongs to the Ifiayong group of villages in Uruan known for commercial activities trade in particular in the past. Only some past trading activities are visible now and farming, fishing and petty trading are the major occupation of people in the present day Ifiayong Usuk. The sloped topography of the community has caused it to be regularly affected by gully erosion with a big gully running through the village and emptying in Ikpa River. Crop cultivation, fishing, water transportation and brewing of local gin (*akai kai*) are the prominent livelihoods.

Mbiabet Eyehedia: Mbiabet Eyehedia is a rural and farming community located in Ini LGA of Akwa Ibom State. It is popular for rice production, especially swamp rice. Other crops include cassava, yam, cocoyam, okro, leafy fluted pumpkin and other vegetables. Oil palm trees, raphia palm, banana and plantain are also grown. Mbiabet Eyehedia is one of the six associated villages which make up Mbiabet group of villages. It has floodplains which lie approximately six kilometres to the south of the Enyong River. The Mbiabet system is flooded for approximately six months of the year between June and early December (Akwa Ibom Agricultural Development Project, 1995). Due to its intensive farming activity and its importance as one of the communities that make up the "food basket" of Akwa Ibom State, a rice mill and Agricultural Extension post have been established in the community. Due to its low elevation, Mbiabet Eyehedia is frequently flooded during the peak of the rainy season.

Ayadehe: Ayadehe is about a 20 minute drive from Uyo, in Itu LGA of Akwa Ibom State, on the bank of the Cross River at the boundary of Akwa Ibom and Cross River State. It is highly populated due to the prominence in fishing activities, including trading. It is known for a popular fish species *Inaha* (*Heterobranchus*sp.). Ayadehe is straddled by the Calabar-Itu Road, has a popular fish market and is a stopover spot for long distance travellers at the bridge head. Farming in the community is done mainly in the wetland with little upland farming activities. The common crops cultivated are fluted pumpkin, okro and other vegetables, water yam, cocoyam, yam, sweet yam, and cassava. Besides farming and fishing, sand drilling and hunting are also an important commercial activities. Due to its low-lying topography and proximity to the sea, the community is often affected by flooding and sea-level rise.

Ibaka: Ibaka is in Mbo LGA of Akwa Ibom State. It is a popular fishing community and is populated by both Nigerians and foreigners. Ibaka is a gateway to the Republic of Cameroun and, because of its strategic location; it is host to a naval base – Forward Operation Base. Little farming is done in Ibaka for subsistence. Ibaka is vulnerable to many climate change-related hazards, particularly sea level rise, flooding and wind and rain storms. Due to the seriousness of sea level rise (many neighbouring communities have been displaced), an embankment has been constructed by the Federal Government of Nigeria in collaboration with Shell Petroleum Development Company (SPDC) at Ibaka beach to protect the beach.

Ondo State

Ode Mahin: Ode Mahin is a typical fishing community in Ilaje LGA of Ondo State, located about 40 kilometers from Okitipupa. It forms the closest geographical link to the Atlantic Ocean in Ondo State. It is inhabited mainly by the Ilaje people of Yoruba ethnic group in Nigeria. It has an estimated population of over 4,000 people. The major occupation of the people is fishing, followed by food crop farming. True to the meaning of its name, "Mahin", which means "a forest of beautiful economic trees", the community is endowed with forests and water bodies. Being a coastal community, Ode Mahin is susceptible to occasional flooding arising from a rise in water level.

Ayede Ogbese: Ayede Ogbese is located along Akure-Owo highway about 24 kilometers from Akure, the Ondo State capital. It has an average temperature of about 27^0C and annual rainfall of between 1000mm and 1200mm. The existence of Ayede Ogbese dates back to 1907 during it was under the direction of Gorruva Egbe who presided over their meetings. It now has a *Baale* with appointed chiefs to assist in the traditional institution of the settlement.

Ayede Ogbese has a social infrastructure that has contributed to its growing commercial nature. This includes a weekly market, the Ayede Ogbese market, NEPA office and a transformer, six sawmills a post office, a secondary school and four filling stations. The main attraction in Ogbese is the market situated along the Akure-Benin Express Way.

Agriculture is the mainstay of the economy of Ayede Ogbese. Cash crop includes cocoa, kola nut trees and oil palm trees. Timber species are also flourishing. Economic trees such as Iroko, Mahogany and Obeche are found in large quantity in the area.

Ayede Ogbese has an important river, River Ogbese, from which the community picked its name. This river has a dam which also serves the neighboring communities of Uso Owo. A noticeable climate change impact in the community is the shrinking volume of Ogbese River, which has receded beyond its original boundary. The community can at times, however, be vulnerable to adverse impact of the river overflowing its banks.

Ikun Akoko: Ikun Akoko is a farm community in Akoko South West LGA of Ondo State. It is located about 15 kilometers from Oko Akoko, the headquarters of Akoko South West LGA. It has an estimated population of over 5,000 people. Crop production is the livelihood of majority of the population. Its population is dominated by Yoruba-speaking people. Traditionally, the community is ruled by an Oba supported by quarter chiefs.

Araromi Ayika: Araromi Ayika is a farming community in Irele LGA of Ondo State. It is populated by Yoruba-speaking people called *Ikale*. People from other ethnic origins are also found in the community. Farming is the main economic activity in Aramori Ayika. It is a coastal community located about five kilometers to Okitipupa. Due to its coastal nature, farming is done in the abundant wetlands around the community. Fishing is also an important occupation. Its proximity to the coast makes the community susceptible to frequent flooding, and sea level rise.

Ode Erinji: Erinji is a farming community located in Okitipupa LGA of Ondo State. Both edible crops as well as tree crops are cultivated. These include yam and cassava, oil palm trees, and kola nut. The community is regularly flooded when it rains. Both wetland and upland farming is practiced. Petty trading, particularly agricultural produce, is also an important livelihood for both men and women in the community.

Rivers State

KaaTown: Kaa is one of the communities in Khana LGA of Rivers State. It is a fishing community located in "Ogoniland" of Rivers State. Kaa town is found on the Andoni border of the state, along the coastal plains terraces to the north of the Niger delta. The inhabitants of the community are mainly fisher folk and farmers. Before the advent of intense industrial activities in Ogoniland, the community had fertile alluvial soils of the plain which provided a rich harvest of yam, cassava and vegetable. The pure streams and seas brimmed with fish and other sea food. However, intense petroleum exploration and production including the drilling rigs have torn up farmlands and now emit gas flares.

Okwale: Okwale is an upland community, located in Khana LGA of Rivers State. Important crops cultivated include cassava, fruit trees, oil palm trees, okro, etc. In recent years, tree crops, particularly, coconut trees have been dying due to attacks by a bird species not known to the community members.

Omalem: Amalem is a community in Abua/Odual LGA of Rivers State. It is located geographically between latitudes 4^o5^1 and 6^o5^1 degrees north of the equator and longitudes 6^o0^1 and 7^o0^1 degrees east of the Greenwich Meridian. It is located about 65 kilometres from the Rivers State Capital, Port Harcourt. Economic activities carried out by people in the area include farming, petty trading, fishing, transport business and artisan/professionals mostly welders, carpenters, tailors and auto mechanics.

Omudiaga Town: Omudiaga Town is an upland farming community in Emuoha LGA of Rivers State. It is located about a 20 minute drive from Elele, an important commercial town in Emuoha LGA. Crop farming predominates, with common crops cultivated including cassava, maize, vegetables and plantain and banana. Tree crops include oil palm and coconut trees, mango trees, etc. Livestock such as goats and chicken are also kept. Trading in agricultural produce, manufactured goods, sea food as well as craft-making are also practiced as livelihoods by the people in the community.

Odiabidi Town: Odiabidi Town is located in Ahoada East LGA of Rivers State. It located along Abua road. It has a police station, making the community multi-cultural, a primary and a secondary school. The people are principally farmers although a few are teachers and a few others work at the police station. The community s served by national communication networks –MTN and Glo. Odiabidi is a lowland farming community which is prone to flooding.

Institutional Data

In order to have comprehensive information on climate change in the Niger Delta region, data were also collected from some weather stations located in the three states studied. Data were collected from a total of nine such stations: (i) Akwa Ibom State: University of Uyo Geographical Station; (ii) Rivers State: Naval Base Weather Station, University of Port Harcourt Weather Station, University of Science and Technology Weather Station, Port Harcourt International Airport weather Station, Federal College of Education Geographical Garden; and (iii) Ondo State: Nigerian Meteorological Station (Akure), Federal University of Technology, Akure Geographical Station, Federal College of Agriculture (Akure) Geographical Garden. The data collected include observations on climate variation, type of data they collect, users of climate information, their capacity in terms of personnel and equipment and challenges facing them. However, given the focus of this study, only data on observations on climate variability by users of climate information were analysed.

Methods of Data Analysis

A variety of analytical tools appropriate for each objective were used in analyzing the data collected in the study. These range from descriptive presentation, storylines, to prescription through econometric modeling.

Objective 1: This objective was to examine the trends and variations in climatic elements in the Niger Delta region. This objective was analysed through graphs and other descriptive statistics including means.

Objective 2: To identify the climate information sources, their availability, accessibility to male and female wetland and upland farming and fishing households and their perceptions of the available sources in the Niger Delta Region, this objective was analysed using proportions, percentages and chi-square statistics. The chi-statistics was used specifically to determine if differences exist in the perception of male and female farmers and fisher folks on appropriateness, timeliness and etc. of climate information they received. The chi-square is given by the formula:

$$\chi^2 = \frac{\Sigma(o-e)2}{e}$$

Where, o = Observed value, e = expected value, χ = Chi square, ? = summation sign

Objective 3: To determine the level of awareness of climate change among men and women-headed wetland and upland farming and fishing households', their knowledge of climate variability and understanding the local forcings of climate variability, the Climate Change Knowledge Index (CCKI) was used. The level of farming and fishing households' knowledge was measured using a scale of 2 and 1. The correct response is given as 2 and the incorrect response is 1. The maximum, average and minimum scores were established. The mean score of each respondent on all climate change issues and the mean score of all respondents on each climate change issue were compared with expected maximum score to ascertain their knowledge level. This was used to gauge the awareness of the study population of a particular climate change issue. The index was constructed for males, females as well as for each location/agro ecology. With this stratification, the intent was to provide reasonable information on which policy on climate information could be built.

Objective 4: To assess the vulnerability of male and female upland and wetland farming and fishing households to climate variability in the study area. Two broad approaches were adopted to assess objective 4: i) Vulnerability Profile; and ii) Vulnerability/Risk Framework. These frameworks allowed a quick assessment to be made of household strengths and weaknesses. These assessments provide a better understanding of where to concentrate efforts in vulnerability reduction and capacity building.

<u>Vulnerability Profile</u>: In this study, separate indicators representing different elements of household vulnerability to climate variability were constructed. In all, nine indicators indicating economic factors, health and nutrition, education, empowerment, ecology, poverty, physical infrastructure, conflict and social capital, and geographical factors were used. Since vulnerability is geographically and socially differentiated (Adger et al., 2004), the study adopted an inductive approach to characterize the indicators. This is in agreement with the work of Ramachandran & Eastman, (1997).

<u>Vulnerability/Risk Assessment Framework</u>: The study adopted the Vulnerability/Risk Framework of Downing et al. (2001) and the Vulnerability Assessment Framework of Jones (2001). This framework focuses on current vulnerability, risk of present and future climatic variations, and responses to reduce present vulnerability and improved resilience to future risks. The framework places the stakeholder at the center of the research. This was considered important since it was assumed that the people in the Niger Delta region have developed an indigenous knowledge system to enable them to cope with climate variability. Factors that predispose households to being vulnerable were examined, including irrigation water availability, precipitation, drought, agricultural productivity and production, labour availability, land tenure, food storage and processing, transportation and distribution, population factors, income and conflicts. These factors were scored on a scale ranging from 1 to 3 (where 1 indicates that the factor does not appear to be a key determinant of vulnerability; 2 means that it is an important factor and 3 that it is very important). The mean scores of the respondents on the importance of each factor was computed and

compared with the maximum expected score (3). The value of the mean score was then used to ascertain the importance of a given factor in pre-disposing households to the impact of climate change.

Objective 5: To examine the impact of climate change on male and female-headed farming and fishing households in the study area. How changes in climatic factors affect the farming and fishing households were assessed using indicators such as reduction in crop yield, fish catch, incidents of pest outbreak, cost of adaptation or mitigation, losses due to flooding or drought, disruption in social activities, etc. Proportions and percentages were the main methods of analysis.

Objective 6: To assess male and female-headed upland and wetland farming households' adaptation and coping strategies to climate change. Initial efforts in modeling household coping or adaptation to climate change were directed to assessing the available indigenous knowledge/methods of coping with climate change. These were to give sufficient ideas of what people know and are used to already and could be improved upon. The indigenous approaches were being compared with best practices in order to build upon what is available to achieve sustainability in adaptation to climate change.

Immediate and short-term responses to climate change hazards/events (coping) were identified and categorized. The long term (adaptation) measures were also identified, which was the focus. The study proceeded to model adaptation capacity of the households. A scaled-down Adger et al. (2004) model from the national level to household level was used. The Adger model proposed to employ national (aggregate) data in modeling climate change coping capacity. In this study, micro level equivalents of macro level data were used to model climate change coping capacity for the Niger Delta Region. The implicit form of the model is:

$$Ac = f(Ka, Ea, Pa,)$$

where Ac = Adaptation capacity, Ka = measures of knowledge or access to information relevant to the process of adapting, Ea = a measure of empowerment and Pa = a measure of the adaptation potential. However, the ordered probit model was used in the analysis. The dependent variable consists of three rank categories based on the farmers' or fisher folk's response to the impact of climate change. The categories rank from 0 to 2.

(1) 0 = respondent has not taken adaptation measure
(2) 1 = respondent has taken some measures
(3) 2= some measures were taken, were effective

It was hypothesized that the probability that a respondent will have the capacity to adapt to climate change is a function of some measures of knowledge of climate change, empowerment and adaptation potentials including some of his or her social and economic characteristics. Thus, the explicit form of the ordered probit model used was:

Prob (1) = Prob($\mathbf{p1/(1-p1))}$ β + βX
Where X = 1, 2, ...8

$\mathbf{X_1}$ = Sex of household head (Dummy variable; male =1; female= 0). The coefficient of the sex of a household head is expected to be positively signed. Discussion in the literature is that women are less able to adapt to climate change than men (www.wedo.org).
$\mathbf{X_2}$ = Age of household head (measured in years). This is expected to be negatively signed as the younger farmers tend to be more productive and innovative than the older farmers. Hence, the older

farmers will be more vulnerable to the impacts of climate change and will have less capacity and strength to adapt.
X_3 = Level of education (measured by year formal education completed).This represents empowerment variable. Its coefficient is expected to be positively signed.
X_4 = Household size (measured by number of persons living together under one decision maker/income earner). Household size represents a measure of adaptation potential. The coefficient of household size is expected to carry positive sign. The assumption is that a large family size is normally associated with a higher labour endowment, which would enable a household to accomplish various agricultural tasks. Households with a larger pool of labour are more likely to adopt agricultural technology and use it more intensively because they have fewer labour shortages at peak times. Here it is expected that households with large families are more likely to adapt to climate change.
X_5 = Farm size (measured in hectares). Farm size represents a measure of adaptation potential. The *a priori* expectation is that the coefficient of farm size will carry positive, implying that the larger the farm size, the higher the probability of household having the capacity to adapt to climate change.
X_6 = Income (measured in naira). Income represents the empowerment variable. It is expected to have positive relationship with the odd that a household will have the capacity to adapt to climate change.
X_7 = Accessibility to climate information. The coefficient of accessibility to climate information is expected to be positively signed. The more access a household have to climate information, the more its capacity to adapt would improve, all other things being equal.
X_8 = Community type (upland, wetland/fishing community). A dummy variable was used to capture community type: Upland = 1, 0 otherwise. It has been established in the literature (Heger et al., 2008; Derressa et al., 2008) that agro-ecological settings have significant effects on farmers' perceptions of as well as adaptation to climate change. It can be safely assumed that communities located close to the sea (e.g. fishing and wetland communities) are more exposed to climate change related hazards. Nicholls & Small (2002) argued that coastal and "near coastal zones" represent the area in which populations are most likely to be exposed to the direct and indirect consequences of coastal hazards. Thus, the coefficient of community can carry either a positive or negative sign. In this case, upland community type is labelled 1, while wetland and fishing communities are labelled 0, implying that upland community types have a higher mathematical sign. Therefore, community type here should be positively related to adaptation to climate change. Also, upland communities are far from the coast, implying that they will be less vulnerable to ocean surges unlike the wetland and fishing communities.

Limitations of the Data and Methodology

This study was faced with two important limitations. The first is concerned with the primary data. The respondents relied on memory recall in providing answers to the questions. It was therefore, difficult to depend on information obtained through this method to draw inferences on climate hazards that occurred in the past such as 10, 20 or 30 years ago. Timeline analysis was conducted to gain some insight to past climate hazards and disasters, their impacts and adaptation measures adopted.

The second limitation was on the scope and coverage of the secondary data on climatic elements. Nigerian Meteorological Agency (NIMET) was the source for data on rainfall and temperature. However, data sets could not be obtained that spanned the same period. For example, while the data on rainfall was available from 1961-2006, the data on temperature could only be obtained for the period 1971-2006.

5. RESULTS AND DISCUSSION

Summary Statistics of Climatic elements in the Niger Delta Region

The mean, minimum, maximum rainfall and standard deviations of rainfall and temperature for three states of the Niger Delta studied (Akwa Ibom, Ondo and Rivers State) for the period 1971 to 2006 are presented in Table 2. Standard deviation was employed in this study to assess the extent of variability of two climatic elements- rainfall and temperature. The mean annual rainfall was highest in Akwa Ibom State and lowest in Ondo State. The other statistics - maximum, minimum and standard deviations also follow a similar pattern. Rainfall was heaviest in Akwa Ibom State during the period, which may be as a result of its location compared with other states. The southern end of Akwa Ibom State is beside the Atlantic Ocean. The south west wind, which blows across the Atlantic Ocean for several months brings with it heavy rain. One of the implications of this finding is that climate hazards related to abnormal rainfall, such as flooding, rainstorms and thunderstorms could be expected in Akwa Ibom State. The deviation of rainfall from the mean is also widest in Akwa Ibom State. Rivers State recorded the least deviation of rainfall from the mean for the period. This implies that climate change would be most noticeable in Akwa Ibom State than any of the other states studied.

The highest temperature and highest deviation were recorded in Ondo State. The magnitudes of the deviation of the temperature in the three states range from 1.20^{o}C (Rivers State) to 2.12^{o}C (Ondo State). The result also shows that Ondo experienced higher minimum and maximum annual temperatures among the states studied. The climate change literature (e.g. IPCC, 2001c) explains that temperature variation of up to 0.4^{o}C is significant enough to have impact on the environment. With the range of temperature variation recorded, it would be expected that the impacts of variations in temperature will be manifest in the Niger Delta with Ondo State experiencing the greatest impact.

Table 2. Summary of Rainfall and Temperature Statistics in the Niger Delta Region (1971-2006)

Statistics	Rainfall (in mm)			Temperature (in ^{0}C)		
	Akwa Ibom State	Ondo State	Rivers State	Akwa Ibom State	Ondo State	Rivers State
Mean	2791.31	1274.85	2211.20	30.6	31.5	31.2
Maximum	3862.1	1966.4	2868.6	31.4	33.3	31.9
Minimum	2049.5	622.5	1816.4	29.6	30.3	30.2
Standard Deviation	**1281.70**	**950.28**	**744.02**	**1.3**	**2.12**	**1.20**

Source: Authors' computation

Trends and variation in climate elements in the Niger Delta

Data on the climate elements used, rainfall and temperature, pre-date the creation of the three states studied (e.g. Akwa Ibom State was created in 1987, but data covers earlier periods). The fact is that some of the weather stations from which data were obtained by NIMET had existed in locations within these states even before the state creation. It was assumed that since the states exist in the location where the data were collected, the condition depicted by the data could be applied to that geographical location with a new status of a state.

Trends in climate elements

Trend in rainfall

1) Akwa Ibom State

The trends of variation in rainfall and temperature in the Niger Delta were analyzed using graphs shown in Figure 3 to Figure 11. The two climate elements are considered because of their importance to agriculture as well as data availability. In Akwa Ibom State, rainfall range has been between 2000mm and 4000 per annum. The least annual rainfall volume was recorded about 1975, followed by 1995 and 2005. It is observed, however, that there is always a sharp decline in rainfall amount in the years following the year of increase. The result of the fitted trend line indicates that there is a linear positive relationship between year (period) and rainfall amount, although the variation explained by the year is very small (0.99%). The trend sign is positive indicating that there has been an increase in rainfall in Akwa Ibom State in the past three decades. This increasing trend is insignificant. This corroborates with the IPCC (2001) findings that rainfall will increase in the rainforest and coastal zones of Nigeria but may not be significant.

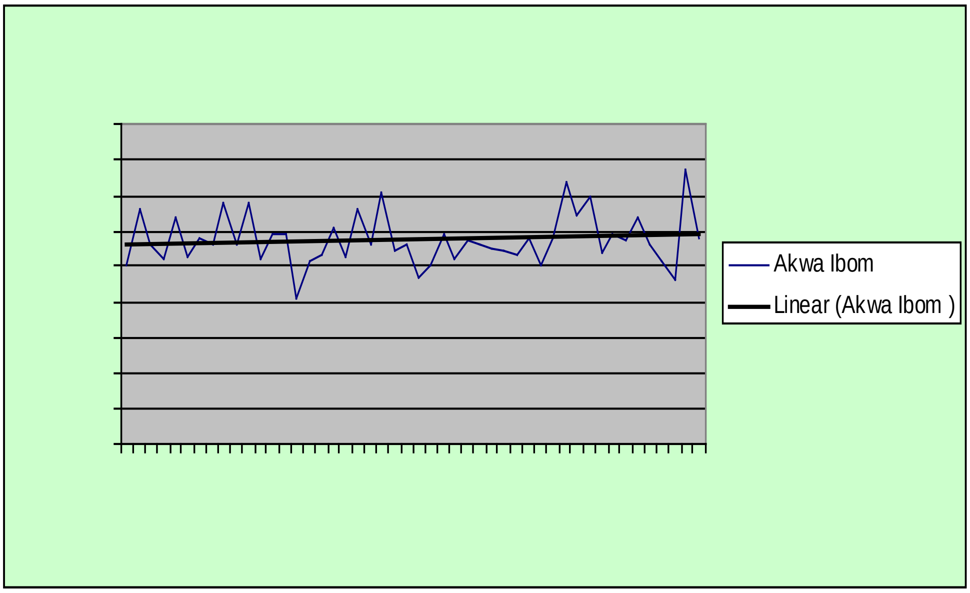

Figure 3. Trend in Rainfall Amount in Akwa Ibom State (1961-2007)

2) Ondo State

The rainfall volume in Ondo State for the period covered in this analysis ranged from about 1300mm per annum to 2700mm per annum (Figure 4). The lowest rainfall volume was recorded about 1986 while the highest was recorded in 1997. There is an increasing trend in rainfall amount in Ondo State as well as in Akwa Ibom State, however this increasing trend is insignificant. The result of trend line analysis indicates that the rainfall amount could increase by as much as 3.15mm as the year progresses. However, one year explains a very small percentage of the variation (1.75%) in rainfall amount. The trend sign is positive, indicating that rainfall has been on the increase in Ondo State. In addition, the coefficient of the trend variable (year) is about 3.15. This implies that rainfall could increase by as much as 3.15mm per year in the state. While rainfall is required for rain-fed agriculture as practised by small holder farmers in the rural communities of Ondo State and indeed the Niger Delta, beyond a given threshold, it could become injurious to crop health.

Therefore, practical steps are required to assist farmers to adapt to the impact of rainfall variation. These include climate change early warning systems, among others.

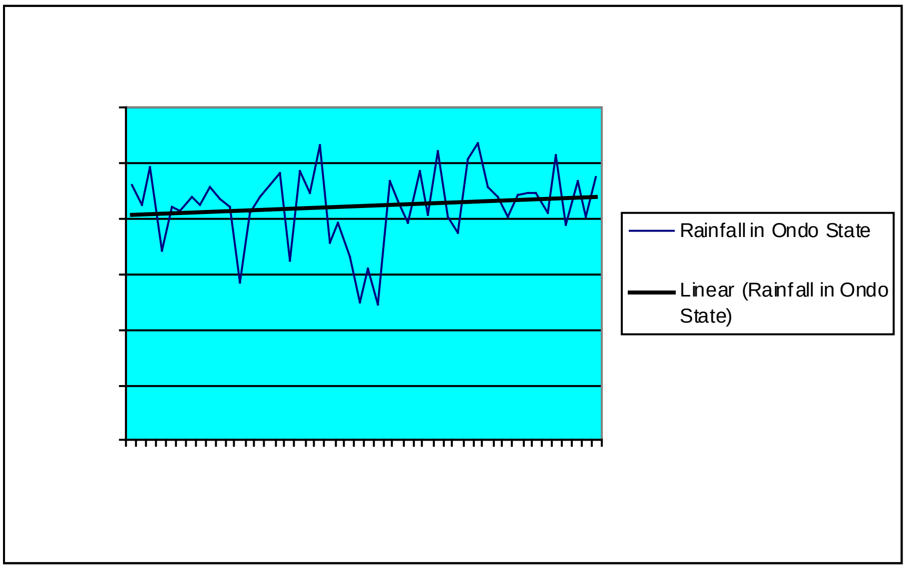

Figure 4. Trend in Rainfall Amount in Ondo State (1961-2007)

3) Rivers State

The range of variation in Rivers State is narrow (Figure 5). The heaviest rainfall was experienced 1962, when about 3000mm of rain was recorded. Since that time, rainfall amount ranged between 2000 and 3000mm. An increase in rainfall volume started from around 2005. The result of the trend analysis revealed an inverse relationship between the year and rainfall amount. About 3% of the variation in rainfall amount is explained by change in year. Of the three Niger Delta States studied, the sign carried by the trend variable of Rivers State is contrary to *a priori* expectations. It is negative (-3.617) showing that rainfall amount has been decreasing in the state. The trend line also depicts this decline. Although there are a few studies that report declining rainfall amounts, the majority of studies and projections of climate change indicate an increase (NEST, 2004). While so many factors could be responsible for this result, this study is focused more on the implications of the result to farming in the region if adaptation measures are not taken. Farming and fishing would be adversely affected by any variation in rainfall and measure must be taken to adapt to this variation.

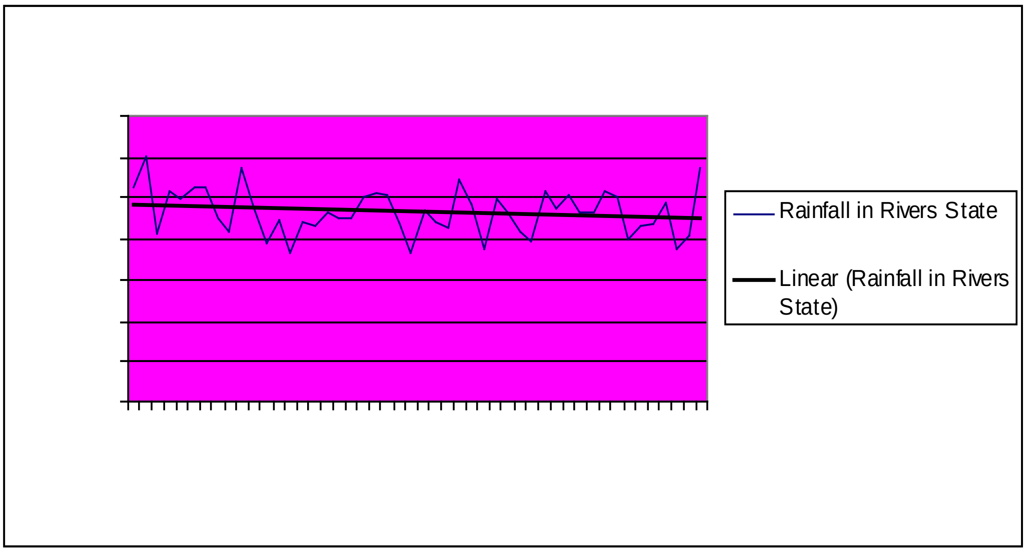

Figure 5. Trend in Rainfall amount in Rivers State (1961-2007)

Comparative Analysis of the trend in rainfall amount in the Niger Delta region

Figure 6 shows that there are regional differences in the rainfall amount in the Niger Delta region. Akwa Ibom State seems to have experienced a higher rainfall amount throughout the decades while Ondo received the least. The recent period (2000 - 2007) seems to show more contrasting rainfall scenarios in the region. While Akwa Ibom State experienced an increasing rainfall amount, Ondo and Rivers State had less.

Generally, the findings from the trend analysis have some implications for farming, and fishing in the study area, the fact that the swings in rainfall amount could be as sharp as in the mid-1980s and early 2000s (Figure 6), implying that crops used to a given rainfall range could be adversely affected. However, the pattern of rainfall emerging in this study can be utilized in an early warning programme, whereby farmers could be advised on impending upward or downward movement of rainfall volume with suggestions and directions on how to mitigate disasters.

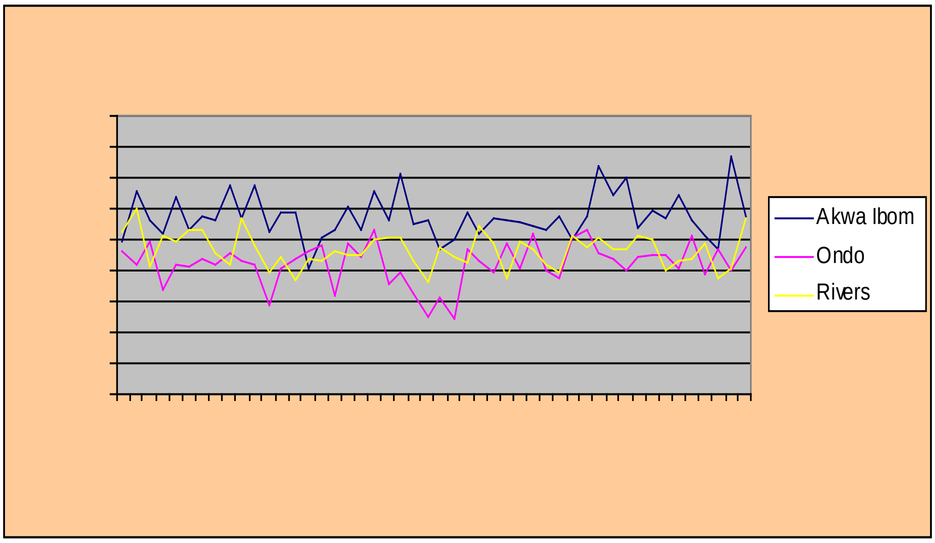

Figure 6. Trend in Rainfall Amount in the Niger Delta Region (1961-2007)

Trends in temperature

The range and duration of temperature is crucial to growth and productivity in the agricultural sector. Estimates for most crops grown in the Niger Delta indicate that most crops thrive within a temperature of 23°C and 30°C (Opeke, 1987; Udoh et al., 2005). The temperatures that prevailed in the three States of the Niger Delta studied are presented Figures 7 to 10.

1) Akwa Ibom: The atmospheric temperature in Akwa Ibom State has ranged between 29.6^{0}C (minimum) and 31.4^{0}C (maximum). Figure 7 shows that the periods in 1971 and the early 1980s were periods of relatively low temperature and there was an unusually high temperature in 1983. The late 1990s and early 2000s were periods of high temperatures, indicating inter-annual variability in temperature in the state. The trend equation reveals less than a proportionate response of temperature to change in years. However, the change in year/period explains 22.5% (R^2 = 0.2253) of the variation in temperature. The trend sign is positive, implying that temperature has been increasing over the years in Akwa Ibom State. Thus, the situation there is in line with situations projected by IPCC about Africa in general. According Christen et al. cited in Speranza (2010), the IPCC Fourth Assessment Report states that "all of Africa is very likely to warm (as a result of increase temperature) during the century. Warming is very likely to be larger than global annual mean warming throughout the continent and in all seasons, with drier sub-tropical regions warming more than the moister tropics". Temperature increase as shown in this study has some implications for farming activities. Each crop and livestock has an optimum range of temperature and temperatures higher or lower than what can be tolerated by the crop or livestock could lead to reduction in yield and productivity and even death. The ultimate impact of this could be food insecurity and increased poverty in farm households.

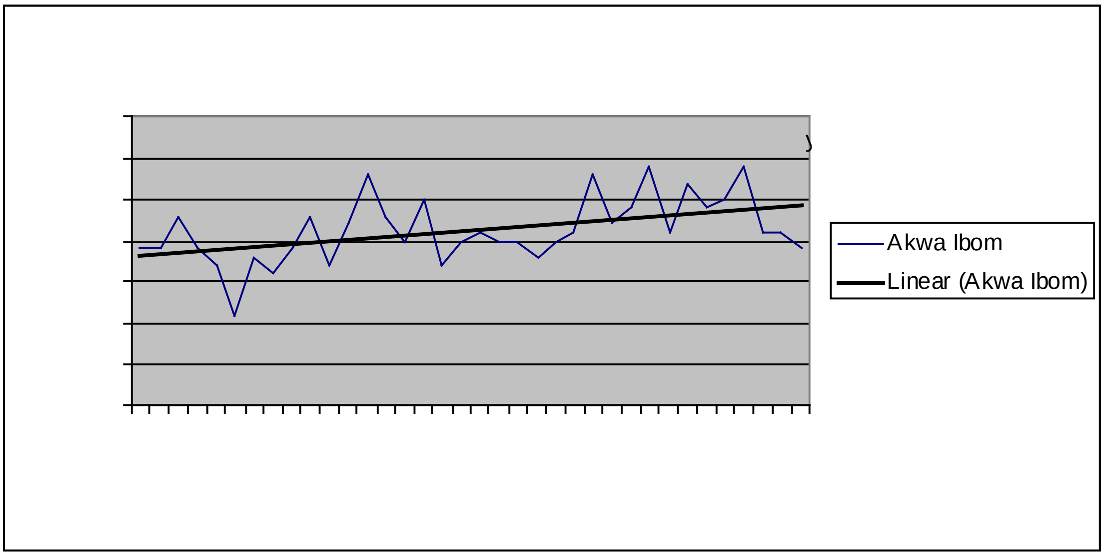

Figure 7. Trend in Temperature in Akwa Ibom State (1971-2006)

2) Ondo State: The mean annual temperature for Ondo State for the period spanning 1971 to 2004 is 31.5^{0}C; the minimum temperature is 30.3^{0}C, while maximum temperature was 33.3^{0}C (Figure 8). Except in 1998 when the temperature rose beyond 33^{0}C, atmospheric temperatures in Ondo State remained within 30^{0}C to 31^{0}C. The late 1990s and early 2000s witnessed mild fluctuations in temperature. Variation in year/period explains about 17% (R^2 = 0.1738) of the change in atmospheric temperature. The coefficient of the trend variable (year) was positive. This indicates that temperature has been increasing in Ondo State in the period under investigation. The magnitude of the coefficient of trend variable suggests that temperature increased by about .02^{0}C

per year in Ondo State. The value of the coefficient indicates that the change is perhaps, barely perceptible and may not be easily observed by rural farmers. This may be a hindrance to adaptation as any minor change may be taken as normal and not requiring serious attention.

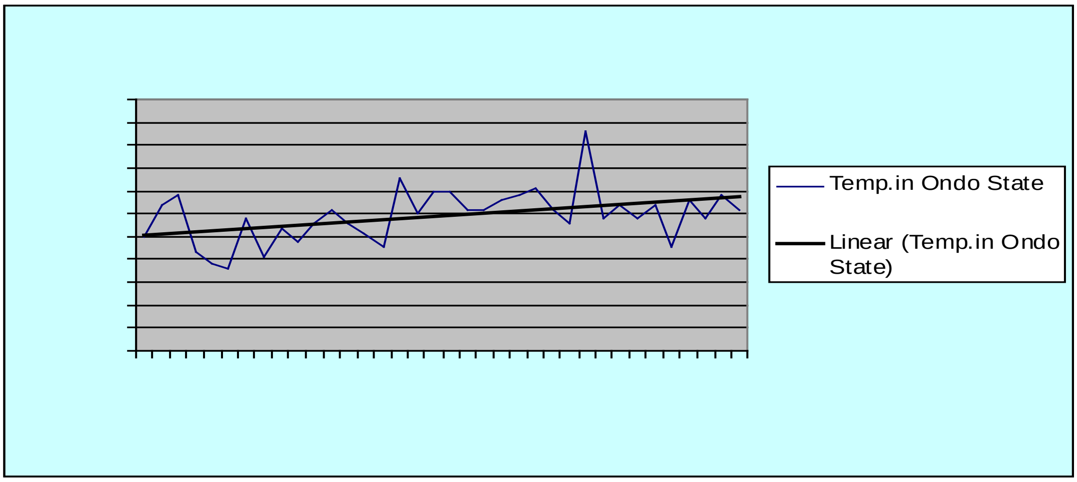

Figure 8. Trends in Temperature in Ondo State (1971-2006)

3) Rivers State: The maximum atmospheric temperature recorded in Rivers State in the period 1971 to 2007 was 30.2^0C and 31.2^0C (Figure 9). Trend analysis reveals a steady rise in temperature from 1980 reaching the peak about 1988. The 1980s seem to have been the hottest period in Rivers State. The trend sign is positive signifying that temperature increased over time in Rivers State. The trend line shows less than proportionate change in temperature due to change in year. A change in year is found to account for only about 8% variation in temperature. This means that besides the year, there are other very important determinants of the variation in atmospheric temperature in Rivers State.

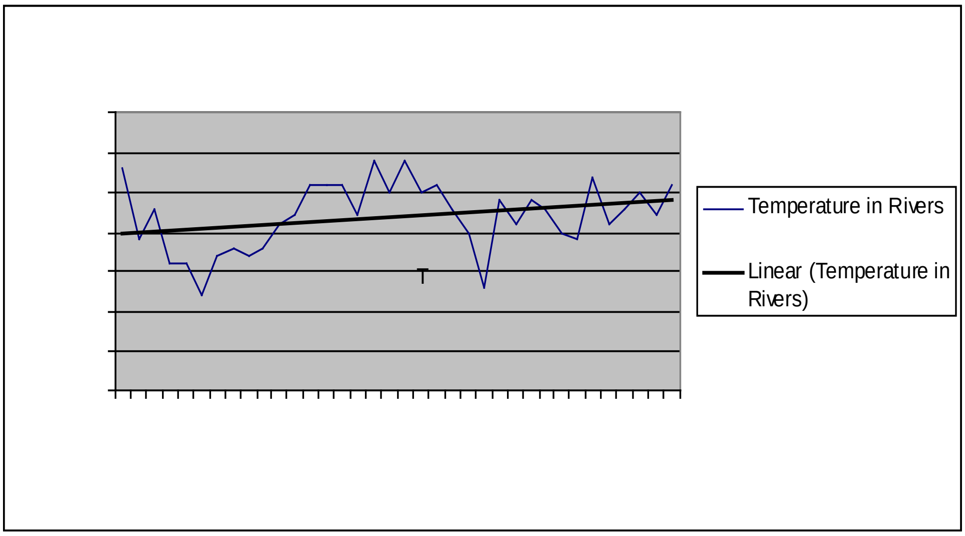

Figure 9. Trend in Temperature in Rivers State (1971-2006)

Comparative Analysis of the trend in temperature in the Niger Delta region

In comparative terms, Ondo State has experienced hotter years than any of the other states studied. It is followed by Rivers State (Figure 10). A contrasting temperature scenario is observed between 1989 and 1992. The patterns of variation in temperature at other periods remain similar, but the opposite occurred between 1989 and 1992. While high temperatures were recorded in Rivers and

Ondo States within this period, Akwa Ibom recorded its lowest temperature. Thereafter, the pattern of inter-annual temperature change is similar across the three states.

Higher temperatures in the Niger Delta have implications for the environment and ultimately the livelihoods in the region, farming and fishing. Higher temperatures could lead to low fish catch as well as lower crop yield. In the final analysis, such a situation may result in loss of income by the majority of the Niger Delta population who depend on these activities for sustenance.

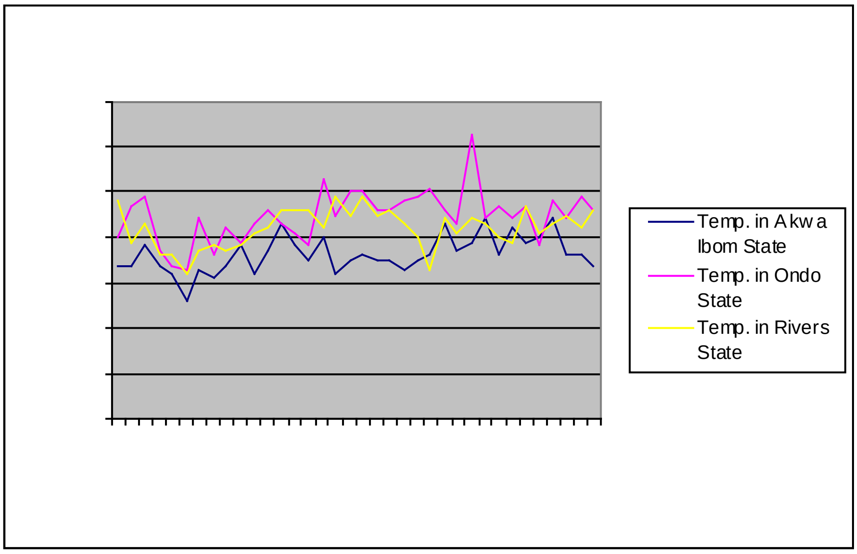

Figure 10. Trend in Temperature in the Niger Delta Region (1971-2006)

Farmers' Perception of climate change

Perceptions of rainfall

Respondents' observations of rainfall vary across the state by location (community) and by gender. In Akwa Ibom State, a greater percentage of females in upland communities reported increased volume of rainfall, while more males reported decreased volume. Similar observations are made by the respondents in Rivers State. In contrast, both males and females in the upland communities of Ondo State did not observe variation in the volume of rainfall. In the wetland communities, Akwa Ibom and Rivers States, both male and female respondents observed a decrease in volume of rainfall, while those in Ondo State did not observe any variation in the rainfall volume. The observation in the fishing communities, follow closely those in the wetland communities. Both males and females in Akwa Ibom and Rivers State reported decreased rainfall volume.

The perception of female upland farmers in Akwa Ibom State supports the evidence obtained from the trend analysis which shows that rainfall amount has been increasing in Akwa Ibom State. The male farmers' perception, however, run contrary to the trend results. Again, the perceptions of both male and female farmers in Rivers State reflect the result from the trend analysis which revealed that rainfall amount has been decreasing in Rivers State. However, participants in the FGD seem to be confident that there has been variation in rainfall.

Discussants in Ifiayong Usuk reported their experience this way:

"In 1983, there was a long dry season which lasted up to the month of May. All the plantains and other crops wilted, withered and died due to lack of water. Since then, things have not been the same again! It is even worse these days. We do not experience normal rainy season again. Sometimes, rain can start from the month of April and fall till December. In some years we can stay as late as the month of June and the rain will not come".

The situation emerging from the farmers' perceptions can be attributed to climate change in the Niger Delta region is imperceptible, although it is real. This is shown by the size of the trend variable obtained from the trend analysis above. Thus, it is possible that farmers may regard events in their environment as normal and not readily attribute them to climate change. A similar situation has been reported in Ghana by Tshikata & Awumbilla (2004). In their study of women's livelihoods and vulnerability to climate change, they concluded that "even though the women have observed changes in the planting season, most of them were not sure about the exact time these changes occurred or for how long. Only two of them thought the changes were associated with the climate." Madison (2006) reported that a significant number of farmers in 11 African countries believe that precipitation has declined. Farmers with the greatest farming experience were reported to be more likely to notice changes in climatic conditions which, according to the author, are consistent with farmers engaging in Bayesian-updating of their prior beliefs.

Table 3. Percentage distribution of respondents by their perception of variations in rainfall amount

Community Type	Observed Change	Akwa Ibom		Ondo		Rivers	
		Male (%)	Female (%)	Male (%)	Female (%)	Male (%)	Female (%)
Upland	Increased Volume	35.38	53.33	20.00	26.67	32.31	73.33
	Decreased Volume	40.00	26.67	20.00	20.00	56.92	13.33
	No Variation	24.62	20.00	60.00	53.33	10.77	13.33
	Total	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**
Wetland	Increased Volume	44.62	26.67	29.23	46.67	4.62	6.67
	Decreased Volume	47.69	66.67	16.92	6.67	67.69	60.00
	No Variation	7.69	6.67	53.85	46.67	27.69	33.33
	Total	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**
Fishing Community	Increased Volume	13.33	20.00	6.67	20.00	6.67	20.00
	Decreased Volume	53.33	40.00	33.33	60.00	86.67	60.00
	No Variation	33.33	40.00	60.00	20.00	6.67	20.00
	Total	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**

χ^2 cal = 274.067

Source: Field data, 2011

Perceptions of the variation in temperature

The percentage distribution of respondents, according to their perception of variation in temperature, is presented in Table 4. In Akwa Ibom State, both male and female farmers in upland communities perceived temperature as being on the increase. The male farmers in upland communities of Rivers State made similar observations. In contrast, both male and female upland farmers in Ondo State do not perceive any variation in atmospheric temperature in their communities. A total of 86.7% and 80% of male and female farmers respectively reported “no variation” in temperature. While the male and female upland farmers in Ondo State share a similar opinion on temperature in their communities, this is not the case in Rivers State. In Rivers State 67.7% of the male farmers reported increase in temperature while 60% of the female upland farmers said they noticed a decreased in temperature in their communities.

The perceptions of farmers in wetland communities in the three states studied are similar to those of upland farmers. The perceptions of the male and female farmers in all Akwa Ibom communities and those of the male farmers in Rivers State are in line with the results of the trend analyses. The signs of the trend variable obtained for the three states are positive indicating that temperature has been increasing (Figures 7, 8 and 9). In general, there have been mixed reports on the direction of change in temperature in the climate literature. While Hillre et al. (2001) report a temperature decrease of 0.1- 0.5^0C between 1901 and 1995, Madison (2006) reports that in 11 African countries farmers believe that temperature has already increased and that precipitation has declined. Emerging micro level studies in the Niger Delta report a temperature increase (Umoh & Eketekpe, 2010). Testimonies of participants in FGDs as well as the key informants point to the fact that there is an increase in temperature in the region.

The different opinions on the direction of variation in temperature simply show that climate variation and long-term climate change studies and discourses are in the early stages. The farmers in particular may be yet unable to read meaning into variation in climatic elements taking place. This, again, may adversely affect their readiness and ability to adapt or to mitigate climate impacts. The lack of awareness of the farmers about variations in climate temperatures could have adverse impacts on agriculture. Higher than normal temperature, for instance, without mitigation could reduce food availability because of its negative effects on the basic elements of food production – soil, water and biodiversity.

Table 4. Percentage distribution of respondents by their perception of variation in temperature

Community Type	Observed	Akwa Ibom		Ondo		Rivers	
	Change	Male	Female	Male	Female	Male	Female
		%	%	%	%	%	%
Upland	Increased	66.2	86.7	4.6	6.7	67.7	13.3
	Decreased	9.2	6.7	9.2	13.3	4.6	60.0
	No Variation	24.6	6.7	86.1	80.0	27.7	26.7
	Total	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**
Wetland	Increased	50.8	60.0	16.9	33.3	67.7	33.3
	Decreased	9.2	13.3	30.7	20.0	7.7	33.3
	No Variation	40.0	26.7	52.3	46.7	24.6	33.3
	Total	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**
Fishing Community	Increased	60.0	20.0	0.0	0.0	46.7	40.0
	Decreased	13.3	40.0	33.3	40.0	26.7	20.0
	No Variation	26.7	40.0	66.7	60.0	26.7	40.0
	Total	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

χ^2 cal = 199.184; Source: Field data, 2011

Perceptions of Sunshine Hours

Observations of the respondents on sunshine hours are presented in Table 5. In the upland communities of Akwa Ibom State, both the male and female farmers perceived increased sunshine hours. In Ondo State, the male and female upland farmers differ in their opinion of variation of sunshine hours. While a half (50.8%) of the male farmers studied reported that they have not observed variation in sunshine hours in their communities, 80% of the female farmers said they had decreased. The male upland farmers in Rivers share in the observation of the female farmers in Ondo State. The females, however, perceived increased sunshine hours in their communities. This pattern of observation is also the case in the wetland communities. In the fishing communities, the common observation is that there has been decrease in sunshine hours. This pattern cuts across all the states. The dominant perception across state, location and gender tend to be that sunshine hours have been decreasing. The decreasing sunshine hours as reported across the communities studied have some implications for crops and livestock production. Any deviation from normal sunshine duration in the crop or livestock environment, may lead to reduction in yield, overall output and lead to food insecurity.

Table 5. Percentage distribution of respondents by their perception of variation in Sunshine Hours

Community Type	Observed	Akwa Ibom		Ondo		Rivers	
	Change	**Male**	**Female**	**Male**	**Female**	**Male**	**Female**
Upland	Increased	59.4	50.0	10.8	0.0	7.14	66.7
	Decreased	37.5	43.	38.5	80.0	71.43	33.3
	No Variation	3.1	6.3	50.8	20.0	21.43	0.0
	Total	**100.0**	**100.0**	**100.0**	**100.0**	**100.00**	**100.0**
Wetland	Increased	72.2	88.5	9.2	6.7	0.00	0.0
	Decreased	9.3	3.9	33.9	46.7	100.00	100.0
	No Variation	18.5	7.7	56.9	46.7	0.00	0.0
	Total	**100.0**	**100.0**	**100.0**	**100.0**	**100.00**	**100.0**
Fishing Community	Increased	20.0	0.0	0.0	0.0	9.09	5.3
	Decreased	46.7	100.0	40.0	80.0	90.91	84.2
	No Variation	33.3	0.0	60.0	20.0	0.00	10.5
	Total	**100.0**	**100.0**	**100.0**	**100.0**	**100.00**	**100.0**

χ^2 cal = 263.676; Field data, 2011

Perceptions of relative humidity

Relative humidity, like the other factors discussed thus far, has an influence on farming. Table 5 shows farmers' and fisher folk's perception of variation in sunshine hours. Respondents in Akwa Ibom and Rivers upland and Rivers wetland communities reported a decrease in relative humidity. The male respondents in Akwa Ibom observed higher relative humidity while the females observed no variation in relative humidity. This may have been influenced by the reported decreased in rainfall volume and could translate to a drier environment. All the respondents in the fishing communities except Rivers State did not observe any variation in relative humidity.

Table 6. Percentage distribution of respondents by their perception of variations in relative humidity

Community Type	Observed Change	Akwa Ibom		Ondo		Rivers		
		Male	Female	Male	Female	Male	Female	All
Upland		%	%	%	%	%	%	**%**
	Higher	26.6	31.3	15.4	6.7	14.3	33.3	**20.3**
	Lower	48.4	43.8	7.7	46.7	57.1	66.7	**33.9**
	No Variation	25.0	25.0	76.9	46.7	28.6	0.0	**45.8**
	Total	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100**
Wetland	Higher	40.7	3.9	1.5	6.7	0.0	0.0	**14.7**
	Lower	33.3	34.6	0.0	0.0	100.0	80.0	**21.2**
	No Variation	25.9	61.5	98.5	93.3	0.0	20.0	**64.1**
	Total	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**
Fishing Community	Higher	0.0	0.0	0.0	0.0	40.9	57.9	**24.7**
	Lower	0.0	0.0	0.0	0.0	18.2	10.5	**7.4**
	No Variation	100.0	100.0	100.0	100.0	40.9	31.6	**67.9**
	Total	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100**

Wind speed

Table 8 shows the percentage distribution of respondents' perception of variation in wind speed. Windstorms, whirlwinds and high speed winds are known to be destructive, particularly to tree crops such as banana and plantain, rubber, oil palm trees, etc. Like the case on farmers' perception of the variation of other climatic elements, there is a difference of opinion across the states and by gender on the pattern of wind speed. For upland and wetland communities, it can be concluded that no noticeable variation in the wind speed was observed. Similar conclusions can be drawn about the fishing communities, except in Rivers States where the view of both males and females is that the wind speed has decreased over time. With majority of the respondents reporting "no variation" and "decreased" wind speed, it would be expected that wind-related hazards will not be a serious problem in the farming and fishing communities in the study area. Nonetheless, the outcome of the FGDs contains instances of occurrence of wind-related hazards in some of the study communities.

From the results of the FGDs, it can be inferred that although the variation in wind speed is not noticeable by majority of the respondents, it however exists as a climate change-related hazard in the Niger Delta communities.

Table 7. Percentage distribution of respondents by their perception of variation in wind speed

Community Type	Observed Change	Akwa Ibom		Ondo		Rivers		All
		Male	Female	Male	Female	Male	Female	
		%	%	%	%	%	%	
Upland	Increased	40.6	56.3	6.2	0.0	14.3	33.3	**23.7**
	Decreased	43.8	25.0	6.2	20.0	57.1	33.3	**27.1**
	No Variation	15.6	18.8	87.7	80.0	28.6	33.3	**49.2**
	Total	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**
Wetland	Increased	38.9	53.9	3.1	6.7	0.0	0	**22.4**
	Decreased	38.9	34.6	0.0	0.0	100.0	100	**23.5**
	No Variation	22.2	11.5	96.9	93.3	0.0	0	**54.1**
	Total	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100**	**100**
Fishing Community	Increased	33.3	0.0	6.7	0.0	4.6	15.8	**11.1**
	Decreased	20.0	0.0	0.0	0.0	95.5	84.2	**51.9**
	No Variation	46.7	100.0	93.3	100.0	0.0	0	**34.6**
	Total	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100**	**100.0**

Source: Field data, 2011

Climate Change evidence from Weather Stations

Information was obtained from local weather stations on trends in rainfall and temperature in an attempt to cross check the perception of farmers and fisher folk. Data were sought on any variation in regard to harmattan haze, onset and cessation of rain, rainfall amount, duration of dry season and the short dry spell ("August break") usually experienced in the Niger Delta region. From the results presented in Table 8, 72.7% of the stations reported increased temperatures, 54.5% reported decreased rainfall volume. Variation in the onset and cessation of rain was reported by 36.4% of the institutions studied. Relating the reports from these institutions with the farmers' perceptions, it can be inferred that: i) there may be inter-regional differences in climate (i.e. climatic condition may vary from one community to another). This may account for the differences in the perception of respondents across the states as well as in the sign of the trend variables (e.g. the sign of the trend variable in Rivers rainfall is negative; those of all other states are positive); and ii) climate change is yet to be understood by different segments of the Niger Delta population. This has some implications for adaptation. Nhemachena et al. (2007) suggest that improving adaptive capacity of disadvantage communities (such as farming communities) requires ensuring access to resources, including appropriate climate information.

Table 8. Percentage distribution of weather stations by reported variation in climate parameters

Variations observed/reported	Institutions reporting
Reduction in harmattan dust haze	9.09%
Changes in onset of rain	9.09%
Higher temperature(increased heat)	72.73%
The time and cessation of rainy season has changed/ Late onset and early cessation of rainfall	36.36%
Rainfall volume has decreased	54.55%
Reduction in length of "August Break"	9.09%
Period of dry season has increased	9.09%

Source: Field Data, 2011

Climate information sources, their accessibility and perception by farmers and fisher folk

Climate Information Sources

The sources of information on climate change for both male and female farmers and fisher folks in upland, wetland and fishing communities are presented in Table 10. Across locations and states, the common response is that they do not have an information source supplying them with climate information. About 62% of the female upland farmers in Akwa Ibom State made this claim. In Ondo State, 84.6% of male and 86.7% of female upland farmers said they do not have any source from which they obtain climate information. The condition reported in upland communities also prevail in the wetland as well as fishing communities. Radio and television seem to be the sources of climate information available to the farmers and fisher folk. In upland communities in Akwa Ibom and Rivers States, about a half (50%) of the male farmers identify radio as the source of climate information. Newspapers and television are utilized by female farmers in River State while 21.4% of their male counterparts report that they obtain climate information from television. These two sources were common to all categories of respondents, both male and female. In addition to these mass media sources, fellow farmers also share climate information with their colleagues. Discussants in the FGDs as well as key informants reported that in the absence of climate information institutions and irregularity of the "news" on weather from the radio stations, they rely more on their peers for climate information. Within the fishing communities, fisher folk and divers were said to be important sources of information on climate.

Besides the aforementioned sources of information, respondents claimed that from their personal experiences, they are able to compare the current situations with the past and form an opinion as to how the climate situation is. Based on this, they make decisions on their livelihood activities.

Climate institutions such as weather stations and meteorological stations did not appear on the list of sources of climate information of the respondents, which indicates that the institutions do not make information available to the farmers. Of interest too is the fact that extension agents do not act as climate information sources to farmers in the communities.

Both climate institutions and extension agents are crucial in agricultural development, particularly for rain-fed farming as practised in Nigeria. The farmers need regular information on the weather/climatic situation and extension agents are expected to be in regular contact with the farmers to disseminate this information on new technologies that might assist farmers to forecast weather. The fact that they are not playing that role requires action. Climate information gathering and dissemination needs to target farmers and fisher folks. The aim of targeting and tailoring information is to ensure that the most vulnerable to climate change-subsistence farmers and fisher folk, women and the poor get the right kind of services to increase their adaptive capacity.

Table 9. Percentage distribution of Respondents by their Climate Information Sources

Community Type	Climate Information source	Percentage distribution of respondents							
		Akwa Ibom		Ondo		Rivers		All	
Upland		Male	Female	Male	Female	Male	Female	Male	Female
		%	%	%	%	%	%	%	%
	Nil	31.3	62.5	84.6	86.7	28.6	33.3	55.2	70.6
	Radio	51.6	18.8	0.0	6.7	50.0	0.00	28.0	11.8
	TV	1.6	0.0	15.4	6.7	21.4	33.33	9.8	5.9
	Ext. Agent	1.6	0.0	0.0	0.0	0.0	0.0	0.7	0.0
	Peers	12.5	18.6	0.0	0.0	0.0	0.0	5.6	8.8
	Social Groups	1.6	0.0	0.0	0.0	0.0	0.00	0.7	0.0
	Newspapers	0.0	0.0	0.0	0.0	0.0	33.3	0.0	2.9
	Total	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**
Wetland	Nil	40.7	69.2	44.6	46.7	80.0	100.0	44.4	65.22
	Radio	27.8	15.4	38.5	26.7	20.0	0.0	33.1	17.4
	TV	9.3	0.0	18.5	26.7	0.0	0.00	13.71	8.7
	Ext. Agent	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Peers	14.8	7.7	0.0	0.0	0.0	0.0	6.5	4.4
	Social Groups	7.4	7.7	0.0	0.0	0.0	0.0	3.2	4.4
	Newspapers	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Total	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**
Fishing Community	Nil	65.0	70.0	73.3	100.0	73.3	100.0	70.0	66.5
	Radio	20.0	21.0	0.0	0.0	0.0	0.0	14.0	16.0
	TV	0.0	9.0	26.7	0.0	26.7	0.0	16.0	12.5
	Ext. Agent	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Peers	15.0	0.0	0.0	0.0	0.0	0.0	6.0	5.0
	Social Groups	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Newspapers	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Total	**100.0**	**100.0**	**100.0**	**100.0**	**100.00**	**100.0**	**100.0**	**100.0**

Source: Field data, 2011

Availability of climate information

Efforts were made to determine how readily available climate information is to farmers and fisher folks in the Niger Delta region. The results in Table 11 show that climate information is not available to most of the farmers and fisher folks in the study area. In Akwa Ibom upland communities, 84.6% and 86.7% of male and female farmers respectively reported that climate information was not available to them. An equally high % of male and female farmers in both Ondo (75.3% of males, 80.0% of female farmers) and Rivers (75.3% male farmers, 33.4% female farmers) States reported that climate information is not available to them. In the wetland communities of Akwa Ibom State, more females (60%) than males (55.4%) reported that climate information was not available to them. In Ondo State, more male (44.6%) and females (40.0%) in wetland and fishing communities report climate information being readily available to them. The situation is the reverse in Rivers State where climate information was more readily available to female-headed households. Overall, climate information is not available to most households in the region. But information seems to be available to more wetland and fishing households than upland households. The possible reason for this difference may be found in the information-seeking behaviour of wetlands and fishing households which in turn may be influenced by these environments being more prone to climate related hazards than uplands. This is an assertion which requires further investigation to empirically establish what actually account for this difference. Differences in opinion notwithstanding, the value of chi-square statistics reveals that there is significant difference in the opinion of the respondents as to the availability of climate information to them.

The non-availability of climate information to farmers in the Niger Delta region has serious implications for households in the region who depend on agriculture for livelihood. If farmers are without information on climate change which could affect them, then they may be vulnerable to the adverse impacts. This implies that farmers and fisher folk may not be well enough informed to take preventive actions to mitigate the impact of climate change.

Table 10. Percentage distribution of respondents by the perception of availability of Climate Information

Community Type	Availability of climate information	Percentage distribution of respondents							
		Akwa Ibom		Ondo		Rivers		All	
		Male	Female	Male	Female	Male	Female	Male	Female
		%	%	%	%	%	%	%	%
Upland	Not Available	84.6	86.7	75.3	80.0	75.3	33.4	78.5	66.8
	Readily Available	4.6	6.7	10.8	6.7	16.9	53.3	8.2	22.2
	Rarely Available	10.8	6.6	13.9	13.3	7.7	13.3	13.3	11.1
	Total	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**
Wetland	Not Available	55.4	60.0	49.2	46.7	75.4	73.3	60.0	60.0
	Readily Available	36.9	20.0	44.6	40.0	15.48	20.0	32.3	26.7
	Rarely Available	7.7	20.0	6.2	13.3	9.2	6.7	7.7	13.3
	Total	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**
Fishing Community	Not Available	80.0	40.0	53.3	60.0	46.7	60.0	60.0	53.3
	Readily Available	13.3	40.0	33.3	20.0	20.0	20.0	22.2	26.7
	Rarely Available	6.7	20.0	13.4	20.0	33.3	20.0	17.8	20.0
	Total	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

χ^2 cal:316.89***, Source: Field data, 2011

Accessibility of Climate Information

Having established climate information sources and availability of climate information, the study investigated how accessible the available sources were to respondents. Virtually all the respondents reported not having access to formal climate information sources. Discussants at the FGDs said they were aware of the existence of meteorological weather situations but they do not readily access the weather/meteorological stations for weather information. The respondents said they are aware of the existence of meteorological/weather stations. These consist of both public weather stations such as Nigerian Meteorological Agency (NIMET) and those in research institutions/centres as well as private stations, particularly those owned by oil companies. However, these stations do not provide weather information to communities or directly to the public. This situation causes community members to rely more on their own perceptions of weather or information provided by neighbours or fellow farmers or fisher folk. Neighbours and fellow farmers and fisher folk are not likely to be reliable sources of climate information. Therefore, it can be inferred that farmers and fisher folk in the region may not be getting reliable information on climate. Thus, they may not be properly informed and equipped for effective adaptation to climate change. This situation calls for re-examination of the mandates of weather stations. Should their duty not include providing information to the farmers, then this should looked into and corrected so that farmers and fisher folks whose livelihoods are vulnerable to the impact of climate change are well informed to adapt accordingly.

Perceptions of Climate Information

It is one thing to have information on climate change and another thing for the information received to have a useful purpose. In this study, effort was made to determine this through the perception of the climate information received by respondents. Two measures were employed; these were: i) how the weather forecast announced by the media houses or weather stations occur; and ii) how appropriate the climate information is for farmers and fisher folks.

<u>Accuracy of climate information</u>: The results on the accuracy or correctness of climate information supplied to farmers and fisher folks are presented in Table 12. The percentage is based on the number of respondents who reported to have ever received information on or heard of climate change. In general, most of the respondents said that, the climate information supplied is never correct. This assertion cuts across all the states and community types. In the upland communities, 76.9% of male and 86.7% of female farmers in Akwa Ibom State said the climate information received is never correct. Almost equal numbers also reported “never correct” in Ondo State. However, most men in the upland communities said climate information received are “sometimes” correct. The perception of respondents in Ondo State is slightly different from those of other states. The percentage of respondents who said information received is always correct is greater than those who reported that they are sometimes correct. The percentage of respondents in these two categories is much smaller than who reported that information available is never correct. More men than women in both Ondo and Rivers fishing communities reported climate information made available to them is always correct.

The results from these qualitative data also reveal that the respondents have differing views as to the reliability of weather information obtained from radio and television stations. Discussants in both wetlands and uplands communities of Ondo State consider these two sources neither reliable nor dependable sources of climate information. One key informant summed up the views as: “These sources are not reliable. They give reports of their environment over there.” In contrast, discussants in Akwa Ibom State considered the sources as being reliable. They said when the Nigerian Television Authority (NTA) gives weather information during its 9pm news broadcast; such forecasts do come to pass in most cases.

The situation where information available is “never correct” could be attributed to the fact that it is not tailored to the need of the farmers and fisher folks. Field observation show that the weather stations collect information for use by either institutions such as airlines, companies and NIMET, without a specific focus on the needs of farmers/fisher folks. Indeed, the weather parameters that are reported occasionally on the television and radio stations are always on rainfall and temperature in various locations across the country. The result, therefore, points to the fact that farmers in the region do not have reliable climate information to assist them in their livelihoods. This might account for reliance by farmers and fisher folks on their peers for information on climate as reported in the previous section. This suggests that targeted climate information need to be collected and disseminated regularly to those who rely on it.

The findings presented in Table11, reject the hypothesis that there is no significant difference in the perception of the respondents on the correctness of climate information. The chi-square statistics support the descriptive statistics which show most male and female farmers in all agro-ecosystems and states reporting that the climate information they receive is "never correct".

Table 11. Percentage distribution of respondents by their perception of the correctness of Climate information

Community Type	Response	Akwa Ibom		Ondo		Rivers		All	
		Male	Female	Male	Female	Male	Female	Male	Female
		%	%	%	%	%	%	%	%
Upland	Never Correct	76.9	86.7	75.4	80.0	90.8	73.3	81.1	80.0
	Sometimes Correct	16.9	6.7	10.8	6.7	6.25	13.3	11.3	8.1
	Always Correct	6.2	6.7	13.9	13.3	3.1	13.3	7.7	11.1
	Total	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**
Wetland	Never Correct	58.5	66.7	40.0	60.0	80.0	53.3	59.5	60.0
	Sometimes Correct	13.95	26.7	12.3	20.0	10.8	33.3	12.3	26.7
	Always Correct	27.7	6.7	47.7	20.0	9.2	13.3	28.2	13.3
	Total	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**
Fishing Community	Never Correct	73.3	60.0	40.0	60.0	26.7	60.0	46.7	60.0
	Sometimes Correct	20.0	20.0	13.3	20.0	6.7	20.0	13.3	20.0
	Always Correct	6.7	20.0	46.7	20.0	66.7	20.0	40.0	20.0
	Total	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

χ^2 cal:171.86***; Source: Field data, 2011

Appropriateness of climate information: In addition to examining how correct the climate information received by the respondents is, the study also examined how appropriate the climate information was to the farmers' and fisher folks' needs and purposes. The result of appropriateness of climate information is presented in Table 12. The general opinion tends to be that the climate information receive is not appropriate to the farmers' and fisher folks' needs. All the male and female (100%) wetland farmers and fisher folks said the climate information they receive is not appropriate. The majority of the respondents in Akwa Ibom State also affirmed inappropriateness of the climate information they receive. The only exceptions to this position are the wetland farmers in

Ondo State. More than 50% both male and female respondents in these communities reported that climate information available to them was appropriate. Across the states and community types, except in the fishing communities of Akwa Ibom State, more female respondents seem to find climate information available to them as inappropriate.

Studies over the years have established the fact that women form the bulk of the farming population in Nigeria. A situation where women find available climate information inappropriate implies that the contents of climate information generated and disseminated in Nigeria and particularly the study area are not meeting the needs of the farming population. Indeed, it could be safely said that government-owned weather stations in Nigeria hardly focus on providing data for farmers' use at all. It is only recently that NIMET started providing annual weather forecasts with explanations for possible impact on agriculture. Efforts seem to have been more concentrated on providing daily weather data to the air transport sector. Two important inferences can be made from this result: i) it could be that climate information is not available to the farmers which explains why there is no difference in their perception of appropriateness of climate information or, ii) because both male and female in the wetland and upland communities are engaged in similar livelihoods e.g. farming, that is the reason there is no statistical differences.

The important concern is the effect of inappropriateness of the climate information may have on farmers and fisher folks in livelihoods, income as well as adaptive capacity. The enabling institutions for making climate available in the right form and at the right time will be a good first step in making appropriate information on climate change to the farmers and fisher folk. In addition, appropriate climate information communication channels need to be created and used.

Table 12. Percentage distribution of respondents by their perception of appropriateness of climate information

Community Type	Response	Akwa Ibom		Ondo		Rivers		All	
		Male	Female	Male	Female	Male	Female	Male	Female
		%	%	%	%	%	%	%	%
Upland	Appropriate	18.7	6.3	15.4	13.3	28.6	0.0	18.2	8.8
	Not Appropriate	81.3	93.6	84.6	86.7	71.4	100.0	81.8	91.2
	Total	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**
Wetland	Appropriate	24.1	7.7	50.8	53.3	0.0	0.0	37.1	21.7
	Not Appropriate	75.9	92.3	49.2	46.7	100.0	100.0	62.9	78.6
	Total	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**
Fishing Community	Appropriate	5.0	24.6	30.0	12.0	0.0	0.0	12.3	0.0
	Not Appropriate	95.0	75.4	70.0	88.0	100.0	100.0	87.7	100.0
	Total	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

χ^2 cal:128.76***, Source: Field data, 2011

Users of Climate Information from Climate Institutions:

As a way of cross-checking the claims by both the farmers and fisher folks of both sexes that climate information is not readily available to them, the weather stations studied were requested to state who uses the information they generate and how frequently they supply information. Responses from the weather stations are presented in Table 13. The results reveal that farmers and fisher folks are not the target beneficiaries of the weather stations activities. Over 60% of the weather stations supply data/information to researchers including students conducting studies. The next in ranking of those receiving information from these stations are companies, particularly construction firms (45.5%), followed by such institutions as airlines and the Central Bank of Nigeria. Only 27.3% of the weather stations reported giving information to farmers. The result corroborates the reports of the farmers and fisher folk that they do not receive information from the relevant institutions. The issue of frequency of supply of climate information is even more revealing. It is only institutions that obtain information daily. Information to the airlines is for purposes of transportation, the farmers and other users only obtain information from these institutions on demand.

There are few weather stations the Niger Delta and in Nigeria generally, thus making it difficult for farmers, particularly the poor farmers, to individually demand and obtain climate information. It is therefore, not surprising that farmers rely on weather forecasts on radio and television for climate information. Such broadcasts usually give information on the weather situation (rainfall and temperature) expected in a day or two. It may be difficult for the farmers to plan with such short-term information. Given the risky nature of farming in Nigeria, it implies that the farmers are exposed to these risks every year due to lack of climate information. The outcome of all these could be loss of crops, livestock, catch and fishing equipment which could exacerbate poverty.

Table 13. Percentage distribution of weather stations by users and frequency of climate information

Users		Frequency of Supply				
	Institution Reporting (%)	Daily	Weekly	Monthly	Yearly	On demand
Researchers	63.6	0	0	0	0	45.5
Private Individuals	9.1	0	0	0	0	9.1
Companies (Construction firms, etc.)	45.5	0	0	0	0	45.5
Farmers	27.3	0	0	0	0	27.3
Institutions (Airlines, government institutions e.g. CBN)	36.4	18.2	0	0	9.1	18.2

Source: Field data, 2011

Awareness, knowledge level and understanding of local forcings of climate change

Awareness of climate change

Table 14 shows the results of respondents' awareness of climate change. Looking at the percentage of respondents who reported that they have heard of climate change, no particular pattern can be established across states and community types. In Akwa Ibom State, a greater percentage of males and females in upland and wetland communities have heard of climate change. However, while more males in the fishing community in the state have heard of climate change, most women claimed that they have never heard of climate change. In Ondo and Rivers States, more men and women in wetland communities have heard of climate change. Discussions with the respondents during the FGDs across the upland, wetland and fishing communities indicate that people have information on climate variation, although some rely on personal observations to arrive at the conclusion that there is variation in climate.

From the pattern of responses, it appears that information on climate change is gradually reaching the people. The results imply that this un-informed segment of the population may remain more vulnerable to the impact of climate change. Lack of information on climate change may imply that they may not be well informed to take coping or adaptive measures in the event of climate change hazards. Such an un-informed population may, out of ignorance, inadvertently expose themselves to a greater risk of climate change impacts. Given the impact and potential impact of climate change on all aspects of life of the farmers and fisher folk, more awareness need to be created in order this important segment of the population would be sufficiently informed.

Table 14. Percentage distribution of respondents by their awareness of climate change

Community Type	Response	Akwa Ibom		Ondo		Rivers		All	
		Male	Female	Male	Female	Male	Female	Male	Female
		%	%	%	%	%	%	%	%
Upland	Yes	80.0	66.7	43.1	26.7	36.9	33.3	53.3	42.2
	No	20.0	20.0	57.0	73.3	63.1	66.7	46.7	57.8
	Total	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**
Wetland	Yes	60.0	66.7	52.3	53.3	66.2	73.3	59.5	64.4
	No	40.0	33.3	47.7	46.7	33.8	26.7	40.5	35.6
	Total	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**
Fishing Community	Yes	60.0	20.0	33.3	20.0	55.5	40.0	48.9	26.7
	No	40.0	80.0	66.7	80.0	44.5	60.0	51.1	73.3
	Total	**100.0**	**100.0**	**100.0**	**100.0**	**10.3**	**100.0**	**100.0**	**100.0**

Source: Field data, 2011

Knowledge Level of Climate Variability and change

The results of the respondents' knowledge level of climate change are presented in Tables 15, 16 and 17. The scale of knowledge ranges between 1 and 2, a score of 1 means that the respondents have no knowledge of the particular climate change issue while a score of 2 implies that they are knowledgeable on the issue. The knowledge level of the farmers in each state studied is presented subsequently.

Akwa Ibom State farmers' and fisher folks' knowledge level of climate change

The result of the knowledge level of farmers and fisher folk in Akwa Ibom State is presented in Table 15. From the analysis, upland farmers are more knowledgeable about the link between forest fire, change in temperature, flooding and appearance of new plant species and climate change. Their knowledge of the relationship between changes in wind speed, sunshine hours and sunshine intensity is very low (1.16). Given that climate change is largely anthropogenic, this low level of knowledge means that farmers and fisher folks may continue to carry out those activities that contribute or even accelerate climate change since they do not realize their impacts on the environment.

The knowledge level of wetland farmers is very low on most climate change issues. They have no knowledge of the link between climate change, especially in the onset of rain, duration of rain, pattern of rainfall as well as sunshine hours and intensity. The fisher folks are knowledgeable on the links between climate change and sea level rise, disappearance of some species of fish, flooding and change in sunshine intensity. The respondents in the fishing community of Akwa Ibom State were more knowledgeable on the possible effect of climate change and forest fire and deforestation. Generally, the respondents in Akwa Ibom State seem to associate forest fire and disappearance of fish species followed by flooding and drying up of streams as a consequence of climate change.

Comparatively, the fisher folks have higher knowledge (1.17) of climate change issues, followed by upland farmers (1.16). The knowledge level of climate change is lowest in wetland communities of Akwa Ibom State.

From the results, it is evident that in none of the agro-ecosystems in Akwa Ibom, are farmers completely knowledgeable about climate change issues. This may be a reflection of the lack of climate information earlier reported. Without knowledge of climate change issues, the farmers and fisher folks would hardly be able to take effective climate change adaptive measures.

Table 15. Climate change knowledge index for Akwa Ibom

Climate Change Statement	Knowledge Level Index			
	Upland	Wetland	Fishing	All
Change in the onset of rain is caused by climate change	1.10	1.00	1.10	1.04
Change in duration of rainfall is caused by climate change	1.13	1.00	1.10	1.06
Change in the pattern of rainfall is caused by climate change	1.10	1.00	1.10	1.06
Sea level rise is a result of climate change	1.13	1.08	1.20	1.13
Change in temperature is caused by climate change	1.26	1.03	1.15	1.14
Change in sunshine hours is caused by climate change	1.08	1.00	1.15	1.07
Change in sunshine intensity is caused by climate change	1.05	1.00	1.20	1.09
Change in seasons is caused by climate change	1.13	1.08	1.10	1.12
Appearance of new plants & fish species can caused by climate change	1.23	1.10	1.10	1.13
Disappearance of some plants & fish species can be caused by climate change	1.18	1.18	1.20	1.15
Flooding is caused by climate change	1.26	1.03	1.20	1.16
Climate change can lead to drying up of streams	1.28	1.05	1.10	1.16
Forest fire is caused by climate change	1.38	1.15	1.50	1.46
Deforestation is caused by climate change	1.18	1.05	1.40	1.23
Changes in wind pattern/speed	1.02	1.03	1.05	1.08
Average	**1.16**	**1.05**	**1.17**	**1.14**

Source: Field data, 2011

Ondo State farmers’ and fisher folks’ knowledge level of climate change

In Ondo State, the knowledge index of upland and wetland famers is relatively higher on the relationship of climate change and change in season, flooding, disappearance of certain plants and fish species, and sea level rise than on other climate change related changes. While the climate change knowledge index of fisher folks is low on most climate change issues, the respondents have very high knowledge index on climate change as the cause of disappearance of some plants and fish species (1.9) and flooding (1.5) as well as drying up of streams (1.5). In general, the climate change knowledge index of respondents in Ondo State is high on the link between climate change and forest fires, disappearance of some plant and fish species and well as appearance of new plants and fish species, flooding and sea level rise. The result is consistent with the responses of farmers in the wetland communities of Ondo State. For instance, in the previous sections, some percentage of respondents in the wetland communities have indicated that they receive climate information (through the radio), over 40% both male and female wetland farmers said climate information was readily available as well as climate information being correct. It is therefore expected that their knowledge of climate change is high and that farmers in the wetland communities would adapt to climate change.

Table 16. Climate change knowledge index for Ondo State

Climate Change Statement	**Knowledge Level Index**			
	Upland	**Wetland**	**Fishing**	**All**
Change in the onset of rain is caused by climate change	1.1	1.1	1.0	1.1
Change in duration of rainfall is caused by climate change	1.1	1.0	1.0	1.1
Change in the pattern of rainfall is caused by climate change	1.2	1.0	1.0	1.1
Sea level rise is a result of climate change	1.4	1.4	1.0	1.4
Change in temperature is caused by climate change	1.2	1.0	1.0	1.0
Change in sunshine hours is caused by climate change	1.1	1.0	1.0	1.0
Change in sunshine intensity is caused by climate change	1.1	1.1	1.0	1.1
Change in seasons is caused by climate change	1.4	1.1	1.0	1.2
Appearance of new plants & fish species can caused by climate change	1.3	1.4	1.5	1.4
Disappearance of some plants & fish species can be caused by climate change	1.4	1.5	1.9	1.5
Flooding is caused by climate change	1.4	1.4	1.5	1.4
Climate change can lead to drying up of streams	1.2	1.2	1.5	1.2
Forest fire is caused by climate change	1.1	1.1	1.4	1.7
Deforestation is caused by climate change	1.1	1.1	1.0	1.1
Changes in wind pattern/speed	1.2	1.3	1.1	1.2
Average	**1.2**	**1.3**	**1.2**	**1.2**

Source: Field Data, 2011

Rivers State farmers' and Fisher folks' knowledge level of climate change

The climate knowledge index for Rivers State shown in Table 17 reveals that upland farmers are more knowledgeable about climate change issues than wetland farmers and fisher folks. On specific climate change-related issues, upland farmers have a high knowledge index on appearance of new plant and fish species, sea level rise, changes in season and changes in wind pattern. Wetland farmers seem to be less knowledgeable on most climate change related changes. The climate change knowledge index indicates that farmers in upland communities have knowledge of the relationship between climate change and sea level rise (1.45), change in season (1.47), appearance of new plants species (1.51) and change in wind pattern and speed (1.45). The fisher folks are knowledgeable on the relationship between climate change and change in season (1.49). While upland farmers seem to be knowledgeable on many climate change impacts, the knowledge of their wetland counterparts seem to be low. Based on the knowledge level, wetland farmers and fisher folk may be less capable of adapting to climate change impacts.

Participants in FGDs as well as key informants were able to describe how the pattern and characteristics of rainfall used to be in the past compared to the present. They were also quick to point at intense heat they experience now as compared with before. This level of knowledge was the same in the male and female groups. Discussants in the fishing communities could identify sea level rise, beach erosion and flooding as arising from climate change. However, the respondents' views on the causes of climate change differed. Education and religious belief seem to influence people's opinions on the causes of climate change. Educated members of the FGDs and key informants could talk about the greenhouse gases and their effects as reported in the media. Respondents in Amalem, put it this way: "*We have heard that ozone layer is wearing away*". Others who are not as informed attribute the observed change in rainfall and intensity of heat (arising from higher mean temperatures) to either failure of people to offer sacrifices to the gods or they keep to their traditional norms of relationship with nature. This view seems to be common among the aged and traditionally inclined. A more dominant view is that climate variability is a sign of "the world coming to an end". It was also the opinion of some of the respondents that God was punishing them for their sins. This and the former views are strongly held by the Christian non-literate population.

Table 17. Climate change knowledge index for Rivers State

Climate Change Statement	Knowledge Level Index			
	Upland	Wetland	Fishing	All
Change in the onset of rain is caused by climate change	1.11	1.19	1.07	1.13
Change in duration of rainfall is caused by climate change	1.02	1.02	1.00	1.01
Change in the pattern of rainfall is caused by climate change	1.04	1.02	1.00	1.02
Sea level rise is a result of climate change	1.47	1.05	1.00	1.17
Change in temperature is caused by climate change	1.06	1.00	1.00	1.02
Change in sunshine hours is caused by climate change	1.13	1.11	1.17	1.13
Change in sunshine intensity is caused by climate change	1.17	1.06	1.02	1.09
Change in seasons is caused by climate change	1.45	1.13	1.49	1.32
Appearance of new plants & fish species can caused by climate change	1.51	1.10	1.29	1.28
Disappearance of some plants & fish species can be caused by climate change	1.09	1.05	1.20	1.10
Flooding is caused by climate change	1.23	1.02	1.27	1.14
Climate change can lead to drying up of streams	1.28	1.05	1.12	1.23
Forest fire is caused by climate change	1.26	1.24	1.2	1.11
Deforestation is caused by climate change	1.26	1.03	1.05	1.18
Changes in wind pattern/speed	1.45	1.08	1.05	1.19
Average	**1.23**	**1.08**	**1.13**	**1.14**

Source: Field Data, 2011

Understanding of Local Forcings of Climate variability and climate Change

Besides determining the knowledge level of respondents on climate change, an attempt was also made to determine respondents' understanding of the local factors that contribute to changes that led to climate change. It is important to assess people's understanding of the local forcings since anthropogenic factors are implicated in climate change. An understanding of these factors might be the first step to taking action that can contribute to process of reducing climate change. The knowledge index is measured on a scale of 1(no knowledge) and 2 (knowledgeable).

Respondents' knowledge level of local forcings of climate variability and climate change in Akwa Ibom State

The knowledge index of local climate forcings by farmers and fisher folk in Akwa Ibom is presented in Table 18. The results reveal that upland farmers' knowledge of what, in their locality, could lead to climate change is generally low. The highest knowledge index is on sand-filling and watershed management as local factors that drive climate change. The wetland farmers seem to be more knowledgeable of the local factors that contribute to climate change. They are quite knowledgeable of the contribution of gas flaring, fumes from both industries and automobiles. Wetland farmers also know about the possible contribution of fuel wood use and watershed destruction to climate change. The knowledge index of the fisher folks is highest on effect of sand-filling on climate change. This is followed by knowledge on continuous cropping, bush burning and fumes from industries. The knowledge level of the farmers and fisher folks seem to be in tandem with estimates by NEST (2004) which show that in Nigeria, the energy sector (whose products, fuel, is used by industries and automobiles) followed by land-use change and forestry and agriculture dominates the other sectors in its contribution to gross national emissions of greenhouse gases. The relatively high knowledge level of Akwa Ibom respondents on the importance of gas flaring, fumes from industries and automobiles, watershed destruction and bush burning as local climate change forcings could be due the preponderance of these activities in their communities. However, the relatively low knowledge of upland farmers on virtually all the factors considered has implications for climate change adaptation. Lack of sufficient knowledge of those factors that can contribute to climate change could mean continuous engagement of people in activities that contribute to the impact of climate change.

Table 18. Knowledge index of local forcings of climate change in Akwa Ibom

Local Forcings	**Community Type**		
	Upland	**Wetland**	**Fishing**
Gas Flaring	1.2	1.6	1.3
Deforestation	1.2	1.2	1.4
Bush burning	1.1	1.3	1.5
Fumes from automobiles	1.1	1.5	1.2
Fumes from industries	1.2	1.5	1.5
Increase use of power generating plants	1.1	1.3	1.3
Sand filling	1.3	1.3	2.0
Continuous cropping	1.1	1.3	1.6
Use of fuel wood	1.1	1.4	1.4
Watershed destruction	1.3	1.4	1.1
Land cover change	1.1	1.1	1.2
Average	**1.2**	**1.4**	**1.4**

Source: Field data, 2011

Respondents' knowledge level of local forcings in Ondo State

In Ondo State, respondents across all community types are knowledgeable about gas flaring as a factor that contributes to climate variability. This high knowledge level may be attributed to the fact that Ondo State, and indeed, the Niger Delta is the oil producing region in Nigeria. Gas flares are common sights. Adverse environmental consequences of gas flaring may have led to the enormous level of awareness of its effect on environmental degradation and role climate change. The respondents' knowledge index of other factors varies from one community type to another. For instance, the knowledge index of sand filling as a factor contributing climate change is relatively high across location, but is highest in wetland communities (1.8), followed by upland communities (1.6) and lowest in the fishing communities (1.1) which is close to having no knowledge of this factor at all. Destruction of watershed and continuous cropping are also well known by wetland farmers and fisher folks as factors contributing to climate change.

Table 19. Knowledge index of local forcings of climate change in Ondo State

Local Forcings	Community Type		
	Upland	**Wetland**	**Fishing**
Gas Flaring	1.9	1.8	1.5
Deforestation	1.1	1.1	1.0
Bush burning	1.2	1.2	1.5
Fumes from automobiles	1.4	1.0	1.0
Fumes from industries	1.5	1.8	1.5
Increase use of power generating plants	1.1	1.0	1.0
Sand filling	1.6	1.8	1.1
Continuous cropping	1.1	1.7	1.8
Use of fuel wood	1.0	1.3	1.0
Watershed destruction	1.1	1.7	1.5
Land cover change	1.4	1.4	1.5
Average	**1.3**	**1.4**	**1.3**

Source: Field data, 2011

Respondents' knowledge level of local forcings in Rivers State

The results of the analysis of the knowledge index of local forcings of climate in Rivers State are presented in Table 20. Across community types (upland, wetland and fishing communities), respondents are knowledgeable about the effect of fumes from industries on climate change. This could be due to the fact that Rivers State is an industrial state. Therefore, the people witness on daily basis, the fumes from industrial plants, thus informing their knowledge. The knowledge index of respondents in upland as well as wetlands on the use of fuel wood is high. Generally, there is variation in the knowledge index of local forcing of climate change across communities in Rivers State. The knowledge index of upland and wetland farmers is closer to 2 in 5 factors while only one factor is closer to 2 in fishing communities. This shows differences in knowledge level among communities. The fisher folks seem not to have knowledge of the effect of increase use of generators and bush burning. Again this shows that upland and wetland farmers are more knowledgeable about local forcing of climate change than fisher folks. This situation is also reflected on the average knowledge indices.

Table 20. Knowledge index of local forcings of climate change in Rivers State

Local Forcings	Community Type		
	Upland	**Wetland**	**Fishing**
Gas Flaring	1.1	1.4	1.5
Deforestation	1.2	1.3	1.1
Bush burning	1.1	1.3	1.0
Fumes from automobiles	1.3	1.5	1.2
Fumes from industries	1.5	1.5	1.4
Increase use of power generating plants	1.2	1.5	1.0
Sand filling	1.8	1.3	1.2
Continuous cropping	1.5	1.2	1.4
Use of fuel wood	1.5	1.6	1.3
Watershed destruction	1.7	1.2	1.2
Land cover change	1.3	1.5	1.2
Average	**1.4**	**1.3**	**1.2**

Source: Field data, 2011

Vulnerability of households to climate change

Vulnerability Profile

Nutrition: The literature suggests that one aspect of household life that is usually adversely affected by any shock from an adverse event is food consumption. For this reason, consumption expenditure on major food items during normal periods as well as during periods of a climate event or disaster was estimated (Table 21). The results show that for Akwa Ibom State, climate disaster expenditure on all the food items considered was lower than normal time expenditure. For example, on the average, normal time expenditure on carbohydrate by households is ₦9924.49 while mean disaster time expenditure is ₦5711.76. This amount is lower than the normal time expenditure by ₦4211.73. This is also the case for other important food items. This implies lack of food to purchase during climate disasters. Akwa Ibom State depends on states such as Cross River, Benue, among others for most of its food supply. Occurrence of a disaster may restrict the movement of traders, thus reducing the food supply to the disaster communities. The situation could lead to hunger and starvation by households thereby making them more vulnerable to other adverse conditions. The situation in Ondo State is similar to Akwa Ibom. However, the amounts expended on these food items are lower in Ondo State that Akwa Ibom State. Average disaster time expenditure on protein food is N2639.66 while that of normal time is N2132.42. In Rivers State, disaster time food expenditure is higher than normal time expenditure. The general pattern observable from this result is that across the state, more money is spent by households on carbohydrates followed by protein, vitamins/minerals and fat and oil (in that order). This means that more carbohydrate-rich foods are consumed by households than any other type of food in the Niger Delta region.

Table 21. Mean monthly expenditure on basic/important food components

Food component	**Akwa Ibom**		**Ondo**		**Rivers**	
	Normal Time expenditure (₦)	Disaster Time expenditure (₦)	Normal Time expenditure (₦)	Disaster Time expenditure (₦)	Normal Time expenditure (₦)	Disaster Time expenditure (₦)
Carbohydrate	9924.49	5711.76	3844.44	4000	5373.24	7105.63
Protein	5295.81	2639.66	3636.11	2132.42	4274.64	5070.42
Vitamins, minerals	2757.88	1589.33	765.44	434.98	2109.86	2479.58
Fats & oils	1793.18	153.63	598.33	677.50	1098.59	1246.48
Others	766.20	175	278	267.62	535.21	901.41

Source: Field data, 2011

Technical Capacity**:** The number of household members with **s**cience-based as well as indigenous knowledge of climate change was used as indicator of the technical capacity of households to adapt to the impact of climate change (see Adger et al., 2004). In this study, the number of male and female household members enrolled in science-based courses in tertiary institutions or who have graduated from a science-based discipline was used. In addition, the number of male and female household members with indigenous knowledge of climate issues was also considered. The assumption was that the adaptive capacity of households could be enhanced by the number of persons with either science or indigenous knowledge. In Tables 22 - 24, the percentage distribution of households by number of members with science-based, non-science-based knowledge, and indigenous knowledge of climate change is presented. The general pattern across the state and community type is that a large percentage of the households do not have many of their household members either enrolled in science-based courses or have graduated from science-based courses.

In Akwa Ibom State, the percentage of individuals with indigenous knowledge is greater in all community types (upland, wetland and upland) than those with science-based knowledge. Of those with indigenous knowledge, 11.1% of the male and 25% of the female respondents in upland communities respectively reported that they have 1-3 members of the male household members with indigenous knowledge. On the other hand, 49.2% of male respondents and 37.5% of the female respondents said 3 female members of their households have indigenous knowledge. The percentage of respondents reporting having at least 3 members of their household in the wetland communities is less than those in the upland. However, quite a high percentage of the male households in the fishing communities reported having up to 3 members of their households with indigenous knowledge of climate and weather-related issues. It is expected that more female household members than the males in the upland and wetland communities have indigenous knowledge. This may be due to more women engaging more in farming than men. Agriculture is concerned with management of natural resources - soil, water, plants, etc. Over the years, more women would have acquired indigenous knowledge than their male counterparts who are not as involved in natural resource management on a daily basis. The results tend to indicate the need to pay more attention to women's role as custodians of indigenous knowledge.

The results on the number of members of households who are graduates of science-based courses shows that 12.5 % of the female household heads have at least 3 female members of their household as graduates of science-based courses whereas 4.3% of male household heads said there are 1-3 female graduates of science-based discipline in their households. It thus seems that the sex of the household head influences whether it is the boy child or the girl child that gets science education. Supporting this assertion is the fact that 4.3%, 9.4% and 7.5% of male household heads in upland, wetland and fishing communities respectively have at 1-3 male graduates of science-based course as members of their households whereas no female households in the three community types have male science graduates in their households.

Table 22. Percentage distribution of respondents by their household's technical capacity - Akwa Ibom

Technical capacity	Respondent	Upland				Wetland				Fishing			
		Number of Household members				Number of household members				Number of household members			
		Nil	3	>3	Total	Nil	3	>3	Total	Nil	3	>3	Total
Science-based knowledge													
Male household members in science-based courses	Male Female	90.4 93.8	7.9 6.3	1.6 0	100 100	81.1 92.6	18.9 3.7	0 3.7	100 100	85 0	15 0	0 0	100 100
Female household members in science-based courses	M ale Female	95.2 87.5	4.8 12.5	0 0	100 100	90.6 100	9.4 0	0 0	100 100	90 0	10 0	0 0	100 100
Male graduate household members in science course s	Male Female	95.2 100	4.8 0	0 0	100 100	88.7 96.2	7.5 3.8	1.9 0	100 100	85 0	15 0	0 0	100 100
Female graduate household members in science courses	Male Female	93.7 87.5	4.3 12.5	0 0	100 100	90.4 96.2	9.4 3.8	0 0	100 100	92.5 0	7.5 0	0 0	100 100
Indigenous Knowledge													
Male household members with indigenous knowledge	Male Female	82.5 75	11.1 25	6.3 0	100 100	49.4 96.2	17.0 3.8	5.7 0	100 100	75 0	20 0	5 0	100 100
Female household members with indigenous knowledge	Male Female	50.8 56.3	49.2 37.5	0 6.3	100 100	75.5 88.5	22.6 11.5	1.9 0	100 100	10 0	90 0	0 0	100 100

Source: Field Data, 2011

The technical capacities of households in Ondo State, measured by the number of household members with science-based knowledge as well as indigenous knowledge of climate change are presented in Table 23. Generally, a very small percentage of households have members with science-based knowledge or as indigenous knowledge. The percentage is even smaller in wetland and fishing communities. In the upland communities, only 1.5% of the male-headed households have male graduates from science-based courses. Some households have 1-3 members with science-based knowledge. The percentage distribution reveals that 15% of the male households in the fishing communities have 1-3 female graduates from science-based courses. One striking revelation from this result is the low percentage of households whose members have indigenous knowledge of climate change. A total of 13.3% of the male household heads in the fishing communities reported that 1-3 male members of their households have indigenous knowledge of climate change. In the fishing communities of Ondo State, no household members of the female-headed households have any indigenous knowledge of climate change. These results should be interpreted with some caution, however. The attitude of discussants at the FGD shows that people with local/indigenous knowledge are looked down upon as possessing knowledge capable of harming people. For this reason, people do not want to admit they have this knowledge although they use such skills on occasions e.g. in rainmaking. Adaptation intervention may target legitimizing and popularizing this knowledge to reduce the vulnerability of farming communities to the impacts of climate change.

Table 23. Percentage distribution of respondents by household technical capacity in Ondo State

Technical capacity	Respondent	Upland				Wetland				Fishing			
		Number of household members				Number of household members				Number of household members			
		Nil	1- 3	>3	Total	Nil	1- 3	>3	Total	Nil	1- 3	>3	Total
Science-based knowledge													
Male household members in science-based courses	Male	95.4	4.6	0	100	98.5	1.5	0	100	100	0	0	100
	Female	98.2	2.8	0	100	95.5	4.5	0	100	100	0	0	100
Female household members in science-based courses	Male	96.9	3.1	0	100	98.5	1.5	0	100	100	0	0	100
	Female	94.3	5.7	0	100	100	0	0	100	100	0	0	100
Male graduates in science-based courses	Male	95.5	3.1	1.5	100	96.9	3.1	0	100	100	0	0	100
	Female	95.4	5.6	0	100	93.1	6.9	0	100	95	5	0	100
Female graduates in science-based courses	Male	95.9	3.1	0	100	93.8	4.6	1.5	100	85	15	0	100
	Female	92.2	7.8	0	100	100	0	0	100	0	0	0	100
Indigenous knowledge													
Males with indigenous knowledge	Male	93.8	4.6	1.6	100	96.9	3.1	0	100	86.7	13.3	0	100
	Female	100	0	0	100	100	0	0	100	100	0	0	100
Females with indigenous knowledge	Male	95.4	4.6	0	100	96.9	3.1	0	100	100	0	0	100
	Female	100	0	0	100	100	0	0	100	100	0	0	100

Source: Field data, 2011

In upland communities of Rivers State, some households have 1- 3 male and female members either enrolled or have graduated from science-based courses. This is not the case in wetland and fishing communities. The same pattern is seen with non-science-based courses.

The fact that very few households have members with science-based and tertiary level knowledge has implications for adaptation to climate change. Knowledge and the use of it are what households need to, first, reduce human-induced climate hazards and, second, to take informed actions to mitigate the impact of climate change. When this is lacking, adaptation responses may be hindered. Technical capacity of households needs to be built if Nigeria is to respond effectively to the impact of climate variability and long-term climate change.

Results further indicate that some households have 1-3 members with indigenous knowledge of climate change. The result also reflects the responses of participants in FGDs in some of the communities. In each community, members have a way of ascertaining if rain will fall or not. Sometimes, the direction of the rain-forming clouds or appearance of certain insects or birds is used as indicators of how the weather will look in the near future. However, in most communities, respondents were discrete and reluctant to talk about the rain- makers. Rain-makers have a reputation of stopping rain or causing rain to fall. They are looked upon as “un-Christian”, heathen and diabolic. This attitude has negative implications for climate change adaptation. If the current attitude continues, this valuable knowledge may be lost.

Table 24. Percentage distribution of respondents by household technical capacity in Rivers State

Technical capacity	Respondent	Upland Community: Number of household members				Wetland Community: Number of household members				Fishing Community: Number of household members			
		Nil	1-3	>3	Total	Nil	1-3	>3	Total	Nil	1-3	>3	Total
Science-based knowledge													
Male household members in science-based courses	Male	71.4	28.6	0	100	80	20	0	100	95.5	4.5	0	100
	Female	33.3	66.7	0	100	100	0	0	100	84.2	15.8	0	100
Female household members in science-based courses	Male	71.4	28.6	0	100	100	0	0	100	100	0	0	100
	Female	33.3	66.7	0	100	100	0	0	100	73.7	21.0	5.3	100
Male graduates in science-based courses	Male	64.3	35.7	0	100	60	40	0	100	95.5	4.5	0	100
	Female	33.3	66.7	0	100	80	20	0	100	94.7	5.3	0	100
Female graduates in science- based courses	Male	78.6	21.4	0	100	100	0	0	100	100	0	0	100
	Female	33.3	66.7	0	100	100	0	0	100	100	0	0	100
Indigenous knowledge													
Males with indigenous knowledge	Male	64.3	35.7	0	100	100	0	0	100	90.9	9.1	0	100
	Female	0	100	0	100	80	20	0	100	78.9	21.1	0	100
Females with indigenous knowledge	Male	71.4	28.6	0	100	100	0	0	100	90.9	9.1	0	100
	Female	0	33	67	100	80	20	0	100	78.9	21.1	0	100

Geographical factors: Geographical factors such as distance from coastline and population within 100km of the coastline have been identified as capable of making households vulnerable to climate change impact (Heger & Julca, 2008). The assumption is that the nearer households and communities are to climate hazard-prone sites such as the coast, ravines and erosion sites, the more vulnerable they are to climate change impacts. The distribution of the respondents in the three states studied according to the location of their homes from the coast, ravine and erosion sites is presented in Tables 25 - 27.

The location of upland, wetland and fishing communities from the coast, ravine sites and erosion sites is presented in Table 25. From the analysis, more male-headed households (33.9%) than female-headed households (26.7%) live less than less than 1 kilometre from the coast in Akwa Ibom State. More female-headed households (80%) live less than 1 kilometer from ravine sites. What seems to be common to both male and female households is their closeness to erosion sites. More than half of the male respondents (56.9%) and 33.3% of the female respondents reported that their homes are located less than 1 kilometre from erosion sites. More households in the wetland and fishing communities live a distance of less than 1 kilometer from the coast, ravine and erosion sites. This result is not unexpected because the Niger communities are faced with serious erosion problems. With these features, it can be inferred that these communities may be easily affected in the event of climate hazards/events.

Table 25. Percentage distribution of respondents by the distance of their homes to the coast, ravine and erosion sites in Akwa Ibom State

Community Type	Distance (Km)	Coast		Ravine		Erosion Site	
		Male	Female	Male	Female	Male	Female
		%	%	%	%	%	%
Upland	= 1	33.9	26.7	1.6	80.0	56.9	33.3
	2 – 3	40.0	13.3	21.5	20.0	24.6	46.7
	= 3	26.1	60.0	76.9	0.0	18.5	20.0
	Total	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**
Wetland	= 1	80.0	26.7	6.1	.73.3	53.8	40.0
	2 – 3	16.9	13.3	27.2	26.7	38.5	30.0
	= 3	3.1	60.0	66.7	0.0	7.7	30.0
	Total	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**
Fishing	= 1	100.0	100.0	86.6	40.0	100.0	80.00
	2 – 3	0.0	0.0	6.7	60.0	0.0	20.0
	= 3	0.0	0.0	6.7	0.0	0.0	0.0
	Total	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**

Source: Field data, 2011

The location of the male and female respondents in the upland, wetland and fishing communities of Ondo State is presented in Table 26. The results show that the upland households are closer to ravine and erosion sites than they are to the coast. More than 60% of the female-headed households live within a distance of less than one kilometer from an erosion site. In contrast, in the wetland and fishing communities, the percentage of respondents living within one kilometer from the coast is greater than those living within same distance from either a ravine or an erosion site. In the fishing communities of Akwa Ibom, 100% of the male and female respondents live within one kilometer to the coast. Only 6.7% live within one kilometer to a ravine and 21% to erosion sites. Slightly less than .5% of female-headed households (40%) in the wetland communities of Ondo State live a distance of less than one kilometer to a ravine and erosion site respectively. The results tend to indicate that most households in the Niger Delta region are close to hazard sites, thus making them more vulnerable to climate change impacts.

Table 26. Percentage distribution of respondents according to the distance of their homes to the coast, ravine and erosion sites in Ondo State

Community Type	Distance (Km)	Coast		Ravine		Erosion Site	
		Male	Female	Male	Female	Male	Female
		%	%	%	%	%	%
Upland	= 1	23.1	6.7	7.7	6.7	26.1	66.7
	2 – 3	30.8	26.7	53.8	33.3	58.5	13.3
	= 3	46.1	66.6	38.5	60.0	15.4	20.0
	Total	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**
Wetland	= 1	76.9	46.7	46.2	40.0	12.3	40.0
	2 – 3	21.5	33.3	38.5	26.7	49.2	33.3
	= 3	1.6	20.00	15.3	33.3	38.5	26.7
	Total	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**
Fishing	= 1	100.0	100.0	6.7	0.0	21.0	7.0
	2 – 3	0.0	0.0	0.0	0.0	34.0	13.5
	= 3	0.0	0.0	93.3	100	45.0	79.5
	Total	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

Source: Field data. 2011

The distribution of the households in Rivers State according to the location of their homes from the coast, ravine sites as well as erosion sites is presented in Table 27. On the basis of community type, more respondents in wetland and fishing communities are located closer to the coast. As would be expected, 100% of the male respondents in the fishing communities live a distance of less than 1 kilometer to the coast while 81% of those in the wetland communities live within 1 km to the coast. All female respondents (100%) in the upland communities live more than 3 kilometers away from the coast. Fishing is a livelihood of the coastal communities and, wetlands are transition zone between water environment and dryland. It is therefore not surprising that the majority of the respondents in the two locations live close to the coast. However, a smaller percentage of the respondents live close to a ravine as well erosion sites. Although, the percentage of respondents living close to a ravine and erosion sites is less than those living close to the coast, it is high enough to give attention, particularly in the face of increasing climate change(IPCC, 2001c).

Table 27. Percentage distribution of respondents by the distance of their homes to the coast, ravine and erosion sites in Rivers State

Community Type	Distance (Km)	Coast		Ravine		Erosion Site	
		Male	Female	Male	Female	Male	Female
		%	%	%	%	%	%
Upland	= 1	7.1	0.0	7.3	0.0	22.9	10.5
	2 – 3	0.0	0.0	0.0	0.00	27.1	19.5
	= 3	92.9	100.0	92.7	100.0	50.0	70.0
	Total	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**
Wetland	= 1	81..0	100.0	0.0	0.0	4.0	0.0
	2 – 3	0.0	0.0	5.0	0.0	10.4	6.6
	= 3	0.0	0.0	95.0	100.0	85.6	93.4
	Total	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**
Fishing	= 1	100.0	79.0	0.0	0.0	10.0	4.5
	2 – 3	18.2	21.0	4.5	0.0	0.00	8.7
	= 3	0.0	0.00	95.5	100.0	90.0	86.8
	Total	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

Source: Field data, 2011

Economic: Many studies report that agriculture is one sector that is very vulnerable to climate change. For this reason, the economic factor that can make households vulnerable to climate change impact is the extent of households' dependence on agriculture. The extent of dependence is measured by number of household members in agriculture as well as offering services as hired agricultural labour. The results of our analysis are presented in Tables 28 - 30. Findings from the study show that a high percentage of male and female-headed households in upland communities of Akwa Ibom State have more than half of their members in agriculture as well as hired agricultural labour. In the upland communities, 85.7% of the male respondents said more than half of their household members are in involved in agriculture. All female-headed households (100%) have more than half of their members in agriculture. This implies agriculture is more of an occupation of women. In the wetland communities, less than 50% of the male households have more than half of their members in agriculture. Hired agricultural labour does not seem to be popular in wetland households as indicated by the percentage of the households that do not have any member as hired agricultural labour. This means that offering services as agricultural labour is not a popular practice. Discussants were quick to point out that due to rural to urban migration; there is scarcity of hired agricultural labour in the rural communities. They stated that farmers rely more on exchange of labour, though this is insufficient and limits the size of land cultivated. The implication of this situation is that income of households from this livelihood is low, leading to poverty and reduction in adaptive capacity of farming households.

Table 28. Percentage distribution of households by proportion of members in agriculture and hired labour in Akwa Ibom State

Community Type	Proportion of household members	Household Members in Agriculture		Household members as Hired labour	
		Male	Female	Male	Female
		%	%	%	%
Upland	None	7.9	0.0	55.6	50.0
	½	6.4	0.0	34.9	50.0
	More than ½	85.7	100.0	9.5	0.0
	Total	**100.0**	**100.0**	**100.0**	**100.0**
Wetland	None	25.9	57.7	75.5	66.7
	½	27.8	26.9	18.9	29.6
	More than ½	46.3	15.4	5.6	3.7
	Total	**100.0**	**100.0**	**100.0**	**100.0**
Fishing	None	46.7	0.0	80.0	100.0
	½	6.3	0.0	5.0	0.0
	More than ½	47.0	100.0	15.0	0.0
	Total	**100.00**	**100.0**	**100.0**	**100.0**

Source: Field data, 2011

In Ondo State, most households, both male and female-headed, have at least half of their members involved in agriculture. This trend occurs in upland, wetland and fishing communities. In the upland communities, 63.1% of the male respondents and 66.7% of female respondents report that half of their household members are in agriculture. Similarly, a high percentage of male (84.6%) and female (66.7%) respondents in wetland communities also have half of their members involved in agriculture. In the fishing communities, all households have all their members in agriculture. It can be inferred from this result that agriculture is the primary occupation in the communities studied. Because agriculture is highly vulnerable to the impact of climate change, it can be deduced that these farming households are prone to the impacts of climate change.

The results of the study also reveal that agricultural labour is not a common practice in Ondo State as only 7.7% and 6.7% of male and female-headed households in the upland communities report that half of their household members are agricultural labourers. The findings point to the fact that agriculture in these communities is still at subsistence level, thus requiring less hired labour, depending more on family labour.

Table 29. Percentage distribution of respondents by proportion of household members in agriculture and as hired labour in Ondo State

Community Type	Proportion of household members	Household Members in Agriculture		Household members as Hired labour	
		Male	Female	Male	Female
		%	%	%	%
Upland	None	36.9	33.3	92.3	80.0
	½	63.1	66.7	7.7	6.7
	More than ½	0.0	0.0	0.0	13.3
	Total	**100.0**	**100.0**	**100.0**	**100.0**
Wetland	None	15.4	33.3	93.8	80.0
	½	84.6	66.7	6.2	20.0
	More than ½	0.0	0.0	0.0	0.0
	Total	**100.0**	**100.0**	**100.0**	**100.0**
Fishing	None	0.0	0.0	100.0	100.0
	½	100.0	100.0	0.0	0.0
	More than ½	0.0	0.0	0.0	0.0
	Total	**100.0**	**100.0**	**100.0**	**100.0**

Source: Field data, 2011

The distribution of respondents by proportion of their household members in agriculture or as agricultural labourers in Rivers State is presented in Table 30. Findings show that 28.6% of the male respondents in upland communities have more the a half of their household members in agriculture. Unlike Akwa Ibom and Rivers States, hired labour is common in the fishing communities. About 12.6% of the male respondents and 16% of the female respondents have up to half of the household members who offer services as agricultural labourers. In both upland and wetland farming communities, none of the respondents have household members as agricultural labourers. The situation in the fishing communities could be attributable to the nature of fishing activities that require a crew comprising the canoe man (the head) and canoe boys to conduct a successful fishing expedition. It is also practised at commercial level. Therefore, members of the fisher folks' household alone may not be sufficient to make up a crew, thus necessitating the need for extra hands.

Table 30. Percentage distribution of households by the proportion of members in agriculture and as hired labour in Rivers State

Community Type	Proportion of household members	Household Members in Agriculture		Household members as Hired labour	
		Male	Female	Male	Female
		%	%	%	%
Upland	None	57.1	100.0	100.0	100.0
	½	14.3	0.0	0.0	0.0
	More than ½	28.6	0.0	0.0	0.0
	Total	**100.0**	**100.0**	**100.0**	**100.0**
Wetland	None	80.0	100.0	100.0	100.0
	½	20.0	0.0	0.0	0.0
	More than ½	0.0	0.0	0.0	0.0
	Total	**100.0**	**100.0**	**100.0**	**100.0**
Fishing	None	50.0	63.2	64.5	72.0
	½	18.2	15.8	12.9	12.0
	More than ½	31.8	21.0	22.6	16.0
	Total	**100.0**	**100.0**	**100.0**	**100.0**

Source: Field data, 2011

Current Vulnerability

The following is the rating of factors that make households in each state vulnerable to climate change hazards:

Akwa Ibom State

<u>Upland communities of Akwa Ibom State</u>

The result of farmers' rating of factors that make upland households in Akwa Ibom State vulnerable to the impact of climate change is presented in Table 31. Women farmers rated low agricultural output as the number one factor that make their households vulnerable to the impacts of climate change. This is followed by insufficient farm labour, conflict and non-availability of water for irrigation facilities, in that order. For the men, inadequate storage facilities are rated as the main factor that exposes their households to the impacts of change. Following closely are non-availability of irrigation facilities and insufficient farm labour. While non-availability of water for livestock is rated as important by women, rainfall, low-agricultural output, insufficient farm labour, insufficient food storage facilities, inadequate means of transportation, distribution and increased population are considered as factors that predispose households to the impact of climate change. Most of the factors listed are rated as not important.

Table 31. Rating by respondents of factors that make upland households in Akwa Ibom State vulnerable to the impacts of climate change

Factor	Sex	Rating			Mean	m= ranking by Males m= ranking by Females
		Not Important (1)	Important (2)	Very Important (3)		
Non availability of irrigation facilities	Male	75.00	71.43	49	2.72	m 2
	Female	25.00	28.57	15.52	2.69	f 4
	All	**100.00**	**100.00**	**100.00**	2.71	
Non availability of water for livestock	Male	84.62	80.95	80.00	2.07	m 8
	Female	15.38	19.05	20.00	2.19	f 10
	All	**100.00**	**100.00**	**100.00**	2.11	
Low agricultural output	Male	90.00	90.91	75.00	2.45	m3
	Female	10.00	9.09	25.00	2.85	f 1
	All	**100.00**	**100.00**	**100.00**	2.59	
Insufficient farm labour	Male	88.24	72.73	80.77	2.45	m3
	Female	11.76	27.27	19.23	2.74	f 3
	All	**100.00**	**100.00**	**100.00**	2.55	
Non availability of agricultural land	Male	82.35	80.00	81.40	2.32	m5
	Female	17.65	20.00	18.60	2.63	f 6
	All	**100.00**	**100.00**	**100.00**	**2.43**	
Insufficient food storage facilities	Male	80.95	80.00	83.33	2.06	m9
	Female	19.05	20.00	16.67	2.22	f 9
	All	100.00	100.00	100.00	2.11	
Inadequate processing facilities	Male	96.30	70.00	78.26	1.89	m11
	Female	3.70	30.00	21.74	2.22	f 9
	All	**100.00**	**100.00**	**100.00**	2	
Inadequate means of transportation and distribution	Male	95.24	84.38	66.67	1.96	m 10
	Female	4.76	15.63	33.33	2.41	f 8
	All	**100.00**	**100.00**	**100.00**	2.11	
Increased population	Male	76.92	82.61	80.95	2.09	m7
	Female	23.08	17.39	19.05	2.07	f 11
	All	**100.00**	**100.00**	**100.00**	2.09	
Low income	Male	90.91	88.00	75.00	2.4	m4
	Female	9.09	12.00	25.00	2.63	f 6
	All	100.00	100.00	100.00	2.44	
Conflict	Male	87.50	66.67	81.82	2.14	m6
	Female	12.50	33.33	18.18	2.65	f 5
	All	**100.00**	**100.00**	**100.00**	2.32	

Source: Field data, 2011

Table 32. Rating by respondents of factors that make wetland households in Akwa Ibom State vulnerable to the impacts of climate variability

Events/Factor	Sex	Rating			Mean	m= ranking by Males f= ranking by Females
		Not Important	Important	Very Important		
Non availability of irrigation facilities	Male	75	71.4	84.5	2.72	m2
	Female	25	28.6	15.5	2.69	f 4
	All	100	100	100	2.71	
Non availability of water for livestock	Male	84.6	81	80	2.07	m7
	Female	15.4	19	20	2.19	f 9
	All	100	100	100	2.11	
Low agricultural output	Male	90	90.9	75	2.45	m 3
	Female	10	9.1	25	2.85	f 1
	All	100	100	100	2.59	
Insufficient farm labour	Male	88.3	72.7	80.8	2.45	m3
	Female	11.7	27.3	19.2	2.74	f 3
	All	100	100	100	2.55	
Non availability of agricultural land	Male	82.4	80	81.4	2.32	m4
	Female	17.6	20	18.6	2.63	f 6
	All	100	100	100	2.43	
Insufficient food storage facilities	Male	81	80	83.3	2.06	m8
	Female	19	20	16.7	2.22	f 9
	All	100	100	100	2.11	
Inadequate processing facilities	Male	96.3	70	78.3	1.89	m10
	Female	3.7	30	21.7	2.22	f 9
	All	100	100	100	2	
Inadequate means of transportation and distribution	Male	95.2	84.4	66.7	1.96	m9
	Female	4.8	15.6	33.3	2.41	f 8
	All	100	100	100	2.11	
Increased population	Male	76.9	82.6	80	2.09	m6
	Female	23.1	17.4	19	2.07	f 10
	All	100	100	100	2.09	
Low income	Male	90.9	88	75	2.4	m4
	Female	9.1	12	25	2.63	f 6
	All	100	100	100	2.44	
Conflict	Male	87.5	66.7	81.8	2.14	m5
	Female	12.5	33.3	18.2	2.65	f 5
	All	100	100	100	2.32	

Source: Field data, 2011

Fishing communities of Akwa Ibom State

Table 33. Rating by respondents of factors that make fishing households in Akwa Ibom State vulnerable to the impacts of climate variability

Factor	Sex	Rating			Mean	M= Ranking by Males F= Ranking by Females
		Not Important	Important	Very Important		
Non availability of irrigation facilities	Male	66.7	100	83.3	1.95	M= 6
	Female	33.3	0	16.7	1.3	f =5
	All	**100**	**100**	**100**	1.95	
Non availability of water livestock	Male	75	83.3	70	2.35	m =2
	Female	25	16.7	30	1.2	f =7
	All	**100**	**100**	**100**	2.35	
Low agricultural output	Male	83.3	75	70	2.15	m =5
	Female	16.7	25	30	2.3	f =1
	All	**100**	**100**	**100**	2.15	
Insufficient farm labour	Male	13.3	0	71.4	2.3	m =4
	Female	86.7	0	28.6	1.2	f =7
	All	**100**	**0**	**100**	2.3	
Non availability of agricultural land	Male	75	60	66.7	1.9	m =7
	Female	15	40	33.3	1.9	f =3
	All	**100**	**100**	**100**	1.9	
Insufficient food storage facilities	Male	60	100	80	2.3	m =4
	Female	40	0	20	1.12	f =9
	All	**100**	**100**	**100**	2.3	
Inadequate of processing facilities	Male	100	0	64.3	1.75	m =7
	Female	0	0	35.7	1.5	f =6
	All	**100**	**100**	**100**	1.75	
Inadequate means of transportation &distribution	Male	66.7	83.3	72.7	2.4	m =3
	Female	33.3	16.7	27.3	1.15	f =8
	All	**100**	**100**	**100**	2.4	
Increased population	Male	100	80	71.4	2.3	m =4
	Female	0	20	28.6	1.01	f =11
	All	**100**	**100**	**100**	2.3	
Low income	Male	77.8	66.7	80	1.95	m =6
	Female	22.2	33.3	20	1.05	f =10
	All	**100**	**100**	**100**	1.95	
Conflict	Male	66.7	75	85.7	1.7	m =8
	Female	33.3	25	14.3	1.8	f =4
	All	**100**	**100**	**100**	2.4	

Source: Field data, 2011

Upland communities of Ondo State

In Ondo state, insufficient farm labour and non-availability of agricultural land are rated as important in determining vulnerability. Inadequate food storage facilities and conflict are rated as unimportant in exposing households to the impacts of climate change (Table 34). For the percentage of the respondents reporting on a given factor, it can be seen that women pay more attention to non-availability of agricultural land, insufficient food storage facilities, and inadequate means of transportation and distribution. The importance of these factors may be attributed to the land tenure system whereby land ownership is mainly through inheritance, and male children are primarily the hair to family land. This situation makes women more vulnerable to land-related climate change impacts. In the Niger Delta region, as in most parts of Nigeria, making food available to households is a responsibility of the women (wife). In any intervention directed at reducing the vulnerability of upland farming households in Ondo State to climate change impacts, those rated as important in predisposing households to impact of climate change need to be the focus. These include rainfall, farm labour, land, food storage and processing facilities, transportation, population and income.

Table 34. Rating by respondents of factors that make households vulnerable to the impacts of climate variability in Ondo State

Factors	Gender	Not Important	Important	Very Important	Mean	Rank m= ranking by males, f= ranking by females
Non availability of irrigation facilities	Male	82.1	66.7	91.7	1.46	M= 11
	Female	17.9	33.3	8.3	1.4	f =10
	All	100	100	100	1.45	
Non availability of water livestock	Male	79.4	70.6	89.7	1.98	m =8
	Female	20.6	29.4	10.3	1.73	f =9
	All	100	100	100	1.94	
Rainfall	Male	80	66.7	85	2.72	m =1
	Female	20	33.3	15	2.53	f =4
	All	100	100	100	2.69	
`Drought	Male	88.9	65.2	83.3	1.54	m =10
	Female	11.1	34.8	16.7	1.8	f =8
	All	100	100	100	1.59	
Low agricultural output	Male	81.5	77.8	84.6	2	m =7
	Female	18.5	22.2	15.4	1.93	f =7
	All	100	100	100	1.99	
Insufficient farm labour	Male	82.6	61.1	89.7	2.25	m =6
	Female	17.4	38.9	10.3	2	f =6
	All	100	100	100	2.2	
Non availability of agricultural land	Male	100	81.8	75	2.2	m =5
	Female	0	18.2	25	2.73	f =3
	All	100	100	100	2.56	
Insufficient food storage facilities	Male	0	81.8	79.4	2.68	m =3
	Female	0	27.2	20.6.	2.8	f =1
	All	0	100	100	2.71	
Inadequate food processing facilities	Male	100	72.7	81	2.71	m =2
	Female	0	27.3	19	2.8	f =1
	All	100	100	100	2.71	
Inadequate means of transportation &distribution	Male	0	69.2	82.3	2.71	m =2
	Female	0	30.8	17.7	2.73	f =2
	All	0	100	100	2.71	
Increased population	Male	100	73.3	81.7	2.68	m =4
	Female	0	26.7	18.3	2.73	f =2
	All	100	100	100	2.69	
Low income	Male	82.9	85.7	77.4	1.92	m =9
	Female	17.1	14.3	22.6	2.07	f =5
	All	100	100	100	2.07	
Conflict	Male	80.6	85.7	100	1.12	m =12
	Female	19.4	14.3	0	1.07	f =12
	All	100	100	100	1.11	

Source: Field data, 2011

Wetland communities of Ondo State

The rating by wetland farmers in Ondo State tends to follow the same pattern as those of the upland farmers (Table 35). Female farmers do not regard non availability of irrigation facilities, conflict, non-availability of water for livestock and non-availability of agricultural land as important predisposing factors to climate change impact. However, they rate low agricultural output, non-availability of farm labour, inadequate storage and processing facilities, inadequate means of transportation and distribution, population and income as factors that can make them vulnerable to the impact of climate change. The men in the wetland communities of Ondo State, also do not rate non-availability of irrigation, water for livestock as well as drought as factors that can make them vulnerable to the impact of climate change. They however, consider rainfall, farm labour, non-availability of agricultural land, insufficient food storage facilities, inadequate food processing facilities, inadequate means of transportation and distribution, increased population and income as important factors that can predispose them to the impact of climate change.

Table 35. Rating by respondents of factors that make households in Ondo State vulnerable to the impacts of climate variability

Factors	**Gender**	**Not Important** (1)	**Important** (2)	**Very Important** (3)	**Mean**	**Rank** m=ranking by males f = ranking by females
Non availability of irrigation facilities	Male	80.8	100	100	**1.05**	M 12
	Female	19.2	0	0	**1**	f 11
	All	**100**	**100**	**100**	**1.04**	
Non availability of water livestock	Male	79.5	82.4	100	**1.49**	m 11
	Female	20.5	17.6	0	**1.4**	f 9
	All	**100**	**100**	**100**	**1.48**	
Low agricultural output	Male	50	77.8	87.5	**2.15**	m 7
	Female	50	22.2	12.5	**2.2**	f 5
	All	**100**	**100**	**100**	**2.45**	
Insufficient farm labour	Male	90	77.8	82.4	**2.29**	m 5
	Female	10	22.2	17.6	**2.33**	f 3
	All	**100**	**100**	**100**	**2.3**	
Non availability of agricultural land	Male	88.9	75	83.7	**2.43**	m 3
	Female	11.1	25	16.3	**1.44**	f 8
	All	**100**	**100**	**100**	**2.43**	
Insufficient food storage facilities	Male	87.5	75	84.1	**1.75**	m 10
	Female	12.5	25	15.9	**2.8**	f 1
	All	**100**	**100**	**100**	**2.39**	
Inadequate food processing facilities	Male	88.9	78.6	80.7	**2.58**	m 1
	Female	11.1	21.4	19.3	**2.67**	f 2
	All	**100**	**100**	**100**	**2.6**	
Inadequate means of transportation &distribution	Male	87.5	72.7	87.2	**2.42**	m 4
	Female	12.5	27.3	12.8	**2.27**	f 4
	All	**100**	**100**	**100**	**2.39**	
Increased population	Male	90.9	81.3	79.2	**2.49**	m 2
	Female	9.1	18.7	20.8	**2.67**	f 2
	All	**100**	**100**	**100**	**2.53**	

Factors	Gender	Not Important (1)	Important (2)	Very Important (3)	Mean	Rank m=ranking by males f = ranking by females
Low income	Male	90	77.6	85.7	**2.14**	m 8
	Female	10	22.4	14.3	**2.13**	f 6
	All	**100**	**100**	**100**	**2.14**	
Conflict	Male	81.8	66.7	0	**1.03**	m 12
	Female	18.2	33.3	0	**1.07**	f 10
	All	**100**	**100**	**100**	**1.04**	

Source: Field data, 2011

Fishing communities of Ondo State

Six factors are mentioned by respondents in the fishing communities in Ondo State as factors that make them vulnerable to the impacts of climate change (Table 36). These include low agricultural output, insufficient farm labour, and inadequate land for farming, the problem of transportation, low income and lack of storage facilities.

This result shows what might be expected in the Niger Delta region. Due to long periods of rainfall, farmers do not depend much on irrigation facilities for farming. Except commercial poultry and pig farming (which are either semi-intensive of intensive and require water), most other livestock-rearing activities use little water. The Niger Delta is endowed with good water resources, both surface and ground water. Although drought does occur occasionally in the region, it is, nevertheless, not a phenomenon of concern. Instead, the serious challenge the farmers in the region are regularly faced with is flooding and not drought.

Table 36. Rating by respondents of factors that make fishing households in Ondo State vulnerable to climate change

Factors	Gender	Not Important (1)	Important (2)	Very Important	Mean	Ranking M = ranking by males f = ranking by females
Non availability of irrigation facilities	Male	75	0	0	1	M 9
	Female	25	0	0	1	f 6
	All	100	0	0	1	
Non availability of water livestock	Male	60	0	0	1.6	m 6
	Female	40	0	0	1.2	f 5
	All	100	0	0	1	
Low agricultural output	Male	0	78.6	100	2.27	m 4
	Female	100	21.4	0	1.6	f 4
	All	100	100	100	2.1	
Insufficient farm labour	Male	20	100	88.9	2.47	m 3
	Female	80	0	11.1	1.4	f 5
	All	100	100	100	2.2	
Non availability of agricultural land	Male	75	75	0	1.6	m 6
	Female	25	25	0	1.6	f 4
	All	100	100	0	1.6	
Insufficient food storage facilities	Male	81.8	66.7	0	1.4	m 7
	Female	18.2	33.3	0	1.6	f 4
	All	100	100	0	1.45	
Inadequate food processing facilities	Male	0	100	66.7	2.67	m 1
	Female	0	0	33.3	1	f 9
	All	0	100	100	2.75	

Factors	Gender	Not Important (1)	Important (2)	Very Important	Mean	Ranking
						M = ranking by males f = ranking by females
Inadequate means of transportation &distribution	Male	0	75	75	2.6	m 2
	Female	0	25	25	2.6	f 1
	All	0	100	100	2.6	
Increased population	Male	0	75	0	2	m 5
	Female	0	25	0	2	f 2
	All	0	100	0	2.6	
Low income	Male	71.4	77.8	75	1	m 9
	Female	28.6	22.2	25	1.8	f 3
	All	100	100	100	1.85	
Conflict	Male	73.7	100	0	1.07	m 8
	Female	26.3	0	0	1	f 6
	All	100	100	0	1.05	

Source: Filed data, 2011

Upland communities of Rivers State

Seven factors were rated by both male and female upland farmers in Rivers State as predisposing households to the impact of climate change (Table 37). Similar factors are considered by both genders as important except that females do not consider lack of storage facilities and non-availability of agricultural land as important. Male farmers rate these, alongside other factors, as being important. On the other hand, females consider low agricultural output, drought, among other factors, as those that can make them vulnerable to impact of climate change, whereas, males rated those as not important. The common factors that can expose both male and female farmers to the impact of climate change are rainfall, non-availability of farm labour, increased population, low income and conflict. The result is in conformity with the situation in Rivers State. The state experiences heavy rainfall almost all year round. This, in extreme cases may affect farming adversely. Similarly, because of better pay in the oil industry, there is migration of labour from agriculture to the oil industry. This can adversely affect agricultural production, thus making farming households vulnerable to the impact of climate change.

Table 37. Rating by respondents of factors that make upland farming households in Rivers State vulnerable to impacts of climate change

Factors	Gender	Not Important	Important	Very Important	Mean	Ranking
						M = ranking by males f = ranking by females
Non availability of irrigation facilities	Male	84.4	50	60	1.94	M 6
	Female	15.6	50	40	1.33	f 6
	All	100	100	100	1.35	
Non availability of water livestock	Male	100	75	50	1.79	m 9
	Female	0	25	50	1	f 8
	All	100	100	100	1.82	
Low agricultural output	Male	50	87.5	75	1.94	m 6
	Female	50	12.5	25	2.67	f 1
	All	100	100	100	2.41	
Insufficient farm labour	Male	60	80	80	2	m 5
	Female	40	20	20	2.33	f 3
	All	100	100	100	2.06	
Non availability of agricultural land	Male	71.6	60	87.5	2.21	m 4
	Female	28.4	40	12.5	1	f 8
	All	100	100	100	2.12	

Factors	Gender	Not Important	Important	Very Important	Mean	Ranking M = ranking by males f = ranking by females
Insufficient food storage facilities	Male	50	81.2	71.4	2.21	m 4
	Female	50	18.8	28.6	1.67	f 5
	All	100	100	100	2.12	
Inadequate food processing facilities	Male	50	91.7	50	2.36	m 3
	Female	50	8.3	50	2	f 4
	All	100	100	100	2.12	
Inadequate means of transportation &distribution	Male	50	80	75	2.4	m 2
	Female	50	20	25	1.3	f 7
	All	100	100	100	2.2	
Increased population	Male	100	72.3	66.7	2	m 5
	Female	0	27.7	33.3	2	f 4
	All	100	100	100	2	
Low income	Male	100	72.3	71.4	2.2	m 4
	Female	0	27.7	28.6	2.6	f 2
	All	100	100	100	2.3	
Conflict	Male	75	75	75	2	m 4
	Female	25	25	25	2	f 4
	All	100	100	100	2	

Source: Field data, 2011

Wetland communities in Rivers State

The responses of farmers in the wetland communities of Rivers State (Table 37) reveal that only two factors are weighted equally by male and female farmers: rainfall and low income. The men, in addition, rated low agricultural output, insufficient farm labour, non-availability of agricultural land, insufficient food storage facilities, inadequate food processing facilities, increased population and inadequate means of transportation and distribution as important factors that expose households to the impact of climate change. Speranza (2010) identified farm resources, including land and labour, as important in the resilience of small holder farming systems to climate change impacts. The rating of the lack of farm resources as factors that expose them to climate change impacts is therefore in line with findings from previous studies.

Port Harcourt, the capital of Rivers State, is one of the larger cities in Nigeria, with a high population. This population has spilled over to the peri-urban areas in the state. It is therefore not surprising that increased population is also singled out as a factor that can pre-dispose farming households to the impact of climate change. For the past two decades, the Niger Delta has been a centre of violent conflict, and the conflict has been more severe in Rivers State and other “core” Niger Delta States. As a result, conflict is considered by both men and women as a factor that can expose farming households to the impact of climate change.

Table 38. Rating by respondents of factors that make wetland farmers in Rivers State vulnerable to the impact of climate variability

Factor	Gender	Not Important	Important	Very Important	Mean	Ranking M = ranking by males f = ranking by females
Non availability of irrigation facilities	Male	66.7	66.7	100	1.4	M 7
	Female	33.3	33.3	0	1.2	f 4
	All	100	100	100	1.3	
Non availability of water livestock	Male	63.4	83.3	100	1.6	m 6
	Female	36.6	16.7	0	1.2	f 4
	All	100	100	100	1.3	
Low agricultural output	Male	57.9	83.3	100	2.2	m 3
	Female	42.1	16.7	0	1.4	f 3
	All	100	100	100	1.8	
Insufficient farm labour	Male	66.7	60	83.3	2.3	m 2
	Female	33.3	40	16.7	2.2	f 1
	All	100	100	100	2.3	
Non availability of agricultural land	Male	57.9	100	33.3	2.2	m 3
	Female	42.1	0	66.7	1.8	f
	All	100	100	100	2	
Insufficient food storage facilities	Male	16.7	100	100	2.2	m 3
	Female	83.3	0	0	1	f 5
	All	100	100	100	1.6	
Inadequate food processing facilities	Male	55.6	88.9	100	2	m 4
	Female	44.4	11.1	0	1.2	f 4
	All	100	100	100	1.6	
Inadequate means of transportation &distribution	Male	33.3	80	83.3	2.8	m 1
	Female	66.7	20	16.7	1.6	f 7
	All	100	100	100	2.4	
Increased population	Male	55.6	87.5	100	1.8	m 5
	Female	44.4	12.5	0	1.2	f 3
	All	100	100	100	1.5	
Low income	Male	50	83.3	80	2.2	m 3
	Female	50	16.7	20	2	f 2
	All	100	100	100	2.1	
Conflict	Male	71.6	80	100	1.4	m 8
	Female	28.4	20	0	1.2	f 3
	All	100	100	100	1.3	

Fishing Communities of Rivers State

In the fishing communities of Rivers State, it is mostly the male respondents who rate some number of factors as capable of predisposing the households to the impact of climate change. The factors rated by the males as very important are: low agricultural output, insufficient farm labour, inadequate food processing facilities and inadequate means of transportation and distribution (Table 39). The female respondents rated inadequate means of transportation as the main factor that can pre-dispose the households to the impact of climate change. The reason for this position is that difficult terrain due to the swampy environment is a feature of this area, so transportation is therefore very difficult. Households, particularly those in the riverine communities, would have difficulties adapting to climate change induced hazards because of inadequate transportation.

Both male and female respondents were unanimous in their rating of six of the thirteen factors as important in predisposing households to climate change impacts. These factors are non-availability of irrigation facilities, rainfall, non-availability of agricultural land, inadequate means of transportation and distribution, increased population and low income. The effect of low output was ranked only the women. Men differed from women in rating non availability of water for livestock, and insufficient farm labour as important factors in exposing households to impacts of climate change.

Table 39. Rating by respondents of factors that make fishing households in Rivers State vulnerable to the impacts of climate change

Factor	Gender	Not Important	Important	Very Important	Mean	M = ranking by males f = ranking by females
Non availability of irrigation facilities	Male	50	100	76.2	2.3	m 7
	Female	50	0	23.8	2.7	f 1
	All	100	100	100	2.5	
Non availability of water livestock	Male	0	60	33.3	2.2	m 8
	Female	100	40	66.7	1.9	f 6
	All	100	100	100	2.3	
Low agricultural output	Male	75	75	75	1.9	m 10
	Female	25	25	25	2	f 5
	All	100	100	100	2	
Insufficient farm labour	Male	75	83.3	70	2.4	m 6
	Female	25	16.7	30	1.8	f 7
	All	100	100	100	2.3	
Non availability of agricultural land	Male	50	83.3	75	2.7	m 2
	Female	50	16.7	25	2.6	f 2
	All	100	100	100	2.6	
Insufficient food storage facilities	Male	88.9	62.5	80	1.8	m 11
	Female	11.1	37.5	20	1.8	f 7
	All	100	100	100	1.8	
Inadequate food processing facilities	Male	85.3	60	100	1.8	m 11
	Female	14.7	40	0	1.8	f 7
	All	100	100	100	1.8	
Inadequate means of transportation & distribution	Male	33.3	90.9	66.7	2.8	m 1
	Female	66.7	9.1	33.3	2	f 5
	All	100	100	100	2.4	
Increased population	Male	66.7	80	75	2.6	m 3
	Female	33.3	20	25	2.5	f 3
	All	100	100	100	2.6	
Low income	Male	75	80	72.7	2.5	m 4
	Female	25	20	27.3	2.4	f 4
	All	100	100	100	2.5	
Conflict	Male	83.3	100	75	1.4	m 12
	Female	16.7	0	25	1.3	f 9
	All	100	100	100	1.5	

Source: Field data, 2011

Future vulnerability

Having identified those factors that can make households vulnerable to climate change impacts, efforts were made to investigating the future vulnerability of farming and fishing households in the study area. This was achieved by asking the respondents to indicate the likelihood of occurrence of certain climate change-related events/hazards. Emphasis was on the opinion of men and women as well as the scale of likelihood: not likely, likely or very likely.

Likelihood of occurrence of climate change hazards in Akwa Ibom communities

Farmers were requested to assess the likelihood of certain climate change-related hazards on as “not likely”, “likely” and “very likely”. The response by upland farming communities is presented in Table 40. Results indicate that flooding, windstorms and drying up of streams are considered by farmers as the main climate change related hazards in their communities. A total of 56.3% of the male respondents and 44.3% of all the respondents (i.e. males and females) reported that flooding is likely to occur in their communities. Sea level rise is not regarded as a serious problem in the upland communities. However, windstorms are reported by 38.1% of the male and 4.3% of the female farmers as likely to occur. However, 38.5% of the female farmers said the occurrence of windstorms is "very likely" in the upland communities. A total of 49.2% of the male respondents and 43.8% of the female respondents are of the opinion that streams could dry up as a consequence of climate variability and climate change. In general, the percentage of respondents relating certain hazards to climate change is rather low. This could be attributed to a low level of awareness on climate change as shown in the results from this study. The lack of knowledge of climate change was very evident from the FGDs. This lack of knowledge of climate change is vividly captured by one key informant in Ikot Ebom Itam who said:

"Climate change is as a result of a deviation from the ways of our forefathers. Some norms and traditions of our land are being violated - we are not conscious of our environment. The youth are unruly; they do not appease the gods. Rituals usually performed before planting in the soil is overlooked. All these pollute our land."

Table 40. Views of upland farmers on the likelihood of occurrence of climatic hazard in Akwa Ibom State

Climate hazard	Gender	% not likely	% likely	%very likely	Total
Flooding	Male	26.7	31.7	41.3	100
	Female	25	18.7	56.3	100
Sea level rise	Male	79.9	14.3	5.8	100
	Female	68.8	25	6.2	100
Drying of streams	Male	31.7	49.2	19.1	100
	Female	43.7	43.8	12.5	100
Drought	Male	60.3	25.4	14.3	100
	Female	56.3	37.5	6.2	100
Windstorms	Male	46	38.1	15.9	100
	Female	19.2	42.3	38.5	100
Mudslide	Male	60.3	28.6	11.1	100
	Female	68.7	25	6.3	100
Landslide	Male	63.5	22.2	14.3	100
	Female	68.8	25	6.2	100

Source: Field data, 2011

Likelihood of occurrence of climate change hazards in wetland communities of Akwa Ibom State

In the opinion of wetland farmers, two climate change-related hazards are likely to occur (Table 41). These are flooding and drying up of water bodies such as streams and ponds. However, males (52.8%) and females (46.4%) reported that flooding is likely to occur. More females than male respondents reported that drying up of streams is likely to occur due to climate change. Akwa Ibom State has a low-lying topography and at the same time experiences heavy rainfall. These features may exacerbate incidents of flooding. This then may have informed the respondents' opinion that flooding is likely to occur.

Table 41. Views of wetland farmers on the likelihood of occurrence of climate hazard in Akwa Ibom State

Climate event/hazard	Gender	% not likely	% likely	%very likely	Total
Flooding	Male	32.1	52.8	15.1	100
	Female	42.9	46.4	10.7	100
Sea level rise	Male	58.5	24.5	17	100
	Female	77.8	7.4	14.8	100
Drying of streams/ ponds	Male	43.4	41.5	15.1	100
	Female	42.3	57.7	0	100
Drought	Male	56.6	30.2	13.2	100
	Female	55.6	40.7	3.7	100
Windstorms	Male	62.2	30.2	7.5	100
	Female	86.8	13.2	0	100
Mudslide	Male	73.5	20.8	5.7	100
	Female	74.1	14.8	11.1	100
Landslide	Male	83	9.4	7.5	100
	Female	81.5	11.1	7.4	100

Source: Field data, 2011

Likelihood of occurrence of climate change hazards in fishing communities of Akwa Ibom State

Table 42 shows the views of fisher folks on the likelihood of a climate change hazard to occur in their communities**.** Unlike in the wetland and upland communities, more events are considered by the fisher folks as possible future hazards. These include flooding, sea level rise, drying up of water bodies, windstorms, mudslides and landslides. More males (54.5%) than females (42.5%) consider that flooding could occur. Similarly, more males (45.5%) than females (36.8%) consider sea level rise as a potential hazard in their communities. The pattern is however, reversed in case of drying up of streams. More than 60% of the females felt that streams could dry up. This result can be attributed to the fact that since in the Niger Delta, women traditionally supply the water needs of the households and they are in a position to know more about water supply than men. The occurrence of other climate hazards such as windstorms, mudslides and landslides are also mentioned. The high number of climate change related hazards identified indicates the high level of vulnerability of fishing communities to these hazards. This situation may be due to the location of fishing communities close to the coast which are known to be prone to the impact of climate change.

Table 42. Views of fisher folks on the likelihood of climate hazards in Akwa Ibom fishing communities

Climate event/hazard	Gender	% not likely	% likely	%very likely	Total
Flooding	Male	45.5	54.5	0	100
	Female	52.6	42.1	5.3	100
Sea level rise	Male	50	45.5	4.5	100
	Female	52.6	36.8	10.5	100
Drying of streams/ ponds	Male	31.8	50	18.2	100
	Female	15.8	68.4	15.9	100
Drought	Male	31.8	54.5	13.66	100
	Female	10.5	73.7	15.8	100
Windstorms	Male	50	50	0	100
	Female	31.6	63.1	5.3	100
Mudslides	Male	59.1	36.4	4.5	100
	Female	47.4	42.1	10.5	100
Landslides	Male	50	40.9	9.1	100
	Female	52.6	42.1	5.3	100

Source: Field data, 2011

Likelihood of occurrence of climate change hazards in Ondo Communities

Ondo upland communities

The percentage distribution of respondents in the upland communities of Ondo State according to their opinion of the likelihood of occurrence of climate change hazard is presented in Table 43. In Ondo upland households flooding are drought are not viewed as likely to occur. However, all female respondents (100%) reported that sea level rise is a very likely event. Only 32.3% of the males consider drying up of water bodies as a likely hazard in their communities. Both the male and female respondents consider windstorms as a potential climate hazard in their communities. A total of 53% of both men and women hold this opinion. With this consensus of opinion, it appears that windstorms are a serious climate hazard in the upland communities of Ondo State.

Table 43. Views of farmers on the likelihood of occurrence of climate change hazards in upland communities of Ondo State

Climate event	Gender	Not likely (%)	Likely (%)	Very likely (%)	All (100%)
Flooding	Male	70.8	4.6	24.6	100
	Female	86.7	0	13.3	100
Sea level rise	Male	73.8	4.6	3.1	100
	Female	0	0	100	100
Drying up of streams	Male	67.7	32.3	0	100
	Female	73.3	20	6.7	100
Drought	Male	89.2	7.7	3.1	100
	Female	93.3	0	6.7	100
Windstorms	Male	30.8	53.8	15.4	100
	Female	20	26.7	53.3	100
Mudslides	Male	56.9	41.5	1.5	100
	Female	33.3	40	26.7	100
Landslides	Male	87.7	1.5	10.8	100
	Female	93.3	0	6.7	100

Source: Field data, 2011

Likelihood of occurrence of climate change hazards in wetland communities of Ondo State

Male and female respondents in the wetlands of Ondo State appear to be in agreement on the likelihood of occurrence of certain climate change hazards in their communities (Table 44). For example, 61.3% of the males view sea level rise as a potential hazards while 93.3% of their female counterparts have the same opinion. They also agreed that windstorms are likely to occur (35.4% of males and 46.7% females). However, there was no agreement on the likelihood of drought occurring, as more than a half of the female respondents (66.6%) said drought is likely to occur. On the other hand, 46.7% of the males view the occurrence of mudslides as “likely” while 40% consider the occurrence of this hazard as “very likely”. From the opinions of the respondents, it can be inferred that indeed certain climate hazards are likely to occur.

Table 44. Views of wetland farmers on the likelihood of climate change hazards in wetland communities of Ondo State

Climate event	Gender	Not likely (%)	Likely (%)	Very likely (%)	All (100%)
Flooding	Male	75.4	10.8	13.8	100
	Female	13.3	80	6.7	100
Sea level rise	Male	13.8	61.5	24.6	100
	Female	6.7	93.3	0	100
Drying	Male	52.3	32.3	15.4	100
	Female	66.7	20	13.3	100
Drought	Male	81.5	15.4	3.1	100
	Female	86.7	6.6	6.7	100
Windstorms	Male	26.7	66.6	6.7	100
	Female	38.5	35.4	20	100
Mudslides	Male	13.3	46.7	40	100
	Female	90.8	3.1	6.2	100
Landslides	Male	96.9	0	3.1	100
	Female	100	0	0	100

Source: Field data, 2011

Likelihood of hazard occurrence in fishing communities of Ondo State

Table 45 shows the percentage distribution of the fisher folks' views on the likelihood of occurrence of climate change hazards in the fishing communities of Ondo State. There is some agreement by men and women on the likelihood of occurrence of certain climate change hazards. A total of 93.3 % of the males and 80% of females view flooding as likely to occur. Similarly, 66.7% of the males and 80% of the female respondents reported that streams and other water bodies are likely to dry up, and 53.3% of the males and 60% of the females consider windstorms as likely to occur. The opinion of men and women differ on the likelihood of occurrence of sea level rise. While up only 66.7 % of the males view is likely to occur, 80% of the female respondents view it as very likely. Given the percentage of the respondents reporting on the likely of occurrence of climate change hazards, it may be plausible to consider sea level rise, flooding and drying of streams as likely climate change hazards in the fishing communities.

Table 45. Views of fishing communities on the likelihood of occurrence of climate change hazards in Ondo State

Climate event	Gender	Not likely (%)	Likely (%)	Very likely (%)	All (100%)
Flooding	Male	0	93.3	6.7	100
	Female	0	80	20	100
Sea level rise	Male	26.7	66.6	6.7	100
	Female	0	20	80	100
Drying up of streams	Male	20	66.7	13.3	100
	Female	20	80	0	100
Drought	Male	60	26.7	13.3	100
	Female	80	20	0	100
Windstorm	Male	20	53.3	26.7	100
	Female	40	60	0	100
Mudslides	Male	93.3	0	6.7	100
	Female	100	0	0	100
Landslides	Male	93.3	0	6.7	100
	Female	100	0	0	100

Source: Field data, 2011

Likelihood of occurrence of climate change hazards in upland communities of Rivers State

For upland communities in Rivers State (Table 46), both male and female respondents seem to agree that sea level rise, drought, mudslides and landslides are not likely to occur in their communities. But, flooding and drying up of streams are seen as likely to occur. Specifically, 35.7% of the males and 66.7% of the female respondents view flooding as very likely to occur in the upland communities. However, of all the upland farming respondents, only the females reported that drying up of streams is likely to occur. The views of the respondents may reflect the commonly occurring disaster that farmers are more familiar with.

Table 46. Views of upland farmers on the likelihood of occurrence of climate change hazards in upland communities in Rivers State

Climate event	Gender	% not likely	% likely	% very likely	total
Flooding	Male	50	14.3	35.7	100
	Female	0	33.3	66.7	100
Sea level rise	Male	57.1	14.3	28.6	100
	Female	66.7	0	33.3	100
Drying of streams/ ponds	Male	64.3	21.4	14.3	100
	Female	33.3	66.7	0	100
Drought	Male	71.4	14.3	14.3	100
	Female	65.9	0	34.1	100
Windstorm	Male	57.1	28.6	14.3	100
	Female	33.3	66.7	0	100
Mudslides	Male	85.7	7.2	7.1	100
	Female	100	0	0	100
Landslides	Male	85.7	7.1	7.1	100
	Female	100	0	0	100

Source: Field data, 2011

Likelihood of occurrence of climate hazards in wetlands communities of Rivers State

The wetland communities' views on the likelihood of climate change hazards vary considerably (Table 47). However, there seems to be agreement by both the male and female respondents on the likelihood of flooding and windstorms. A total of 60% of both the male and female respondents are of the view that flooding is very likely to occur. The same percentage of the male respondents feels that sea level rise is a potential climate change hazard in the wetland communities. However, only the male respondents consider drying of streams and other water bodies as a likely climate change hazard. This suggests that adaptation strategies should be designed to address the problems of flooding and windstorms, sea level rise and drying of streams. Without minimizing the risks of the other climate change hazards, it is to be noted that the lack of water either for domestic consumption or agricultural purposes could have devastating effects on the households. Therefore, adequate adaptation measures to deal with the destruction of water sources are required.

Table 47. Percentage distribution of respondents by their views on the likelihood of occurrence of climate change hazards in wetland communities in Rivers State

Climate change hazard	Gender	% not likely	% likely	% very likely	total
Flooding	Male	20	20	60	100
	Female	20	20	60	100
Sea level rise	Male	40	0	60	100
	Female	80	0	20	100
Drying of streams/ponds	Male	40	60	0	100
	Female	40	40	20	100
Drought	Male	40	40	20	100
	Female	60	40	0	100
Windstorms	Male	20	80	0	100
	Female	40	60	0	100
Mudslides	Male	100	0	0	100
	Female	80	0	20	100
Landslides	Male	100	0	0	100
	Female	80	0	20	100

Source: Field data, 2011

Likelihood of climate change hazards in fishing communities of Rivers State

As is the case in the other agro-ecological systems in Rivers State and the Niger Delta region, flooding, sea level rise and windstorms are considered by fisher folks as the main potential climate change hazards in their communities. More than 50% of the male respondents view flooding as likely to occur in the fishing communities. While most men see most climate change hazards as not likely to occur, the women consider some hazards as likely to occur. A total of 68.4% and 63.2% respectively, of the female respondents see drying of streams and windstorms as likely to occur. The result tends to reveal that women may be more observant of environmental changes taking place around them. Their involvement in environment related livelihood activities could cause women to be more aware. Thus, the results point to the fact that for any adaptation programme to succeed, women should be involved at all stages.

Table 48. Views of fisher folks on the likelihood of occurrence of hazards in the fishing communities of Rivers State

Climate change hazard	Gender	% not likely	% likely	% very likely	total
Flooding	Male	45.5	54.5	0	100
	Female	52.6	42.1	5.3	100
Sea level rise	Male	50	45.5	4.5	100
	Female	52.6	36.8	10.5	100
Drying of streams/ponds	Male	31.8	50	18.2	100
	Female	15.8	68.4	15.8	100
Drought	Male	54.5	31.8	13.6	100
	Female	73.7	10.5	15.8	100
Windstorm	Male	50	50	0	100
	Female	31.6	63.2	5.3	100
Mudslide	Male	59.1	36.4	4.5	100
	Female	47.4	42.1	10.5	100
Landslide	Male	50	40.9	9.1	100
	Female	52.6	42.1	5.3	100

Source: Field data, 2011

6. DISCUSSION

There have been some major climate change-related events in the Niger Delta. Every part of the region has had one or a series of events. These events/extremes have affected and also have the potential to affect farmers and fisher folks. Both men and women are vulnerable to these events. A close examination of the responses by community members shows some peculiarities with wetland, upland as well as fishing communities.

Common events in the fishing communities are sea level rise, flooding and beach erosion. Sea level rise is said to occur between July and September (which corresponds to the peak of the rainy season in the region). This result concurs with Zabbey (2007) who asserts that due to its characteristic lowlands, the Delta region is potentially vulnerable to any rise in sea level.

Discussants at the FGDs as well as key informants particularly singled out sea level rise and beach erosion as the main climate change impacts that the households are particularly vulnerable to. This is a problem of many coastal communities. As an example, in Ibaka, Akwa Ibom State, a large proportion of the community, including buildings and farmlands have been washed away by the advancing sea.

Flooding is reported in all the communities studied, largely due heavy rainfall. Temperature extremes are also common in all the communities studied. Discussants complained that they do not have a peaceful night’s rest due to excessive heat. Respondents reported that rainstorms and windstorms are a common occurrence compared with the past. Hailstones were reported in Ayadehe, a wetland community in Akwa Ibom State.

According to respondents, the close proximity of most communities in the Niger Delta to the beach increases the vulnerability of the communities to the effects of fluctuations in weather as well as to long term climate change. Low income levels of the farmers and the fisher make it difficult to cope. It was a general opinion by the respondents that while everyone in the community could be affected by climate change events, women and children were most vulnerable. The vulnerability of women to climate change was attributed to most women depending of farming for their livelihoods. Among the different household categories, farming households were said to be the most affected by climate change extremes. Farming households are said to suffer reduction in crop yield, food insecurity, homelessness and increased poverty.

Impact of climate change in the Niger Delta

Due to non-availability of documented information at the community level on climate change-related disasters, the study relied on secondary sources and oral testimonies from participants in Focus Group Discussions and In-depth Interviews of key informants. Table 49 shows the impacts of sea level rise in the Niger Delta (Awosika et al., 1992). Their report reveals that 26-45 meters of land area is lost to erosion per year. This is 15% of the total area of the Niger Delta. A total of 50 villages are impacted and 0.15 million people are displaced. It is projected that 2-3 million people could be displaced by sea level rise. The implication is that unless practical steps are taken to check sea level rise, a large portion of the Niger Delta can be washed away and millions of people would be displaced. Practical approaches to checking the impact of sea level rise include construction of embankments to protect the coastal environment and tree planting and grassing of fields. Awareness creation and capacity of farmers to adapt to climate change can assist in reducing the impact of sea level rise resulting climate change.

Table 49. Impacts of sea level rise (SLR) in the Niger Delta

Type of Impact	Unit of Measure	Present	1m SLR	2m SLR
Erosion rate	m/year	10-15	16-19	20-25
Area lost to erosion	Km^2	26-45	55-120	130-230
Inundation and erosion	Km^2	3,000	7,000	15,000
Per cent of area lost	%	15	35	75
Villages impacted	No	50	200	350
People displaced	Million	0.15	1-2	2-3

Note: Total area of Niger Delta is about 2 million hectares
Source: Awosika et al., 1992

Besides sea level rise, flooding has also impacted adversely on households in Akwa Ibom State. The impacts come in different forms and severity. The impacts of climate change hazards in Akwa Ibom State have been the subject of concern and discussion in the print, electronic media as well as social media. An example is the report of the impact of flooding, in the newspaper quoted below. Flooding has recently been taking on a new dimension in the Niger Delta. Heavy rainfall has been more frequent, rainfall volume unusually high and the impact has been devastating. The first to be affected is road transportation. Movement is usually grounded and economic activities are always adversely affected. All of this shows that individuals as well as institutions, e.g. Municipal, Ministry of Environment, etc., are yet to take adaptive measures to the impacts of climate change.

Floods: Displaced A'Ibom victims want to return home
(The Punch Newspaper November 17, 2010)

Indigenes of Itak Abasi community in Akwa Ibom State, who were displaced by floods in August, have expressed their desire to return home. The floods were caused by surging waves of the Atlantic Ocean. One of their leaders, Mr. Inyang Itrechio, who spoke to the News Agency of Nigeria (NAN) in the community on Wednesday, said they were yet to see any effort by the government to address the ecological problem caused by the floods. He, therefore, appealed to the state and federal governments to take urgent steps to reclaim the portion of their land submerged by the ocean surge, to enable them to reoccupy the community.

He also appealed to the Ministry of Niger Delta Affairs to assist the community by reclaiming the land, saying that all fishing settlements in the area were swept away by the flood. "The greatest need of the affected people now is to have access to their ancestral land where they have lived for decades. We know that if there is the will by government, the land can be reclaimed. We passionately appeal to the government to reclaim the land for us," he said. Itrechio recalled that some ecological experts, who visited the area after the incident attributed it to the effects of global warming. He said they claimed that the floods displaced more than 4,000 fishing settlements.

He told NAN that the water blocked the creeks and made navigation impossible. Itrechio pointed out that if the situation was not reversed, many communities accessible only by canoe would be cut off. He commended Ibeno Local Government, the state government and the National Emergency Management Agency (NEMA) for their visit to the area and the donation of relief materials to them. The community leader urged NEMA, the state government and the council to find a lasting solution to the problem. Itrechio said the Chairman of the local government, Mrs. Regina Egbe, had constituted a committee to assess the problem and prepared a blueprint for tackling it.

In addition to the newspaper article referred to here, testimonies on the impacts of climate change were taken from FGD discussants. Judging by the testimonies of the respondents in this study, the fact that there is climate change in the study area is not in doubt. The variations in climate have varying degrees of effects on the farmers the fisher folks. Participants in the FGDs in the farming communities noted that late onset of rain has brought about a reduction in sprouting/germination of crops and poor yield. They also reported that high temperatures result in wilting and death of crops particularly banana and plantain. Yam tubers are also said to rot either in the soil or in storage due to extreme heat/temperatures. The overall effects of these are low crop yield, low farm income and food insecurity of farming households. Flooding was reported to "sweep off" farmland leading to loss of crops and income. Buildings, particularly thatch houses are said to be often destroyed by either flooding in the upland and sea level rise in fishing and wetland communities. Livestock are not spared from the adverse effects of climate change. Outbreaks of livestock diseases are said to be common during periods of temperature extremes. Discussants in Amalem, Rivers State specifically reported the appearance of new species of plants which are fast replacing native species. In addition, they also reported an attack on coconut trees by a new species of bird that defecates on young coconut leaves. This causes the leaves to wither and die which affects the entire tree.

Participants in FGDs in all communities made the point that the health of families is adversely affected by climate change impacts. They reported that there are more mosquitoes and increased rates of malaria. Skin diseases are now more common. Households now spend more on medical bills. This coupled with loss of income arising from climate events have rendered households more vulnerable to poverty. Female respondents in Ifiayong Usuk, Akwa Ibom State observed that climate change is affecting women's ability to procreate. They claimed that the number of children a woman can give birth to has reduced. In addition, newborn babies are no longer showing characteristics that used to be identified with newborns, such as folding of the hands, rhythmic beating of the centre of the head and the characteristic cry of babies. Both the key informants and discussants in the FGDs were of the opinion that the impact of climate change is more severe on female-headed households than the male-headed ones. This is said to be engendered by women's limited sources of income and access to resources such as land.

Gender most affected by climate change related hazards

The study also tried to find out which gender is more affected by climate change hazards. From the results presented in Table 50, 87.3% of the male farmers in upland communities of Akwa Ibom State reported that both men and women are equally impacted upon by the impact of climate change in their communities. More women farmers (55%) are of the opinion that women are more affected while 38.7% said men and women are affected in the same magnitude. In Ondo and Rivers States, the opinion of both male and female farmers is that both men and women are affected. The trend seems to be that both men and women have been affected across the communities and states. While the percentage of respondents taking this position differs across communities and states, this group of respondents still form the majority in each location and state. The findings seem to differ from the popular opinion in climate change literature which suggests that the women are more vulnerable (see Speranza, 2010). The result as obtained may be attributed to insufficient gender analysis skills of most rural people. Being gender blind makes it difficult for the respondents to see the specific gender divide of the impacts of climate change among men and women. And as male discussants in Amalem, Rivers States explained: *If I am affected, my wife is affected. And, if my wife is affected, I am affected. Therefore, both men and women are equally affected.*

Table 50. Perceptions of respondents on which gender is more affected by climate change hazards

Community type	Gender	Akwa Ibom		Ondo		Rivers	
		Male (%)	Female (%)	Male (%)	Female (%)	Male (%)	Female (%)
Upland	Men	3.2	6.3	1.5	0	3.2	6.3
	Women	9.5	55.0	19.2	0	10.5	25
	Both men &women	87.3	38.7	73.8	84.7	85.7	68.7
	Total	**100**	**100**	**100**	**100**	**100**	**100**
Wetland	Men	70.3	12.8	1.5	0	20.0	3.8
	Women	11.1	52.8	6.2	0	21.0	46.2
	Both men &women	18.6	34.4	92.3	100	59.0	50.0
	Total	**100**	**100**	**100**	**100**	**100**	**100**
Fishing	Men	60	0	15.0	20	54.6	0
	Women	30	0	65.0	0	34.3	0
	Both men &women	10	100	20.0	80	11.1	100
	Total	**100**	**100**	**100**	**100**	**100**	**100**

Source: Field data, 2011

Ways men and women have been affected by the impact of climate variability and climate change

The percentage distribution of respondents based on their observations on ways men and women have been affected by climate hazards are presented in Tables 51-53. In general, the ways in which households have been affected include loss of income, low yield and loss outputs. Loss of property and health problems are also associated with climate change impacts.

Ways upland communities are affected by climate change

Table 51 shows that in Akwa Ibom upland communities, loss of income, output and yields are the common ways households have been affected. Specifically, 31.7% of male farmers and 37.5% of female farmers reported losses in crop output and poor yield. The findings are supported by Speranza's (2010) assertion that direct dependence on rainfall accounts for the high sensitivity of sub-Saharan Africa agriculture to climate conditions, where agricultural yields fluctuate with climate conditions. As expected, the loss of output and poor yield lead to loss of income as 25.4% of the male farmers and 18.8% of the female respondents reported that they lost income due to the impact of climate change. In Ondo State, while loss of income is common among male farmers, loss of property seems to the common ways the women suffer from the impacts of climate change. More males (35.5%) report loss of income while 40% of female farmers report loss of income. This trend is also found in Rivers State. One indirect way climate variation affects farmers in the upland communities is conflict which results from the struggle for scarce resources. Key informants made the point that because the yield is poor and income is getting low, people have to struggle for more agricultural land for farming purposes. This lead to land disputes which in some cases result in communal clashes, etc.

Table 51. Views on ways men and women in upland communities are affected by climate change

Ways households are affected	Akwa Ibom		Ondo		Rivers	
	Male	Female	Male	Female	Male	Female
None	3.2	0	16.9	20	3.2	0
Loss of property	4.8	12.5	26.2	40	4.8	12.5
Health problems	6.3	12.5	4.6	6.7	6.4	12.5
Increased expenditure	6.3	0	0	0	6.3	0
Loss of income	25.4	18.8	35.4	13.3	25.4	18.7
Loss of output & poor yield	31.7	37.5	16.9	20	31.7	37.5
Conflict	22.2	18.7	0	0	22.2	18.8
Total	**100**	**100**	**100**	**100**	**100**	**100**

Source: Field data, 2011

Ways wetland communities are affected by climate change

The ways climate change affects farming households in wetland communities in Akwa Ibom State differs from upland communities. While 34% of the male farmers report no impact, only 7.4% report some impact. Loss of income is reported by 55.6% of the female respondents while only 15.1% of men share this opinion. Conflict appears to be similar for both male and female respondents (Table 52). Conflict as impact of climate change is also common to respondents in Rivers State but is less of a problem in Ondo State. Another impact of climate change that is common to all states studied is loss of income. In Ondo State, 63% of the female and 50% of the male respondents are affected by loss of income. While more than a half (55.6%) of the female respondents in Rivers State is affected by loss income, only 15.1% see this as one of the ways they are affected by the variation in climate. This means that men and women are not affected in the same way by climate change. This suggests that programmes designed to mitigate the impact of climate should be tailored to the particular needs of the women as well as men.

Table 52. Views on ways men and women in wetland communities are affected by climate change

Ways households are affected	Akwa Ibom		Ondo		Rivers	
	Male (%)	Female (%)	Male (%)	Female (%)	Male (%)	Female (%)
None	34	7.4	4.6	0	34.0	7.4
Loss of property	11.3	0	13.8	35.7	11.3	0
Health problems	1.9	0	7.7	0	1.9	0
Increased expenditure	0	0	10.8	14.3	0	0
Loss of income	15.1	55.6	63.0	50	15.1	55.6
Loss of output & poor yield	9.4	3.7	0	0	9.4	3.7
Conflict	28.3	33.3	26.7	0	28.3	33.3
Total	**100**	**100**	**100**	**100**	**100**	**100**

Source: Field data, 2011

Ways fishing communities are affected by climate change

Given the occupation of the fisher folks, it would be expected that the ways the variation in climatic elements affect fisher folks would be different from the upland and wetland communities. The results in Table 53 reveal an additional dimension to what was observed in the other communities. This other dimension is the impact on the health of the respondents. In AkwaIbom State, 30% of female and 15% of male respondents identified health problems as one of the ways they are affected by variation in climate. Respondents in the fishing communities of Ondo State did not identify this as a problem. In contrast, 20% of male and 40% of female respondents in Rivers State singled out health problems as an impact. More than a half (56.3%) of the male respondents in Akwa Ibom State identifies low catch as one way they are affected by climate variability. Loss of income is another way fisher folks are affected by climate change. A total of 60% of both male and female respondents in the fishing communities observed that climate change affects income.

These differences between community types imply that that climate change adaptation measures need to address these differences which may, to some extent, be influenced by the peculiarities of the livelihoods and the micro-environment of the respondents.

Table 53. Views on ways men and women in fishing communities are affected by climate change

Ways households are affected	Akwa Ibom		Ondo		Rivers	
	Male (%)	Female (%)	Male (%)	Female (%)	Male (%)	Female (%)
None	13.7	0	6.7	0	13.3	0
Loss of property	0	14	33.3	80	0	0
Health problems	15	30.0	0	0	20	40
Increased expenditure	0	10.7	0	0	0	0
Loss of income	10	45.3	33.3	0	60	60
Low catch	56.3	0	0	0	0	0
Conflict	5	0	26.7	20	6.7	0
Total	**100**	**100**	**100**	**100**	**100**	**100**

Source: Field data, 2011

Adaptation strategies to climate change

Some adaptation measures have been adopted by households and communities in the Niger Delta to mitigate the impact of climate change. These adaptation measures seem to depend on the geographical location of the communities and the common climate events. That is whether it is upland, wetland or a fishing community. The distribution of the respondents based on the adaptation measures adopted is presented in Tables 54-56.

Adaptation measures in upland communities

Table 54 shows the percentage distribution of upland farmers based on adaptation measures adopted. While some 21.9% male respondents in Akwa Ibom State upland communities claimed they do nothing to adapt to variation in climate, 43.5% of their female counterparts made the same claim. Planting on mounds and application of fertilizer and other land augmenting technologies are employed by 28.1% and 23.5% of the male upland farmers respectively. On the other hand, the use of irrigation and planting on mounds are common among the female farmers.

A greater percentage of both the male and female respondents in Ondo State, compared with their Akwa Ibom counterparts, claimed they do not take measures to mitigate the impacts of climate change. However, land management practices are common adaptation techniques among those taking long term action to protect their livelihoods from the impact of climate variability. The most important of these is planting on mounds to reduce the effect of flooding on crops. A total 30% of the male and 39.3% of the female farmers adopt this method. Application of fertilizer and other yield-improving practices are also used by both the male and female respondents.

Table 54. Adaptation measures adopted in upland communities

Community Type	Akwa Ibom		Ondo		Rivers	
Adaptation measure	**Male (%)**	**Female (%)**	**Male (%)**	**Female (%)**	**Male (%)**	**Female (%)**
None	21.9	43.5	37.7	53.3	21.9	43.8
Planting on mounds and ridges	28.1	12.5	30	39.3	28.1	20.2
Irrigation and digging of well	9.4	24	3.1	6.7	8.4	12.0
Use land augmenting inputs i.e. fertilizer	23.5	10	18.5	3.3	15.0	15.4
Terracing/sand filling	9.4	0	0	0	9.4	0
Planting and use of windbreaks	3.1	10	1.5	0	3.1	2.3
Planting & use of shade trees	4.6	0	9.2	6.7	14.1	6.3
Total	**100**	**100**	**100**	**100**	**100**	**100**

Source: Field data, 2011

Adaptation measures in wetland communities

Wetland farmers' adaptation measures to climate change are similar to those of the upland farmers (Table 55). However, besides planting on mounds and use of fertilizer used by 22.2% and 20.4% of the male respondents respectively, windbreaks and irrigation are used more by female farmers. It should be noted that the type of irrigation used by wetland farmers is "hand watering" (Plate 2). This system is less efficient and labour intensive. An improved type of irrigation system such as treadle pump, sprinklers, channels or drips, is required in order to enhance the adaptive capacity of the wetland farmers. The use of land management adaptation techniques is also common to farmers in both Ondo and Rivers State wetland communities. In Ondo State, 15.4% of male and 7.2% of female farmers use fertilizer. This indicates that this technique is preferred by men or is more accessible to men than women. However, more women than men use windbreaks. Planting on terraces is employed by 20.4% of male and 3.8% of female farmers in Rivers State. Farmers also plant flood-resistant or flood-tolerant varieties of crops. In Araromi Ayika, Ondo State, female discussants said they now plant late in the season, in response to the late onset of rain in recent years. Respondents in all the communities reported that they have diversified their income-earning activities as a survival strategy in the face of dwindling and unpredictable income from a single source. Farmers plant trees and cover crops to shade their crops from the scorching heat. Besides, the measures which directly related to farming, another adaptation measure found in virtually all communities studied and employed by 38.5% of the female farmers in Rivers State is the planting of shades trees to protect homes from the scorching heat and wind. However, discussants in the FGD in Amalem, Rivers State pointed out the need to properly manage this adaptation measure to reduce its possible adverse impact including destruction of buildings by falling branches of the shade trees, etc. Therefore, in addition to encouraging the adoption of this adaptation technique, training of the communities on the management of shade trees is also necessary to reduce any adverse impacts of this adaptive measure.

Table 55. Adaptation measures adopted in wetland communities

Adaptation measure	Akwa Ibom		Ondo		Rivers	
	Male (%)	Female (%)	Male (%)	Female (%)	Male (%)	Female (%)
None	14.8	3.0	53.8	50	0	0
Planting on mounds and ridges	22.2	9.4	10.8	21.4	21.8	23.1
Irrigation and digging of wells	24.0	23	10.8	0	3.7	7.7
Use land augmenting inputs i.e. fertilizer.	20.4	16.8	15.4	7.2	44.8	23.1
Terracing/sand filling	1.9	3.8	0	0	20.4	3.8
Planting and use of windbreaks	3.7	32.5	1.5	21.4	5.6	3.8
Planting and use of shade trees around houses	13	11.5	7.7	0	3.7	38.5
Total	**100**	**100**	**100**	**100**	**100**	**100**

Source: Field data, 2011

Adaptation measures in fishing communities

As discussed in the previous sections, the fishing communities are affected by beach erosion and flooding on occasion by sea level rise. The fisher's adaptation measures to these and other climate hazards are presented in Table 56. The adaptation measures employed vary between men and women. This may be due to gender-specific roles that are related to fishing activities. For instance, it is not common for women to go out fishing in the wild. Rather it is the men who go out while the women are involved more in fish processing and marketing. A total of 25% of the male respondents in Akwa Ibom and Rivers State fishing communities now do their fishing farther away from the shore than they used to do. Discussants said this is due to the reduced catch arising from rising water levels. Fisher folk (mostly fisher folk) now spend more days in the high sea and carry with them deep freezers to preserve fish until they are able to return. Another measure adopted by fisher folk is the construction of embankments and walkways (also see Plate 4 in Appendix A). It is to be noted that embankments should be constructed by government and other development agencies, as they are capital intensive. Manually constructed walkways are built by communities. In response to sea level rise and beach erosion, males (20% in Akwa Ibom and Rivers State) raise the floor level of their houses. In addition to this, canals and channels are constructed in order to prevent communities and homes being washed away by floods or rising sea water.

Table 56. Adaptation measures adopted in fishing communities

Adaptation measures	Akwa Ibom		Ondo		Rivers	
	Male (%)	Female (%)	Male (%)	Female (%)	Male (%)	Female (%)
None	25	44.4	0	76.5	25	64.5
Using deep cold storage	5	0		0	5	0
Construction of embankments & walkways	10	0	17.8	0	15	0
Constructing canals/channels	15	5.6	47.7	13.5		25
Raising the floor level of buildings	20	0	0	0	20	0
Fishing along the shore	0	50	0	10	10	0
Fishing far from shore	25	0	34.5	0	25	10.5
Total	**100**	**100**	**100**	**100**	**100**	**100**

Source: Field data, 2011

Adaptation Capacity**:** The results of the ordered probit analysis on the adaptation capacity of households are presented in Table 57. For Akwa Ibom State, household income, access to climate information and community type positively and significantly influence household adaptive capacity. Income is statistically significant to 5%, while access to information and community type are significant at 1% respectively. For Ondo households, income significantly and positively influences the probability that a household would have the capacity to adapt to climate change. In Rivers State, household size significantly decreased the probability of a household adapting to climate change while farm size and community type significantly increased the probability of adaptation by households. A new set of factors were found to explain the probability of households adapting to climate change. These include household size, farm size and community type (i.e. whether a community is an upland, wetland or fishing community). However, while farm size and community type would raise the probability of a household having the capacity to adapt to climate change, household size reduces capacity. The capacity of households to adapt to the impact of climate change can be raised by increasing income, farm size and reducing the household size by paying adequate attention to family planning. The likelihood ratio Chi square statistics for the three were all highly significant. This implies that the model has high explanatory power and that the independent variables (sex, age, level of education, household size, farm size, income, access to information, and community type) had a significant influence on the likelihood of household adapting to climate change.

Table 57. Results of adaptive capacity to climate change impacts (Ordered Probit Analysis)

Parameter	Akwa Ibom	Ondo	Rivers
	Estimate		
Sex	-.450 (-1.008)	-.500 (-1.542)	-.202 (-374)
Age	-.011 (-(.846)	-.010 (804)	.004 (.202)
Level of Education	-.019 (-.468)	.013 (.547	.022 (.357)
Household size	.007 (.069)	.023 (.230)	-263 (-2.096)**
Farm size	-.001 (-.011)	-.045 (-1.318)	.412 (2.904)***
Income	.000 (2.205)**	.000 (1.776)*	.000 (.850)
Access to climate information	.619 (2.799)***	.175 (.908)	-.039 (-.152)
Community type	.778 (2,841)***	-.085 (-.397)	.825 (2.835)***
Intercept	-2.293)**	-.190 (-.221)	-1.804 (1.314)
Chi-square	170.873(df,150)	145.035(df,142)	56.504 (df,52)

7. SUMMARY OF FINDINGS, CONCLUSIONS, POLICY IMPLICATIONS AND RECOMMENDATIONS

Summary of Findings

Trends in and variation in climate

Trend analyses indicate that both rainfall and temperature have been on the increase in the Niger Delta Region. The sign of the trend lines for rainfall and temperature are found to be positive for the three states studied except rainfall in Rivers State. The trend for rainfall in Rivers State is negative indicating that rainfall amount has been on the decline over the years. The observations of the respondents across the state and agro-ecological systems indicate lack of pattern or uniformity of either temperature or rainfall amount. Most respondents, however, reported increase in rainfall amount but its onset, cessation and duration are uncertain. The respondents also reported higher than normal temperatures. Thus, respondents seem to be able to correctly perceive the variability in climatic elements.

Climate information sources, accessibility, availability and perception:

There are no formal institutional sources of climate information to farmers and fisher folks. General weather information is received from the mass media mainly by television (NTA), radio and newspapers. Accessibility of climate information sources is poor. There are institutions with the mandate to supply tailor-made information to farmers and fisher folks but they claim they have no access to information. Weather stations report that most users of climate information are institutions such as airlines and companies, and researchers. Climate information is supplied on demand and therefore not available to the farmers and fisher folks, who consider climate information received through mass media sources as not regularly available and inappropriate for their livelihood activities.

Awareness, knowledge level and understanding of local forcings:

Farmers have generalized but limited information on climate change. They simply have heard that climate is changing. Their understanding of local forcings of climate change (i.e. local actions that contribute to climate variability) is low. In some of the communities studied, certain individuals possess indigenous knowledge. However, very few own up to having this knowledge due to the negative perception of community members towards people who have this skill.

Vulnerability of households to climate change:

Both male and female-headed households in all upland, wetland and fishing communities are vulnerable to flooding, windstorms, erosion and drying up of streams. Respondents in the fishing communities are more vulnerable to sea level rise. Respondents consider that these hazards may continue in the communities in the future. They also consider that mudslides and landslides could occur in their communities in the light of current climate change. Those factors that are considered as very important factors that make households vulnerable to the climate hazards are: low agricultural output and income, non-availability of irrigation facilities, insufficient farm labour and lack of storage facilities. Inadequate transport means of transportation is a very important factor that makes households in the fishing communities vulnerable to the impact of climate change.

Except in Rivers State, farming and fishing households tend to spend less on food during disasters. This presupposes lack of income to buy food. Most households lack technical capacity to adapt to climate change and variability. There is high level of dependence on agriculture, and households are located in areas susceptible to the impact of climate hazards and are thus vulnerable to climate change impacts.

Impacts of climate change:

Both men and women have been adversely affected by impacts of climate change. Both men and women in farming and fishing households are affected in the following ways: loss of property due to floods, sea level rise, erosion, loss of income, poor yield and health problems. Both men and women are affected. The male respondents in the fishing communities also suffer from low fish catch, which may or may not be attributed to climate variability/change.

Adaptation measures:

Households adopt a number of measures to adapt to climate change impacts. Upland and wetland farmers use hand irrigation methods, plant on mounds and use land augmenting technologies such as fertilizers. They also plant shade trees. In the fishing communities, women fish close to the shore while men fish further from shore. The men now equip their boats with deep a freezer for the purpose of preserving fish while out at sea. Income, farm size and community type are related to capacity to adapt to climate change while household size limits adaptive capacity.

Conclusions

Communities in the Niger Delta have limited adaptation options to climate change-related events and extremes. Some of these measures may not be sufficient given their high vulnerability. Each community type tends to experience climate risks differently. For example, communities along the coastline are confronted with the risk of ocean surge and sea level rise, while the wetland communities are faced with the risk of pests and flooding. Studies that focus on community-specific are needed in the Niger Delta region.

There exists a vast indigenous and traditional knowledge of weather/climate and climate variability and change which could be tapped for sustainable adaptation to climate change. To draw upon this body of knowledge requires more research time than the present study permits. Indigenous knowledge on climate and climate variability and long term change is being lost due to the negative perception of those who possess this knowledge by members of the community.

Policy Implications and Recommendations

The study of adaptation to climate change by farming and fishing communities in the Niger Delta draws lessons that can help improve the design of policies for climate change adaptation. The relevant Nigerian and global institutions are making efforts to develop policies that will enhance communities', households' and individuals' adaptation to climate change.

1. One important finding of this study is that a large percentage of the Niger Delta population lack science-based knowledge of climate change. Therefore, rigorous awareness creation using science-based information is suggested as the starting point for policy aimed at effective adaptation by all stakeholders to climate variability. Due to the religious nature of the Niger Delta people, it is suggested that religious institutions be employed, alongside other outlets, to disseminate climate change information as is done with HIV/AIDS, Polio, immunization and Roll Back Malaria programmes.

2. The second policy -related finding of this study is that available weather information gathering institutions do not make weather/climate information available to the public. Climate information from the media is not addressed to the particular needs of the farmers and fisher folks. Therefore, policy is required to ensure that relevant climate-based information is available on time to the different end-users. It is recommended that the mandates of existing weather stations be modified to include dissemination of climate information to the farmers. Community-based weather/climate information stations should be established. School-based geographical gardens should be established with a qualified official, preferably a school teacher with background in geography or a similar subject area.

3. This study reveals that indigenous knowledge of climate is not preserved or widely appreciated in the communities. This knowledge may be facing the danger of extinction. The use of IK should be promoted through patronizing the services of custodians of this knowledge. This should be followed by a comprehensive study on the existence of this knowledge which should lead to integration of this knowledge into climate change information systems.

4. Another finding of this study is that local people have limited capacity to adapt to the impacts of climate change. This poses immediate challenges to policy makers as well as development agencies. IPCC (2007) noted that much more extensive adaptation responses than are currently occurring are required to reduce vulnerability to climate change. Policies to enhance the capacity of communities are required. It is recommended that a climate change component be introduced into the annual Tree Planting Campaign. As a part of this campaign, the planting of shade trees around homes as well avenues are done. Campaigns should include management of the shade trees so that they do not become a source of disaster in the communities from windfall. A Community Climate Change and Environmental Workers (CCEW) programme should be established. Technical workers in this scheme are to work with the communities to establish and manage avenues and parks.

The results of the study indicate that the upland and wetlands farming households are vulnerable to flooding, windstorms, drying up of streams, erosion and other impacts. The wetland and fishing communities are, in addition to these climate hazards, also exposed to sea level rise. Several factors are rated as “very important” in exposing the farmers and fisher folks to the impacts of climate hazards. These are low agricultural output, non-availability of irrigation facilities, insufficient farm labour, and lack of agricultural commodities/food storage facilities, low income and inadequate means of transportation, particularly in the fishing communities. Besides the current climate-related hazards, farmers and fisher folks said that mudslides and landslides can occur in their communities.

5. To assist the communities adapt to these hazards, it is recommended that early warning system for extreme climate events be established. Without this warning system, such events could destroy crops or kill livestock that people rely on for livelihoods. Emergency evacuation systems should be established to evacuate communities during extreme climate events. Of particular importance is the need for the creation of a climate information agency to regularly disseminate climate information to the farmers so that disasters can be avoided.

6. Income opportunities and income support programmes and capacity building on enterprise development and management are recommended. This will enable the farmers and fisher folks to diversify their income sources in order to reduce their vulnerability to climate change.

7. Certain cultural practices such as hand irrigation, land augment/management with fertilizer, planting on mounds and planting shade trees should be improved upon and scaled up. Irrigation schemes should be established so that water is available for farming purposes.

8. Analysis shows that household size negatively impacts on adaptive capacity. To improve this situation, the implementation of the national policy on family size should be implemented. In the absence of any existing policy, then one should be formulated and implemented. Such policy if effectively implemented could control the household size and thus release more household resources to take of other needs such as adaptation measures.

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Appendix A Project Photos

Plate 1: Focus Group Discussion in Mbiabet Eyehedia, Akwa Ibom State

Plate 2: Debris of Brick building destroyed by sea level rise in Ibaka, Mbo, Akwa Ibom State

Plate 3: Hand watering by dry season wetland farmer in Ikot Ebom Itam, Akwa Ibom State

Plate 4: Embankment to check sea level rise at Ibaka beach, Mbo LGA, Akwa Ibom State

Plate 5: A Stakeholder contributing at the Stakeholders' Forum

Appendix B Household Questionnaire

DEPARTMENT OF AGRIC. ECONOMICS AND EXTENSION,
UNIVERSITY OF UYO, UYO

HOUSEHOLD QUESTIONNAIRE FOR CLIMATE CHANGE RESEARCH PROJECT

Project Topic: Adaptation to Climate Variability: A Case Study of Farming Households in the Niger Delta Region.

Dear Sir/Madam,

We are investigating how households in the Niger Delta adapt to changes in climate as part of Building Nigeria's Response to Climate Change (BNRCC). You have been carefully selected alongside others in your community to help provide useful information for the study. You are kindly requested to respond to the questions below to enable us fulfil the purpose of the study. We assure you that information provided by you will be used strictly for this research purpose only.

Thank you.

SECTION A: IDENTIFICATION:

State:………………………………………..
Village/community: ……………………………
Name of respondent:……………………………
Name of Enumerator: ……………………..........
Date of Interview: ……………………...........
Name & Signature of Supervisor:..

SECTION B: SOCIOECONOMIC AND GEOGRAPHICAL CHARACTERISTICS
(these questions are to be responded to by the household head or his assignee who should provide information about the head)

1. Name of household head:.....................................
2. How old are you (specify in year)?..................
3. What is your sex? a. Male …………… b. Female………………
4. What is your marital status:
   a. Single b. Married c. Widowed d. Separated e. Divorced
5. How many wives have you (if respondent is a male)? …………………
6. What is your religion?
   a. Christian b. Islam c. African d. Traditional Religion
7. What is your highest educational level? …………………..
   (Indicate highest class completed)..................
8. Indicate the type of building occupied by your household
   a. Mud wall with thatch roof b. Mud wall with zinc roof c. Brick wall with zinc
   d. Brick wall with thatch roof e. Cement block with Zinc f. Zinc wall with roof
9. How many rooms in the building do people sleep in? ………………….
10. Please provide information on household structure in the table below:

Table 1. Characteristics of household members

Name of household member	Sex	Relationship with household head (child, nephew, etc.)	Age	Highest educational level	Employ? Yes/No	Is employment permanent? Yes/No

11. Leadership Characteristic and Empowerment

Kindly supply information on your participation in decision making in your community in Table 2 below.

Table 2. Leadership & Empowerment Characteristics

Social Group	Member of group?		Ever held position?		Position held	Ever participate in taking decision in the group?	
	Yes	No	Yes	No		Yes	Yes
Community as a whole							
Community Committee							
Cooperative							
Other Social Group (List them)							

12. What is the main occupation you depend on for a living?

    a. farming b. fishing c. others (specify)……………………………….

13. Besides your main/primary occupation, what are your other sources of income?

    i.) …………………….. ii.) …………………….. iii.) ………………………….

    iv.) ………………………………….

14. On the average, how much do you earn in a month from all your sources of income?

    …………………………………………….

For Crop Farmers Only

15. State how you acquired the plots, their sizes and the crops grown in the table below:

Table 3: Farm plots and crops grown

Plots	Mode of Acquisition	Size	*Type of Crops grown*
/ 1			
/ *2*			

16. How many years have you been farming? ………………….

For Fisher folk Only
Fishing Vessel Information:
17. What are the type, number and size of vessel you use in fishing? Who owns the vessel(s)? Provide this information in the table below.

Table 4: Fishing Vessel Ownership

Fishing Vessel	Number	State of ownership	*Size*

18. Do you specialize in catching a particular fish (e.g. crayfish, catfish, etc.)?
Please list.---

Objective 1: WEATHER INFORMATION SOURCES, THEIR AVAILABILITY, ACCESSIBILITY AND RESPONDENTS' PERCEPTION OF THEIR SOURCES

Climate information sources
19. Have you ever received any climate information (e.g. on rainfall, temperature, etc.)?
a. Yes b. No
20. If "yes", where do you get information from?
(i.)--
(ii) --
(iii) --
(iv)--
Availability of climate information
21. Do you know of any person/institution that gives information on weather?
a. Yes b. No
22. If "yes" to question 30, name these persons or institutions (include formal and informal institutions e.g. rain maker).
(i)... (ii)...
(iii)... (iv)...
23. What is the distance (in kilometres) to the nearest source of information centre from you?
----
24. How many minutes does it take you to get to the centre? ---------------------
25. Is the centre near enough for you to get information? Yes-------- No---------
26. What kind of climate information do you receive (e.g. information on rainfall, sunshine, windstorm, wind, cloud, temperature, sea level, etc.)? (Indicate in table 5 below).

Table 5. Climate Information Sources, type of information and frequency of supply

Source of information	Type of information	*Frequency (daily, weekly, monthly, yearly)*

27. Describe how readily available are climate information to you (use Table 6 below)

Table 6. Availability of Climate Information

Source of information	Information type	Readily availabl e	Seldom available	Not available

Accessibility of Climate Information Sources

How accessible are the climate information sources to you? How far is the source and how easy to understand are the information supplied? (indicate in Table 7)

Table 7. Accessibility of information Sources

Source of information	Location/distance from your home (e.g. 5 mins, 30 mins trek)	How often do you receive information(indicate either "weekly", "fortnightly", "monthly", "quarterly" or "yearly".	In what language is the information provided? (English language, Native Language, etc.)	How easy to understand are the information provided (indicate either "easy to understand" or "difficult"

28. How much does it cost to get information and what is the attitude of providers? (Indicate in Table 8)

Table 8. Cost of information & attitude of providers

Source of infor-mation	Payment requested ?		How much do you pay for informatio n?	How often payment requested ("every time informati on is requested", "monthly", "yearly"	Are you readily attended to when you need informatio n?		What other conditions are required to be fulfilled for informati on to be provided?	Are you satisfied with services provided?	
	Yes	No			Yes	No		Yes	No

29. How readily accessible is weather information to you? Indicate your view on accessibility of climate information to you in the table 9 below

Table 9. Accessibility of climate information sources

Type of information	Source	Readily accessible	Rarely accessible	*Not accessible*

Perception of climate information

30. Do you consider climate information you get adequate? a. Yes b. No
31. If yes, fill the table 9 below:
32. Which of these sources do you readily receive information from when you need it? List them in order of how readily they make information available to you.
    (i) ---
    (ii.) ---
    (iii) ---
    (iv) ---.
33. Indicate how regular the climate information you receive is in Table 10 below.

Table 10. Regularity of climate information

Source	Very regular	Regular	*Not regular*
(i)			
(ii)			
(iii)			
(iv)			
(v)			
(vi)			

34. How timely is the weather information you receive from your various sources? (Indicate in Table 11 below)

Table 11. Indicate how appropriate, timely, correct and adequate information provided are

Source of information	How correct is information provided? (indicate either always correct, sometimes correct or never correct)	Is the information provided on time? (Yes or No)	Are the information provided appropriate for your farming purpose?(“Yes ” or “No”	Is information provided adequate? (indicate “adequate” or “not adequate”

Objective 2: Awareness, knowledge level of Climate change and understating of Local Climate Forcing

35. Have you observed any change in weather in your community? a. Yes b. No
36. If "yes" in question 35, indicate in which of the following climate elements you observed these variations/changes (use table 12)
37. Indicate variations/changes in weather you observed in the periods indicated in Table 11 below.

Table 12

Weather/climate element	Variation observed 30 years ago	Variation observed 20 years ago	Variation observed 10 years ago	Variation observed now
Rainfall				
Temperature				
Relative humidity				
Sunshine hours				
Wind (speed & direction)				
Others (specify)				

Awareness of climate variability/change

38. (a) Have you ever heard of climate change/variability? a. Yes b. No
(b) If yes, what source(s) did you hear it from? (Tick as appropriate)
(i) Weather station (ii) Extension Agents (iii) Radio (iv) Television
(v) Other sources (list them):
(a)--------------------------------
(b) -------------------------------
(c) -------------------------------

39. Please respond to the following statements in Table 13 on your awareness of climate variability

Table 13. Awareness of climate variability

Statements	Aware	Not aware
There is change rainy period these days		
There is longer dry season these days		
There is stronger wind these days		

Knowledge Level of Climate variability

40. Please answer to the following questions. Climate variability is characterised by? (Indicate in Table 14)

Table 14: Characteristics of climate variability

S/N	Statements	Yes	*No*
1	Change in the onset of rain		
2	Change in duration of rainfall		
3	Change in pattern of rainfall		
4	Change in sea level		
5	Change in temperature		
6	Change in Hours of sunshine		
7	Change in sunshine intensity		
8	Change in season		
9	Appearance of new species of plants, trees & fish		
10	Disappearance of some species of plants, trees & fishes		
11	Flooding		
12	Drying up of streams		
13	Forest fire		
14	Deforestation		
15	Changes in wind pattern/speed		

Understanding of forcing of climate variability

41. Are there certain activities in your community which you consider responsible for variation in climate? Yes..... No........
42. Do you consider any of the under-listed the cause of climate variability?
(indicate in table 15 below)

Table 15. Local forcing of climate variability

S/N	Activity	*Response*	
		Yes	*No*
1	Gas flaring		
2	Deforestation		
3	Bush burning		
4	Fumes from automobiles		
5	Fumes from industries		
6	Increase use of generators		
7	Sand filling		
8	Continuous cropping		
9	Use of fuel wood		
10	Watershed destruction		
11	Change in land cover		

Objective 3: VULNERABILITY OF HOUSEHOLDS TO CLIMATE VARIABILITY

43. Indicate how important the following factors are in exposing your household to the impact climate variability. Rate these factors on a scale of 0 to 2 (0 indicating not important; 1 indicating important; 2 indicating very important) (Use table 16).

Table 16. Rating of impact of climate variability

S/N	Factor	Rating		
		Not important (0)	Important (1)	Very Important (2)
1	Non availability of irrigation			
2	Non availability of water for livestock			
3	Rainfall			
4	Drought			
5	Low agricultural output			
6	Lack of farm labour.			
7	Non availability of agricultural land			
8	Lack of food storage facilities.			
9	Lack of processing facilities			
10	Lack of mean of transportation & distribution			
11	Increased population			
12	Low income			
13	Conflict			

44. What is the distance from your house to the nearest:
    (a) Coast …… (b) Ravine ………… (c) Erosion site……………………
45. How many your household members depend on agriculture?---------------------
46. How many of your household members are hired agricultural labours?----------
47. What proportion of crop output is sold? (Example half, two thirds or none at all)………..
48. What proportion of the livestock you keep is sold? (½, ¾, all or none)……..
49. How many times have you been trained by Agricultural Extension Agents on improved agricultural techniques? …………………………….
50. List the improved agricultural techniques you are using now?
    (i) ....
    (ii) ....
    (iii) ....
51. Please supply information on land resource management by your household (Use table 17).

Table 17. Land Resource Management

Total farmland owned (ha)	Total cropped area (ha)	Total fallow area (ha)	How frequent do you have access to irrigation? (indicate “daily”, “weekly”, “fortnightly”, “monthly”, etc.)

52. What is the likelihood of the following occurring in your community? (Use Table 18)

Table 18. Likelihood of Occurrence of climate hazards

S/N	Events/ hazards	Not likely	Likely	Very likely	*Don't know*
i	Flooding				
ii	Sea Level rise				
iii	Drying of streams/ponds				
iv	Drought				
v	Outbreak of Livestock pest/disease				
vii	Outbreak of crops pest /disease				
viii	Outbreak of human (skin) disease				
ix	Windstorm				
x	Mudslide				
xii	Landslide				

53. How many times have the climate events/hazards listed in Table 19 occurred in your community in your lifetime?

Table 19. Occurrence of climate hazards

Hazards	No of times event occurred 30 years ago		No of times event occurred 20 years ago		No of times event occurred 10 years ago	
	No of times occurred	Damage caused (e.g. no of people killed, houses destroyed, etc.	No of times occurred	Damage caused (e.g. no of people killed, houses destroyed, etc.	Damage caused (e.g. no of people killed, houses destroyed, etc.	Damage caused (e.g. no of people killed, houses destroyed, etc.
Flooding						
Sea level rise						
Drying up of streams						
Drought						
Windstorm						
Mudslide						
Landslide						
Others (specify)						

54. Who among those listed here were more affected by the hazard? (Tick as appropriate)
   (a) men....., (b) women....., (c) both......... (d) children.........

55. Between men and women, who were more adversely affected during the hazards listed above?

----

56. In what ways were men affected? ---
57. In what ways were women most affected? ----------------------------------
58. Which of these climate events/hazards do you think will occur again in your community? (Indicate in table 20)

Table 20. Possibility of occurrence of hazards

S/N	Events/ hazards	Can Occur	*Cannot Occur*
i	Flooding		
ii	Sea Level rise		
iii	Drying of streams/ponds		
iv	Drought		
v	Outbreak of Livestock pest/disease		
vii	Outbreak of crops pest /disease		
viii	Outbreak of human (skin) disease		
ix	Windstorm		
x	Mudslide		
xi	Landslide		

59. Indicate as appropriate, changes in the characteristics climate elements in your community in the last 10years (use table 21)

Table 21. Variations in Rainfall characteristics

Rainfall				
Characteristic	Change observed			When change noticed?
Rainfall amount	Increase	Decrease	No Change	
Rainfall Intensity				
Rainfall Pattern				
Rainfall Duration				
Onset of rain				
Temperature				
Characteristics	Increase	Decrease	No change	When was change noticed
Duration				
Intensity				
Wind				
Characteristics	Increase	Decrease	No change	When was change noticed
Speed				
Pattern				
Relative Humidity				
Characteristics	Increase	Decrease	No change	When was change noticed
Sunshine				
Characteristics	Increase	Decrease	No change	When was change noticed
Duration				
Intensity				
Cloud Cover				
Characteristics	Increase	Decrease	No change	When was change noticed

60. Kindly Provide information on your household’s income and expenditure in the table 22 below

Table 22. Household income and debt profile

Income N/Month	Amount of debt owed	Amount of loan given out by household	Amount of savings	Remittance Received
Primary occupation				
Other Sources				

61. Which of these assets is owned by your household? (Indicate in table 23).

Table 23. Household Assets Profile

Asset	No	Year of Purchased
Building		
Motor-cycle		
Motor Vehicle		
Bicycle		
Boat		
Radio		
Television		

Health & Nutrition Expenditure

62. How much, on the average, does your household spend on the following in a month and what is the average monthly expenditure during disasters?

Table 24. Household Food Expenditure

Item	Monthly Expenditure	Average Expenditure during disaster	% of own produced food
Food			
(i) Carbohydrate Source (e.g. yam, cassava, etc.)			
(ii) Protein (e.g. meat, fish, eggs, etc.)			
(iii) Vitamins and Minerals(e.g. vegetables)			
(iv) Fat & Oil(e.g. groundnut & Palm oil)			
(v) Others			
(vi) Percentage of owned produced food by household			

63. How often did members of your household fall ill in the past one year and how much was spent on health care services? (Indicate in table 25 below)

Table 25. Household Health Expenditure Profile

Household members	Number who fell ill	Frequency of illness	Common illness (e.g. malaria)	Amount spent on treatment
Children (0-5 years)				
Children 6-15 years				
Members over 15 years				

64. What is the distance from your house to the nearest health centre or hospital (indicate in kilometres)?..............................
65. How often do members of your household visit the health care facility (indicate whether weekly, monthly, etc.)?..................................

Technical Capacity of Household.

66. Kindly provide on household technical capacity in the table 26 below.

Table 26. Technical Capacity of households

Household members	Science- based courses		Non Science-based courses		
No. of household members enrolled in tertiary institutions	Male	Female	Male	Female	Total
No. of graduates	Male	Female	Male	Female	Total
No. of household members with indigenous/traditional knowledge on climate change issues	Male	Female	Male	Female	Total

Infrastructure Information

67. Which of the following do you have in your community?
    - i.) Total number of roads----------------------
    - ii.) Total number of motor able roads---------------
    - iii.) Number of exits from community------------------------
    - iv.) Distance from your home to motor able road-----------------------
    - v.) Time to trek from your home to motorable road in minutes------

68. Which of these is available in your community?
    - i.) Portable water
    - ii.) Public Toilet Facilities
    - iii.) Other Public waste disposal facilities
    - iv.) Water storage facilities

69. What is the distance of the community from the coast (in kilometres)?.........

Institutions, Conflict and Social Capital Formation.

70. Indicate your residence status in your community? a. Migrant---------- b. Native---------
71. Are you a member of any social club? a. Yes b. No
72. If yes, list the social clubs you belong to:
    (i)---
    (ii)--
    (iii)--
73. Do you have easy access to and control of local resources? a. Yes b. No
74. Does any member of your household have access to local governance? (e.g. easy access to political leadership or participate in decision making, etc.)
    a. Yes b. No
75. Do you participate in any rural community development activities?
    a. Yes b. No
76. How many times in the last 5 years was there communal conflict in your community?

Dependency on agriculture

77. Kindly complete table 27 with relevant information

Table 27. Household dependency on agriculture

Item	Male	Female	Total
No. of household members that depend on agriculture (a) Children (b) Adult			
No. of household members as paid agricultural labour (a) Children (b) Adult			
Percentage of farm output sold			
Percentage of livestock sold (a) Monogastrics (b) Ruminants			

78. From the climate events that occurred in your community, indicate against each item estimated loss that your household may have incurred in agricultural production
   (i) Farmland (% increase in cost of production)-----------------------------------
   ii.) Yield failure (quantity or monetary value)-------------------------------------
   iii.) Cost of land augmentation (monetary value)-----------------------------------
   iv.) Additional cost of production (monetary value)-------------------------------
   v.) Reduction in cultivable land area (hectarage)
   vi.) Livestock destruction (number)
79. Has there been death of people during occurrences of climate related disasters?
   a. Yes b. No
80. If yes, how many people died and how many were injured?
   No dead ---------------No injured-----------------------------------
81. Kindly give estimated area of cultivable land affected-----------------------------
82. If building, household assets and equipment were destroyed, give an estimated cost of those things destroyed in the table 28 below:

Table 28. Destruction from climate variability

Item destroyed	Number	Estimated cost
Building		
Household property		
Other assets		
Boats/canoes		
Other fishing gears		

Objective 4: Household Coping & Adaptation to Climate Variability

83. What immediate measures have you taken before when climate event occurred (Indicate in Table 29)

Table 29. Climate event & coping measures taken

Climate Event	Coping action	How much did you spend in taking the action(naira)	Did your action take care of the problem? (“yes” or “no”)

84. Which of the following term measures does your household use to adapt to the problems associated with climate variation? Tick as appropriate (For Crop / Livestock Farmers Only)

(i)	Planting different varieties of crops	a). Yes	b.) No
(ii)	Adopting different planting dates	a.) Yes	b.) No
(iii)	Diversifying from farm to non-farm activities	a.) Yes	b.) No
(iv)	Changing from crop to livestock	a.) Yes	b.) No
(v)	Changing from livestock to crop	a.) Yes	b.) No
(vi)	Use of irrigation/ watering	a.) Yes	b.) No
(vii)	Change of soil conservation technique	a.) Yes	b.) No
(viii)	Terracing	a.) Yes	b.) No
(ix)	Drainage	a.) Yes	b.) No
(x)	Planting on mounds/ridges	a.) Yes	b.) No
(xi)	Increasing hectarage of land cultivated	a.) Yes	b.) No
(xii)	Use of short gestation crops	a.) Yes	b.) No

(xiii) Use of flood tolerant crop a.) Yes b.) No
(xiv) Use of drought tolerant crops a.) Yes b.) No
(xv) Use of disease/pest resistant varieties a) Yes b) No

85. Which of these measures are most effective in adapting to climate variability in your community? ---

For Fisher Folks Only

86. Which of these methods do you use to adapt to variation/changes in climate?
    i.) Changing from fishing to crop farming a.) Yes b.) No
    ii.) Changing from fishing to non-fishing/farming activities a.) Yes b.) No
    iii.) Use of bigger vessels a.) Yes b.) No
    iv.) Hunting for different type of fish a.) Yes b.) No
    v.) Changing from hunting from one type of fish to another a.) Yes b.) No
    vi.) Going further ashore a.) Yes b.) No
    vii.) Fishing along the beach/shore a.) Yes b.) No
    viii.) Relocating to a new or different fishing camp a.) Yes b.) No
    ix.) Changing fishing gears a.) Yes b.) No
87. List the measures take and the monetary cost of each measure (use Table 30)

Table 30. Adaptation measures & Cost

Adaptation measure	Amount spent on the measure	How effective is the measure (e.g. “very effective”, “effective”, “not effective”)

88. Which of these measures are most effective in adapting to climate variability in your community?-(List them in order of importance/effectiveness)--

Appendix C Research Team

1.	Dr. Gabriel S. Umoh	Team Leader
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3.	Dr. (Mrs.) Valerie-Aphie Solomon	Gender Specialist
4.	Mrs. Glory Edet	Secretary
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7.	Ms. Nkoyo Bassey	Assistant Data Analyst
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REPORT 2: ASSESSMENT OF IMPACTS, VULNERABILITY, ADAPTIVE CAPACITY AND ADAPTATION TO CLIMATE CHANGE IN THE NIGER DELTA REGION, NIGERIA

A Research Report by Rural Linkage Network (RULIN), Asaba, Delta State

ASSESSMENT OF IMPACTS, VULNERABILITY, ADAPTIVE CAPACITY AND ADAPTATION TO CLIMATE CHANGE IN THE NIGER DELTA REGION, NIGERIA

Research Report
Rural Linkage Network (RULIN)

JUNE 2011



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EXECUTIVE SUMMARY

The Niger delta region of Nigeria is the world's largest wetland, characterized by significant biological diversity. It represents about 12 % of Nigeria's surface area and has a population of approximately 28 million inhabitants (NDDC, 2006). The Niger delta region is made up of nine states which include Abia, Akwa Ibom, Bayelsa, Cross River, Delta, Edo, Imo, Ondo and Rivers States. The region is cut by a large number of rivers, rivulets, streams, canals and creeks. The coastal line is buffeted throughout the year by the tides of the Atlantic Ocean while the mainland is subject to regimes of flood by the various rivers, especially the River Niger. This portends a threat to lives and livelihoods in the coastal areas, made worse by rising sea levels.

The traditional economic activities of the communities are either land-based or water-based and include farming, fishing, collection and processing of palm fruits and forest resources (such as game and raffia) fishing, and trading. The economy of the Niger delta is based on the natural environment and the climate conditions. The natural process of flooding plays a significant role in the build-up and sustenance of the biota and soil improvement through silt nourishment. Communities in the region have developed adaptive and coping strategies over the years. Those cultural practices were found to be compatible with flood regimes and the associated fluvial processes. But with increased population pressure accompanied by urbanization, industrial development and agricultural expansion, the reduction of the sediment load of the major rivers in the region due to upstream dams not only impacts negatively on agriculture in the flood plains but also tends to exacerbate coastal and river bank erosion. As a result the subsisting equilibrium has been altered considerably leading to a situation in which flooding is impacting negatively on the land and livelihood of the people of the region. The result is an increase in the area of land that can no longer be cultivated because of annual floods and drainage problems. These further exacerbate the land pressure inherent in the area.

Also, vital to the sustainability of the Niger delta region is its rich biodiversity, an important resource base. This is threatened by number of factors. These include the degradation of the canals and associated habitat, which has brought about a loss in biodiversity. There are socio-economic threats, such as poverty, which result in over-exploitation of local biodiversity. Also, the occurrence of oil spills causes considerable destruction of local ecosystems. It is evident that the impacts of climate change will further exacerbate these pressures.

There is a dearth of information on the impact, vulnerability and adaptation options for the communities in the Niger delta. The need to generate data for evidence-based policy-making cannot be over-emphasised. The specific objectives for this study were:

- to analyse trends and evaluate the changes in major climate change-related hazards such as temperature, sunshine hours, rainfall, relative humidity and any seasonal changes to establish a priori evidence for existence of climate change in the Niger delta;
- to evaluate gender disaggregated impact of climate change hazards on the biodiversity resource base through local knowledge and perceptions of impact on forest resources, wildlife, plant species, fisheries, water resources and farm lands in the Niger delta communities;
- to evaluate vulnerability of livelihoods to climate change;
- to evaluate adaptive capacity or coping strategies for translation into development policy for the Niger delta region; and
- to identify adaptation options, through participatory processes, to ensure that all people (including poor and vulnerable groups such as women, displaced children, orphans and

vulnerable children, and physically challenged people) in the target communities will benefit from the adaptation process.

The methodology for the study included the use of the Sustainable Livelihood Framework (DFID, 2000) which uses a structured questionnaire survey and was combined with participatory rural appraisal exercises. Three states, Bayelsa, Delta and Rivers, which are described as the core Niger delta states, were intentionally selected. A total of 1630 community members participated in providing information for this research. Due to the crosscutting nature of the impacts of climate change, a multidisciplinary team of researchers were involved in the study, including both university researchers and development practitioners.

In compliance with the national policy on gender (MWASD, 2007), the selection process used gave equal opportunity for men and women to participate. Data collected on human characteristics, adaptation, vulnerability, biodiversity, impact of climate change were disaggregated by gender.

The most pervasive climate change hazards are increasing temperature, rainfall variability and flooding. In the Niger delta, using monthly average temperatures and rainfall data for 1976 to 2009, maximum temperatures in Warri rose by 0.0226^0C while in Port Harcourt they rose by 0.025^0C on the average per unit change in time. Rainfall rose on the average by 0.962mm and 0.498mm per unit change in time for Warri and Port Harcourt, respectively. In line with the IPCC (2007a) observations, precipitation levels are decreasing which corroborates the observations by people living in the Niger delta region. Observations show that changes are occurring in amount, intensity, frequency and type of precipitation. Flooding occurs due to the overflowing of the rivers in the region. IPCC (2007b) predicted that there will be increases in the occurrence of both floods and droughts, which is what is occurring in Oko-Amakom, by the bank of the River Niger. Other important hazards include coastal erosion and windstorms in Abari, sea level rise and sea surge.

The study revealed that the changes in the climate change hazards over the past 30 years have adversely affected agricultural productivity and aquatic life. Yield and output from crops, non-timber forest products, wild life resources, fish stock production in river and streams, and fishery production have declined, while soil erosion, river bank erosion, weed infestation, premature ripening of fruits due to scorching heat and drought events increased. These findings are consistent with IPCC predictions (IPCC, 2007b).

The level of exposure of various livelihood assets to the impacts of climate related hazards varied by asset type and by gender. The findings show that a majority of respondents observed a decline in their financial assets over the past 30 years, with the women being the most affected. Also, there have been changes in the various human capital and assets, such as death rates, the ownership of land, as well as changes in skilled labour and permanent and temporary migration. Lastly, the results show that although there has been an increase in the social capital over the years for both men and women, the increases were higher for men.

Climate change comes with a high price tag for the Niger delta, and the rest of the world. Nigeria will lose an estimate 10% to 30% of GDP by 2050 due to the impacts of climate change (DFID, 1999). Results showed that in the past 30 years, livelihood capitals valued at ₦ 484,892,225 (equivalent to over 3 million US dollars) were lost to climate change or related events in the Niger delta and women were found to be more vulnerable. This is not surprising as women depend to a great extent on collection of forest products, crop farming and fishing. Women depend on the rich bio-diversity of the Niger delta for food, spices, and medicinal plants.

An important result from this study is that gender is an important determinant of adaptive capacity. Gender was found to be a key factor relating to adaptive capacity in the use of wetlands for irrigation, use of weather forecasts and early warning systems, of resistant varieties, expansion of cultivated farmland and change from livestock to crop production. All of these adaptation options, with the exception of weather forecast, are land based and hence dependent on access to land. Women in the Niger delta have limited access to land. Therefore in developing adaptation options for Niger delta communities, gender must be mainstreamed into policy, programmes and budgets at local, state and national levels.

Considering the magnitude of impact of climate change on the Niger delta, adaptation to climate change impacts is expected to be very challenging. The results of this study identified constraints to adopting the various adaptation options identified. Fifteen of these constraints were rated as critical from the perception of the respondents. The most critical of the constraints was governments' lack of responsiveness to climate risk management. Other constraints include lack of access to credit facilities, limited income, the absence of government, lack of information on options, inadequate knowledge on how to respond or build resilience, limited availability of land for farming, limited access to weather forecast technology, poor information and absence of early warning systems, high cost of farmlands, poor access to information source, and limited availability and access to improved farm inputs such as improved cultivars, seeds, seedlings and insecticides.

The Niger delta region has had its share of negative impacts of climate change. This study has established that individual households and the entire communities are highly vulnerable to the impact of climate change. As indicated by farming activities and crop production, it is clear that food insecurity and a food crisis are imminent in the Niger delta communities.

Recommendations include the establishment of climate change information systems by the government, trees should be replanted by those who fell them, the development of a national policy on climate change to guide response to the evidence of impact of climate change is critical and more gender-disaggregated data on the different indicators of climate change is needed. There is therefore a need to setup, equip and finance research and development units in NIMET, Ministry of Environment, all other ministries (particularly the line ministries) and to support universities and research institutes to generate statistical information. Relevant and credible data are required enhance evidence based policy making. This is essential if Nigeria is to make any reasonable progress in response to climate change. Finally, the determinants of adaptive capacity must be targeted in budgeting and in programming and policy-making.

ACRONYMS AND ABBREVIATIONS

CDC	Community development committee
EU	European Union
FME	Federal Ministry of Environment
GDP	Gross Domestic Product
GHG	Greenhouse gases
HFCs	Hydro-fluoro Carbons
IPCC	Intergovernmental Panel on Climate Change
IPCC-CZMS	Intergovernmental Panel on Climate Change- Coastal Zones and Marine Systems
LGA	Local Government Area
MWASD	Ministry of Women Affairs and Social Development
nd	No date
NDDC	Niger delta Development Commission
NGO	Non-Governmental Organizations
NIMET	Nigeria meteorological agency
PHCN	Power Holding Company of Nigeria
PRA	Participatory Rural Appraisal
SLA	Sustainable Livelihoods Analysis
SLF	Sustainable Livelihoods Framework
SLR	Sea level rise

1. INTRODUCTION

Background of the Study

Nigeria's race towards environmental sustainability and the attainment of the Millennium Development Goals (MDGs) is likely to be stalled as Nigeria's rich environmental resource base is being undermined by deforestation (3.5% annually), erosion, floods, desertification, gas flaring and oil pollution. The destruction of natural resources to this extent coupled with climate change impacts on vulnerable communities of the Niger delta, provided the impetus for this study. The Niger delta region of Nigeria is unique in many ways. As the world's largest wetland it is characterized by significant biological diversity (NDDC, 2006). The region takes up about 12 % of Nigeria's surface area and has a population of approximately 28 million (NDDC, 2006) with a population density of 265 people per km^2, which is higher than the national average of 225 people per km^2. The Niger delta region is made up of nine states which include Abia, AkwaIbom, Bayelsa, Cross River, Delta, Edo, Imo, Ondo and Rivers States.

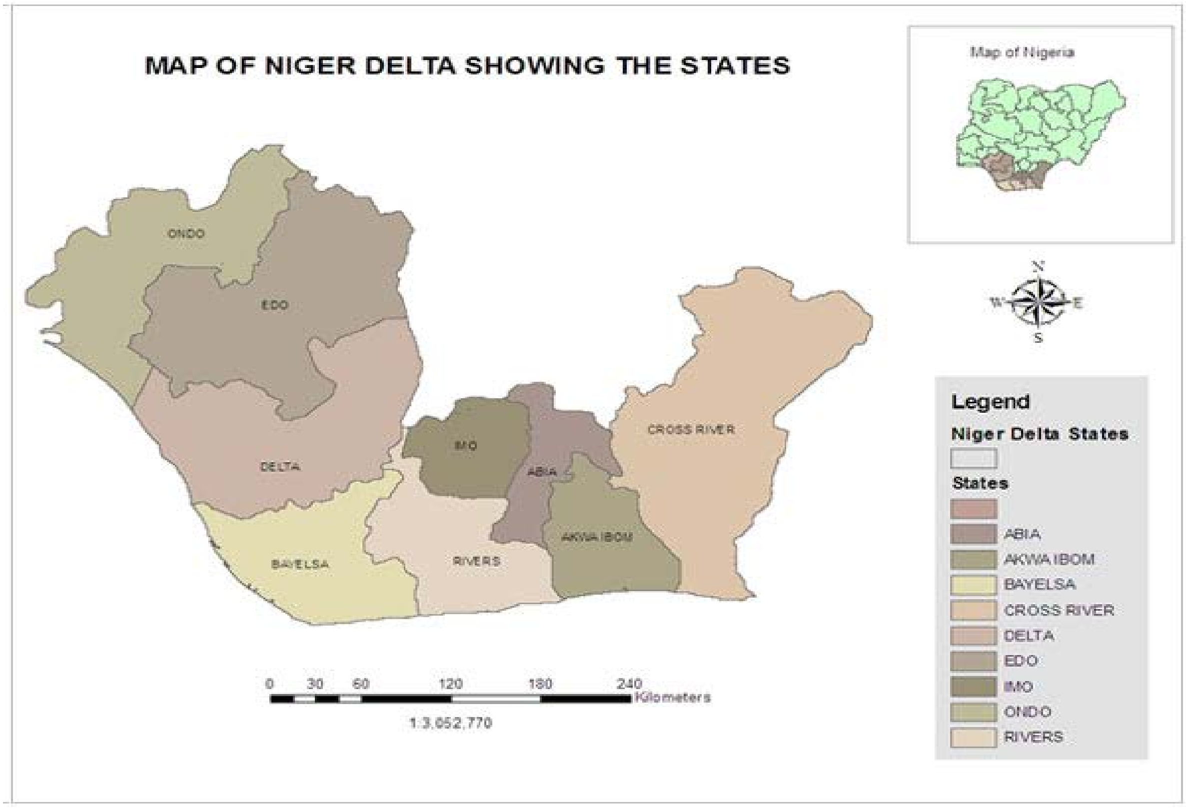

Figure 1. Map of Niger delta states

(Source: http://www.google.com.ng/search?q=niger delta maps. Accessed 13th October, 2010)

The Niger delta region is the bedrock of the Nigerian economy as the oil sector contributes as much as 40% to Gross Domestic Product (GDP), 95% of export and hence foreign exchange earnings and contributes as much as 83% to total government revenue (CBN, 2009). Despite this, the level of poverty, unemployment, intercommunity conflict, conflict over land, housing pressure, crime, depletion of biodiversity are very high in the region (Okoh and Egbon, 1999).

The region is characterized by a large number of rivers, rivulets, streams, canals and creeks. The coastal line is buffeted throughout the year by the tides of the Atlantic Ocean while the main land is subject to regimes of flood by the various rivers, especially the River Niger. This poses a threat to lives and livelihoods in the coastal areas, made worse by rising sea levels.

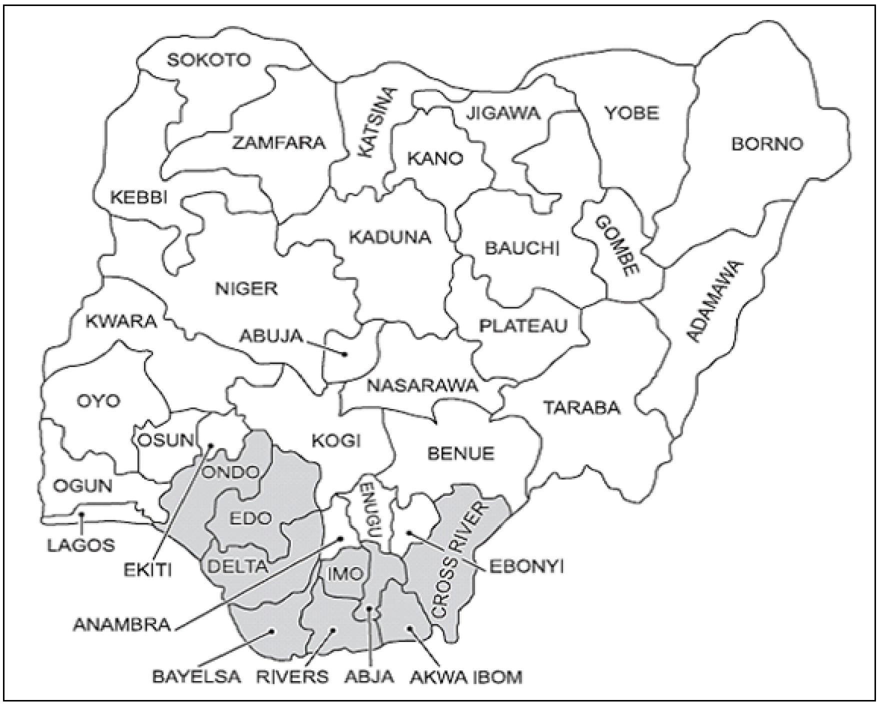

Figure 2. Map of Nigeria showing the Niger delta states

(Source: http://www.google.com.ng/search?q=niger delta maps, accessed 13th October, 2010)

The Niger delta region has five distinct ecological sub-zones: the mangrove forest coastal vegetation zone; fresh water swamp forest zone; lowland rain forest zone; derived savannah zone; and the montane zone. The climate of the Niger delta region varies from the hot equatorial in the southern lowlands to the humid tropical in the northern highlands and cool montane in the Obudu Plateau region of Cross River State. There are two distinct seasons: the wet season which lasts between seven to eight months from March to October; and the dry season, which begins in late November and extends to February or March. There is usually a rain-free period in August popularly known as the “August Break”. The region also experiences the harmattan season in December or early January as a result of the northeast trade winds which blow over the Sahara desert extending its dehydrating and cooling influence on Nigeria. The mean annual rainfall ranges from over 4,000 mm in the coastal towns of Bonny and Brass to 3000 mm in the mid-delta region, to slightly less than 2400 mm in Imo and Abia states. Maximum and minimum temperatures vary from 28°C to 33°C and 21°C to 23°C, respectively (NDDC, 2006).

The people of the Niger delta region have a very rich cultural heritage. The traditional economic activities of the communities include farming, fishing, collection and processing of palm fruits and forest resources (such as game and raffia palm) fishing, and trading. The economy of the Niger delta is based on natural resource use. Flooding plays a significant role in the build up and sustenance of the biota and soil improvement through silt nourishment. Communities in the region have developed adaptive and coping strategies over the years and certain cultural practices are compatible with flood regimes and the associated fluvial processes. However, with an increase in population pressure, urbanization, industrial development and agricultural expansion, more rivers have been dammed upstream. This has reduced the sediment load of the major rivers in the delta region which has had a negative impact on agriculture in the flood plains and also tends to exacerbate coastal and river bank erosion. As a result, flooding no longer replenishes the land but erodes it and affects the livelihoods of the people in the region. The result is an increase in the area of land that can no longer be cultivated because of annual floods and drainage problems. This further exacerbates the pressures on land in the area.

Also vital to the sustainability of the Niger delta region is its rich biodiversity resource base which is threatened by number of factors. Socio-economic issues, such as widespread poverty, play a major role, causing stress on the natural resource base from over-exploitation. In addition, frequent oil spills cause considerable threat to local biodiversity.

According to the Intergovernmental Panel on Climate Change (IPCC, 1995), sea level is projected to rise by 1m every100 years which will lead to flooding over 18,000 km^2 of land. Nigeria's low lying coastal areas, which include about 660 communities with population of 1.2 million, may become inundated. Millions of others will be displaced from flood erosion by a sea level rise of 1.0 m and livelihoods will be lost (IPCC, 1995). Other consequences may include adverse impacts on marine ecosystems such as mangrove swamp forests and lagoons.

The region is exposed to different types of flooding: channel overflow, back swamp and farmland flooding. Generally, as the flood recedes, soil erosion and riverbank collapse occur. Prolonged flooding occurs mostly as a natural phenomenon along the flood plains of the Niger delta. The disadvantage is that over 700,000 hectares of land are rendered useless due to annual floods in the Niger delta (NDDC, 2006).

The basic research questions included:

- What are the impacts of climate change in the region?
- What are the economic and social implications of the impact on the communities mainly affected by extreme flooding?
- What are the current adaptive strategies? How effective are they?
- What is needed to improve adaptive capacity?
- What benefits would adaptation strategies bring to the community-based economy of the Niger delta, in particular, to Bayelsa, Delta and River States?

These questions provided the rationale for this study.

Rationale for the Study

The Niger delta region is already experiencing some important climate change-related hazards such as increased temperature (including seasonal changes) more intensive and frequent storms, sea level rise, more heat waves, more flooding and extreme floods and more extreme rains including seasonal variability. These impacts affect both local biodiversity and the communities whose livelihoods depend on natural resources. There is a dearth of information on the impact, adaptive capacity and adaptation options for the communities in the Niger delta. This study is premised on the need to generate data for evidence-based policy making.

2. OBJECTIVES OF THE STUDY

The goal of the study was to assess the impacts, vulnerability, adaptive capacity and adaptation to climate change by communities in the Niger delta region of Nigeria.

The specific objectives were to:

1. Conduct a trend analysis to evaluate the changes in major climate variables such as temperature, rainfall and any seasonal changes to establish *a priori* evidence for existence of climate change in the Niger delta;
2. Evaluate impacts, disaggregated by gender, of climate change on biodiversity resources by drawing local knowledge and perceptions of impact on forest resources, wildlife, plant species, fisheries, water resources and farm lands in the Niger delta communities;
3. Evaluate impacts, disaggregated by gender, of climate change on livelihood assets;
4. Evaluate the determinants of adaptive capacity for translation into development policy for the Niger delta region; and
5. Identify adaptation options, through a participatory process, to ensure that all people, including poor and vulnerable groups (such as women, displaced children, orphans and vulnerable children, and physically-challenged people) within the Niger delta will also benefit from the adaptation process.

3. REVIEW OF THE LITERATURE

Climate is defined by the IPCC (2001) as the “average weather” over a period of time, generally 30 years. “Climate change” refers to a statistically significant variation in either the mean state of the climate or in its variability, persisting for an extended period (typically decades or longer). The United Nations Framework Convention on Climate Change (UNFCCC), in its Article 1, attributes climate change directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods (UNFCCC, 2006). Significant contributors to climate change are carbon emissions from human activities that occur largely in the transportation and industrial sectors. In Nigeria, gas flaring that occurs in the Niger delta as well as deforestation and the burning of large amounts of biomass are contributors to greenhouse gas emissions (GHGs). Studies by Abare (2004), Ubong (2002) and Okecha (2000) show that hazards resulting from gas flaring related activities contribute to climate change and other health and socio-economic problems. Gas flaring in the Niger delta is a major source of carbon and nitrous oxides. The accumulation of these gases in the atmosphere traps heat and this has become a major cause of global warming. Further, the cumulative heating and environmental impacts of the numerous flares going on within the Niger delta region will also contribute to health-related hazards like respiratory illnesses, kidney problems and mental dysfunction (Ndubisi & Asia, 2007). This is a threat to human capital that deserves serious attention.

GHGs cause increases in the earth's temperature by trapping heat from the sun and concentrating it in the lower atmosphere (Crosson, 1992). Examples of these gases are methane, carbon dioxide, carbon monoxide, water vapour, nitrous oxide, ozone, and chlorofluorocarbons. A report by the Intergovernmental Panel on Climate Change (IPCC, 1996), predicted that the concentration of GHGs equivalent to a doubling of carbon dioxide will force a rise in surface temperatures by 2.5°C by 2100. GHGs are generated by the following processes:

1. Carbon dioxide (CO_2) is generated by burning of gas and oil (fossil fuel combustion), land clearing for agriculture, cement production, etc.
2. Methane (CH_4) is generated by livestock, extraction of fossil fuels, rice cultivation, landfills and sewage.
3. Nitrous Oxide (N_2O) is generated by industrial processes and fertilizer use.
4. The gases containing hydro-fluorocarbons (HFCs) are generated by:

   - Leakage from refrigerators, aerosols, air conditioners;
   - Aluminium production, semi-conductor industry; and
   - Electrical insulation and magnesium smelting (McKeown and Gardner, 2009).

Steinfeld et al. (2006) reported that livestock are responsible for 18% of the world's GHG emission as measured in CO_2 equivalents. Livestock produces 65% of human-induced nitrous oxide, which has 296 times the global warming potential of CO_2 and 37% of human-induced methane, which has 23 times the global warming potential of CO_2 (Olowoyo *et al.* 2010). As outlined in the figure below, the share of GHG emissions by sector is as follows: energy supply (25.9%), industry (19.4%), forestry (17.4%), agriculture (13.5%), transport (13.1%), buildings (heating, cooling, etc 7.9%) (IPCC, 2007).

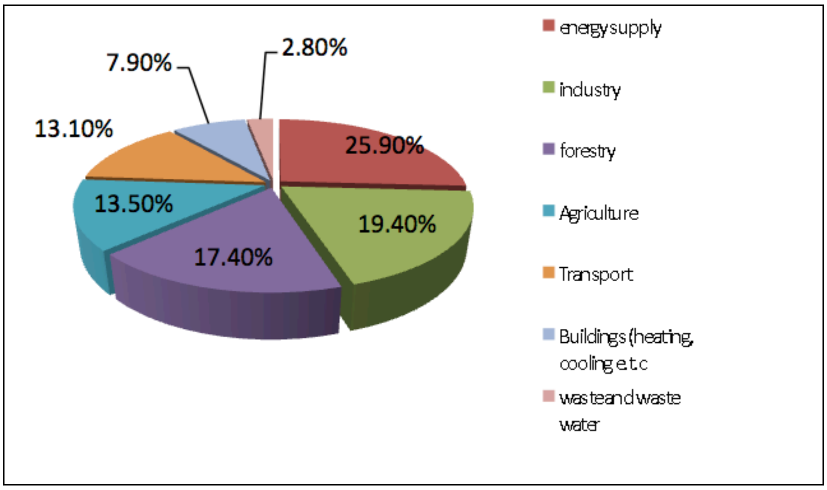

Figure 3. Percentage contributions to GHG's by sector

The European Union (EU) report on climate change (2008) showed that global warming followed the pattern predicted by earlier scholars. The report stated that the earth's temperature has undergone an annual increase of 0.6°C in the past 10 years as a result of the accumulation of GHGs. The report also showed that there is a need to understand climate change in specific regions of the world, even though it is a global problem. Although the warming effect has been significant and real, “its rate and intensity has always varied from year to year, decade to decade, region to region and from zone to zone”(EU, 2008).

Nigeria is highly vulnerable to the impacts of climate change. According to DIFD (2009), climate change impacts will be worse for vulnerable groups such as the poor, elderly, women, children and for those that depend on agriculture for their livelihoods, since they are less able to fend for themselves and are less able to adapt to changing circumstances. The communities in Nigeria identified to be most at-risk are those in the far north and those along the coastline.

Although the issue of climate change has drawn the attention of government and academia in Nigeria, a large proportion of citizens, especially in rural areas, are still unaware of what climate change is and its impacts. However, local people are accustomed to dealing with climatic variation and have developed strategies to cope and adapt. Ishaya & Abaje (2008) observed that in recent years there has been an increasing realization that indigenous groups are a valuable source of information on adaptation to environmental change. Indigenous peoples are not only keen observers of changes in their environment, including climate change, but are also actively trying to adapt to the changing conditions by drawing on already existing mechanisms for coping with short term adverse climatic conditions (Sotannde et al., 2010). It has also been noted that these responses may be traditional including their normal subsistence activities while others may be acute responses used only in case of critical weather conditions (Stott & Kettleborough, 2002).

Indicators of Climate Change

Detailed studies have been undertaken, particularly in the United Kingdom, to see how climate change is affecting humans, agriculture, vegetation, the ozone layer, hydrology, invertebrates, marine life, forests, birds, and the freshwater environment. The Department of the Environment, Transport and the Regions (DETR) have produced a set of indicators which can be used to monitor how the climate of the UK is changing. Data for many of these indicators are available in the UK and include:

- Air temperatures in central England
- Annual mean temperatures in UK since 1659
- Number of hot days per year (max above 20°C)
- Number of cold days per year (min below 0°C)
- Proportion of annual precipitation falling in winter
- Scotland annual precipitation
- SE England annual precipitation
- Predominance of westerly weather (Index of North Atlantic Oscillation)
- Dry and wet soil conditions in southern England (number of days per year that the soil moisture deficit at CEH Wallingford is above 60mm or below 10mm)
- River flows in SE and NW Britain as a percentage deviation from 1961-1990 average
- Risk of rivers drying up or flooding in NW and SE Britain
- Depth of groundwater in the chalk in SE Britain
- Sea level in East Anglia
- Risk of flooding in London
- Domestic property insurance claims
- Domestic gas sales
- Clothing and footwear retailing
- Domestic tourism

- The skiing industry in Scotland
- Number of outdoor fires
- Incidence of Lyme's disease in humans
- Seasonal patterns of human mortality (population and vital Statistics)
- Use of irrigation water for agriculture
- Potato and forage maize yields
- Vineyards - areas under production
- Vegetation indicators (park grass and tree leafing)
- Atmospheric ozone levels in summer in rural England
- Date of leaf emergence on trees in spring
- Forest health - proportion of beech trees with more than 25% reduction in crown density compared with an ideal beech tree
- Dates of insect appearance and activity
- Insect abundance
- Marine plankton abundance
- Upstream migration of salmon
- Birds - arrival date of the swallow
- Egg-laying dates of birds
- Bird populations

This list of indicators provides insight into areas of inquiry about climate change phenomena in the UK and could provide insights for Nigeria's response to climate change with a view to developing Nigeria specific indicators for understanding how livelihoods and biodiversity are being affected and how mitigation and adaptive capacities can be strengthened.

Impact of Climate Change in the Niger Delta Region

According to DIFD (2009), Nigeria's risks due to climate change are particularly high due to its low lying coastline that is highly populated and with a heavy concentration of GDP-generating industry and infrastructure. In addition, the arid Sahel in the north of the country is at risk of further desertification and drought. Flooding, water shortages, increased diseases and associated social disruption could well give rise to a vicious cycle of environmental and economic degradation and social conflict (DIFD, 2009).

A preliminary Integrated Assessment Model by DFID (2009) used IPCC predictions of climate change and the latest research findings on sea level rise, together with a consultation exercise in Nigeria to make domestic predictions. The model calculated that climate change could result in a loss in GDP between 6% and 30% by 2050, worth an estimated US$ 100 to 460 billion dollars. If no adaptation strategies are implemented by 2020, a further 2-11% of GDP could potentially be lost.

In addition to the health-related hazards of gas flaring in the Niger delta, another important impact of climate change is the reduction in crop yield. Rainfall variability and higher temperatures can reduce the yield of crops (Rozenweig & Hillel, 1995). There will be more uncertainty about in the onset of the farming season due to changes in rainfall characteristics (early rains may not be sustained, and crops planted at their instance may become affected by heat waves).

Settlements have already relocated further inland away from their original sites in response to sea incursion. Extreme climate conditions such as high winds and heavy rainfall, temperature changes, more tropical storms, floods, landslides, drought and sea-level rise are affecting coastal settlements. Pests and diseases are also implicated in climate change. Changes in conditions such as temperature, precipitation, sunshine and wind can affect and accelerate their dispersion and increase their numbers. For example, mosquitoes currently thrive in locations where there is standing water and poor drainage. In response to shifts in the patterns of rainfall and temperature, these conditions will increase along the coast and will enhance the breeding of mosquitoes and thus the spread of malaria (BNRCC, 2008). The Niger delta is prone to sea-water intrusion into coastal fresh water resources and consequently inland fisheries and aquaculture are negatively affected. There is a high frequency of coastal erosion and flooding as well as climate change-induced land degradation. Reduced flows in rivers and higher temperatures reduce the capabilities of thermal electric generation. Higher temperatures also reduce transmission capabilities. Hydropower generation will be affected by increased run-off. Excessive drought will lead to higher evapotranspiration, which adversely affects water volume, and will thus reduce hydroelectric capacity. Climate change-induced extreme weather events such as windstorms, floods and tornadoes (which can topple transmission towers and hundreds of kilometres of power lines) will exacerbate the rate of failure of transmission system of electric utilities.

There are gender considerations in assessing vulnerability and impacts of climate change. Collection of firewood under conditions of heat stress could impact more on the health of women and children who are involved in this activity than men. Changes in weather and climate have been known to influence water resources, a factor that increases the vulnerability of humans to infection and it is women who mainly care for the sick. Out-migration by men who are impacted by climate change will also affect women and children who remain in the communities and who are burdened with additional labour as a result.

In Nigeria, this means that some stable ecosystems such as the Sahel savanna may become vulnerable because warming will reinforce existing patterns of water scarcity and increasing the risk of drought in Nigeria and indeed most countries in West Africa. Also, the country’s aquatic ecosystems, wetlands and other habitats will create overwhelming problems for an already impoverished populace.

4. THEORETICAL AND ANALYTICAL FRAMEWORK

Theoretical Framework: Vulnerability and Adaptation

Vulnerability refers to the level of exposure to injury, damage or harm. The IPCC-CZMS (1992) defines vulnerability of coastal communities as the degree to which they are incapable of coping with the impact of climate change and accelerated sea level rise. The literature is replete with studies on vulnerability assessments but there is no concise and generally accepted definition of vulnerability, since the issue of vulnerability transcends biophysical, socio-economic, political and environmental boundaries. In an attempt to provide a comprehensive definition for vulnerability to climate change, Patwardhan (2006) provides a five-part definition which relates to the questions and objectives of a vulnerability assessment. In his view vulnerability may be defined as:

1. **The degree of exposure**: a measure of the possible hazards to human economic systems, such as the outcomes of future sea level changes.

2. **Degree of effects**: a measure of the physical impacts caused by hazards, such as changes in beach width or a shift in the flood-frequency statistics for a coastal location.
3. **The degree of loss**: a measure of the change in benefits from economic goods and services caused by climate change, in a 'do-nothing' situation.
4. **The degree of least loss**: a measure of the changes in benefits from economic goods and services caused by hazards, in a situation where the optional policy response is adapted.
5. **The opportunity cost of inaction**: the difference between the loss for a 'do-nothing' situation and a situation where the optional policy response is considered.

It is important to note that each successive definition of vulnerability in the list above includes the information and analysis requirements of the preceding definitions along with additional inputs. This first definition requires only the specification of climate change scenarios while the 2nd requires local information such as geomorphology and sediment budgets. The 3rd definition requires additional information about socio-economic characteristics such as the extent and value of property at risk from flood damage and population density, while the 4th and 5th definitions require the specification of policy options to respond to sea level change (Patwandhan, 2006).

Vulnerability could also be defined in the words of Cutter (1996), as a rhetorical warning of danger representing a potential for loss. This forms the basis for analysis of vulnerability in natural hazards, disasters, risk assessment and food security in relation to climate change research. A vital aspect of vulnerability is that it is spatially variable, reflecting local economic, social and cultural characteristics as well as local physical and environmental conditions. Accordingly, the World Bank (2002) has noted that "the linkages of climate change impacts to poverty are dynamic, often inter-connected and context-specific, reflecting geographic location, economic, social, and cultural characteristic prioritization and concerns of individuals, household and social groups, as well as institutional and political constraints".

In this respect, three broad characteristics of vulnerability to climate change and natural disasters and hazards have been identified. If combined, these will address the dynamics and integrated nature of social and environmental vulnerability. The first characteristic of vulnerability in terms of exposure to hazardous events (e.g. droughts, floods) gives an indication as to how this affects people and structures. In this respect, a physical event puts individual households and the community in danger. Thus the focus is to identify vulnerable places. The second characterization views vulnerability as a human relationship and not just a physical one, where vulnerability is socially constructed rather than determined by the occurrence of a physical event. Thus vulnerability is a function of social conditions and historical circumstances that put people at risk to a diverse range of climate-related, political, or economic stresses such as poverty (Dolan & Walker, 2004). The third characterization integrates both the physical events and the underlying characteristics of populations that lead to risk exposure and limited capacity of communities to respond. Vulnerability is thus the extent of exposure of the Niger delta communities to danger in both the biophysical environment and human environment (socio-economic, cultural, political susceptibility, resilience and degradation (Dolan & Walker, 2004; Sullvian & Huntingford, 2009).

It is clear that the assessment of climate vulnerability is complex and includes social, cultural and economic factors as well as the physical aspects of climate change. Thus, the information required for a full characterization of vulnerability as in the definitions and the characterizations are too much for developing countries to afford. Hence most studies concentrate on the two definitions provided above which are degree of exposure and degree of effects (Pawardhan, 2006). In this respect, community level perceptions of and experience with climate extremes in recent and historical records may be explored to allow examination of inherent characteristics that enable and/ or constrain a particular community to respond, recover and adapt.

Adaptive capacity helps to reduce vulnerability. Adaptive capacity is a reflection of resilience. Resilience is a measure of the capacity of the system to respond to and recover from impacts and shocks.

The indicators of adaptive capacity in socio-economic systems include (Dolan & Walker, 2004):

1. Efficient transmission of knowledge across space and time;
2. Diversification and sustainable intensification of resources;
3. Mobilization of social networks;
4. Mobility for relocation and access to resources; and
5. Decentralization of decision making.

The report of the Working Group II to the third Assessment Report of the IPCC (IPCC, 2001) identified the determinants of adaptive capacity to include (IPCC, 2001; Dolan & Walker, 2004):

1. Available technology options;
2. Available resources and their distribution;
3. Stock of human capacity including education and security;
4. Stock of social capacity including property rights;
5. Structure of critical institutions;
6. Ability of decision-makers to manage information and validate it; and
7. Public perception.

To effectively measure vulnerability, elements of the human-environmental system must be considered (Dolan & Walker, 2004). These elements are determinants of adaptive capacity within social systems that interact and co-evolve with changes in the physical environment. The adaptive capacity of coastal communities to cope with the effects of severe climate impacts declines if there is a lack of physical economic and institutional capacities to reduce climate-related risks (IPCC, 2007). Exposure of the coastal environment can be characterized by susceptibility (or sensitivity), resilience and resistance. This study combined physical and socio-economic characteristics and cost/value of losses to the physical environment due to climate related hazards, to reach conclusions about vulnerability of the individual households in line with Pawardhan (2006). In particular, households are determined to be vulnerable by the cost of impact of climate hazards in a ‘do-nothing’ scenario. The higher the cost, the more vulnerable is the household.

Adaptation to Climate Change

Adaptation has been defined by the IPCC (2001) as the adjustment in natural or human systems in response to actual or expected climate hazards or their effects. Stated differently, the assessment of adaptation strategies for climate change impacts refers to the identification and evaluation of possible options or changes in policies, practices and technologies as well as actual or expected climate hazards, or their actions designed to adapt to or take advantage of new opportunities that become possible as a result of climate change (FME, 2003). Adaptation is not new to human history as humans have always had to adapt to a certain degree of change in climate and the environment. There is now a new dimension to adaptation as the pace at which the climate is changing is faster and poses a greater challenge thus requiring much faster adaptation than before. Delaying action will certainly lead to increased costs and eventually greater risks to vulnerable communities. The choice of appropriate adaptation may be based on the following criteria identified by Tearfund (2009):

1. Effectiveness in building capacity of vulnerable people;
2. Effectiveness of the adaptation option in increasing resilience to climate changes and environmental degradation;
3. Cost effectiveness of the elected option;
4. Timeframe or speed of response to the threat or risk;
5. Number of people helped by the proposed action;
6. Environmentally sustainable in both long and short-term;
7. Extent to which it helps to prevent population displacement;
8. Compatibility with national adaptation objectives;
9. Culturally and socially compatible and acceptable;
10. Practicality of the option (whether it is achievable and if there is the availability of technical skills, resources and organizational capacity to deliver it); and
11. The extent to which the option can have an ongoing influence over policies, practices and attitudes of local communities, government officials and other stakeholders.

Analytical Framework

For this study, we were guided by the Binary Logit Model Analysis for the determinants ofadaptive capacity. Logit models are regression models in which the dependent or response variable is dichotomous in nature, using the values of 1 or 0. The dependent variable is of the type that elicits a yes or no response. The Logit regression is a univariate or multivariate which allows for estimating the probability that an event occurs or not, by predicting a binary dependent outcome from a set of independent variables. The Logistics distribution function is represented as follows:

$Pi = E(Y=1/Xi) = 1/ 1+ \exp [- (\beta + \beta Xi)] = 1 / 1 + \exp (- Zi)$

Where Pi = the probability that an event occurs or not.

Pi ranges between 0 and 1. It is non- linearly Zi (ie Xi)

Xi = Pi is not linearly related to Zi (ie X i)

$Zi = \beta + \beta_2 Xi$, Zi ranges from $-\infty$ to $+\infty$

B_1 = intercept

B_2 = estimates of the regression relationship

Pi is non-linear not only in X but also in the estimates / parameters ($\beta_1$and β_2).

Determinants of Adaptive Capacity

The variables that determine adaptive capacity are based on the question of whether the selected adaptation option was effective or not. The responses (binary form - yes or no) of the respondents were used as the dependent variable. This, in turn, determined the choice of options. The response is either yes or no which is dichotomous. This makes the Binary Logit Model analysis an appropriate tool for delineating the determinants of adaptive capacity. The literature review showed that a number of variables were identified by researchers in other regions of the world that are also affected by climate change or environmental degradation.

Vulnerability Assessment

This is a procedure used to analyze how impacts from climate change put communities at risk. To measure the level of vulnerability, the cost of climate change-related losses as recorded by respondents in a 'do-nothing' scenario were evaluated in line with the 'with/without' principle (Field & Field, 2009). Here, cost of physical and financial capitals were valued by their market value, while losses in human capital, natural capital and social capital that cannot be valued at market price were valued by a 'willingness to pay' principle (Field & Field, 2009). The higher the losses the more vulnerable they are. Since money has time value, monetary values change over time. To capture this in our analysis the Present Value (PV) of the losses incurred over 30 years were computed using the formula:

$$PV = \sum CV^{*}(1 + r) \qquad (1)$$

Where:
PV = is the Present Value of cost of losses to climate change-related hazards;
CV= Losses incurred in event of climate change-related hazards; costs and benefits were valued with the 'willingness to pay' approach (Field & Field, 2009). Respondents, however, did not report any financial or social benefits;
r = the opportunity cost of capital, (that is the market rate of interest =21% in this case); and
(1 + r)=1.21= is the compound factor that will bring the CV from the past to the present value.

5. STUDY AREA AND METHODOLOGY

Description of study area

The study was conducted in the three core Niger delta states: Delta, Bayelsa and Rivers. The biophysical, demographic and socio-economic characteristics of the states and communities are discussed in this section. The location of the states is shown in Figure 4.

Figure 4. Map showing the core Niger delta states
(Source: http://www.google.com.ng/search?q=niger delta maps, accessed 13th October, 2010)

Delta State

Delta state, located in the south geopolitical region of Nigeria, was created on the 27th of August 1991 out of the former Bendel state. Delta State was initially made up of twelve political divisions called Local Government Areas (LGAs), which later increased to 19 in 1996. Presently there are 25 LGAs in Delta State.

Geographically located within longitude 5° and 6.4°E and latitude 5°00 and 6.30N’, the state is bounded on the north by Edo State, on the east by Anambra State, on the south east by Bayelsa State and on the southwest by the Bight of Benin which covers approximately 160km of the state’s coastline. Southern parts of the state are crossed by numerous flat floored rivers that drain into the Atlantic Ocean. Generally low lying, with some hills can be found northwards within the LGA’s of Ika and Aniocha. The major rivers are the Niger, Ethiope, Warri, Kiagbodo **(**Aweto, 2002). Drainage is through the eastern flank by the Niger River via its several distributaries such as the Forcados, Escravos, and the Warri Rivers and creeks such as the Bomadi creek. Jamieson and Ethiope Rivers rise from the north and northeast respectively and y join to form the Benin River which eventually drains into the sea in the west (Online Nigeria, 2003). In the Niger delta structural basin, three major sedimentary cycles have occurred since the early Cretaceous. The subsurface stratigraphic units associated with the cycles are the Benin, Agbada and Akata formations, (Online Nigeria, as cited in Kogbe, 1976). Surface rock throughout the state consists of the Ogwashi Uku formation. Ogwashi-Asaba formation that lies north east consists of an alternation of lignite seams and clay. Benin formation is 1800m in depth and consists of loose and unconsolidated sands. There is little hydrocarbon associated with it, but the underlying Agbada formation is 3,000m deep and rich in hydrocarbons (Online Nigeria, 2003).

Delta State shares similar climatic features with other states in the Niger delta. The general climate is characterized by a long rainy season from March/April through October. There is an increase in precipitation from the north of the Niger delta which records an average of 2500mm to the coast where mean annual rainfall averages 4,000mm. Relative humidity rarely falls below 60%, fluctuating between 90% and 100% for most of the year (World Wildlife Fund, 2008).

The climate in Delta State shows latitudinal fluctuation in humidity ranging from the humid tropical in the south to the sub-humid in the north east. Decreasing humidity towards the north is accompanied by an increasingly distinct dry season. The climate is influenced by the prevailing air masses: the northeast trade wind that originates in the Sahara desert, ushering in the short dusty harmattan marking the dry season from December to February, followed by the warm, moisture-laden southwest monsoon winds which originate in the Atlantic Ocean, which marks the wet season. Intense but short thunderstorms accompanied by strong winds may blow off roofs and cause property damage. These storms usually mark the end of the rainy season (Aweto, 2002.). Temperatures are high, ranging from 28°C to 34°C. Average annual temperature is 30°C (Delta state Government, n.d.).

The vegetation of Delta State is floristically diverse and structurally complex (Aweto, 2002). Lowland tropical secondary rainforest and swamp forest vegetation are characteristic of the Niger delta. Lowland tropical rainforest refers to a forest which grows on flat lands at elevations generally less than 1,000m, characterised by more than five tier forest levels, with a diversity of fruiting trees (Butler, 2006). The region was a major source of timber with the most notable speces being *Antiaris toxicaria, Milicia (Chlorophora) excelsa, Ceiba pentandra* and *Piptadeniastrum africanum.* Other trees that feature in the rain forest include *Pentaclethra macrophylla, Chrysophyllum albidum and Irvingia gabonensis.* All the rainforest in Delta State has been destroyed as a result of commercial timber production, the establishment of small scale holdings of rubber trees and shifting cultivation. Presently, much of the countryside is dominated by secondary forest regrowth (Aweto, 2002). These areas are characterised (depending on the level of degradation) by a less developed canopy structure, smaller trees and lower biodiversity. Swamp forest is found at the coastal areas of the state. Characteristically, these areas are silt-rich, waterlogged in saline (brackish) waters, called estuaries. Evergreen shrubs and trees (mangroves) with breathing roots (pneumatophores) are the dominant species found in these areas (Butler, 2006).

The predominantly sandy soils are deeply weathered and nutrient-deficient, derived mainly from unconsolidated sediments of sandstone. The proportion of sand in the top 10cm of the soil may be up to 90%. Consequently, soils are loose and poorly aggregated as they contain very low levels of clay and organic matter (Aweto, 2002).

The main occupations in Delta State are farming, fishing, trading, lumbering, mining, palm wine tapping and manufacturing. The major manufacturing industries are concentrated in the major towns. Subsistence farming is the mainstay of the rural economy. There is a distinction between food crop and cash crop production. This distinction is somewhat arbitrary as the farmer occasionally sells crops usually categorized as food crops in order to obtain money to buy basic necessities that she or he does not produce. The main food crops grown in Delta State include cassava (*Manihot esculenta*), white guinea yam (*Dioscorea rotundata*), water yam (*Dioscorea alata*), plantain/banana (*Musa spp).* Rubber (*Hevea brasiliensis*) is grown purely to generate income.

Industries like glass production, chemical industries, paints and pharmaceuticals, ceramics, hotels and tourism are sources of revenue. Mineral resources are crude oil and natural gas, although there are deposits of clay locally utilized for pottery production. There are numerous oil fields in Delta state (e.g. Ughelli, Kokori, Kwale, Ebede, Otorugo, Ugborodo) which make a significant contribution to Nigeria's crude oil output. Crude oil exploration has impacted negatively on the people and rural economy of Delta State. Periodic spills have resulted in destruction of farmland, rubber plantations and aquatic biota, thereby undermining the rural economy and leaving the people unemployed and in poverty. There are numerous gas flare sites in Delta State where natural gas associated with crude oil is burnt off. The continuous burning of natural gas has not only destroyed the vegetation of such sites but has scared away wildlife and transformed nights into permanent daylight for the local people (Aweto, 2002).

The population of Delta State is 4,098,391 (2,074,306 males and 2,024,085 females), as per 2006 National Census (National Bureau of Statistics, 2009). The major tribes in the state are Ikas, Ibos, Urhobos, Izons, Isokos, Itsekiris. The cultural identity is manifested in their festivals and traditional marriage ceremonies.

The state has acquired a high level of infrastructure, such as inter-urban road networks, one state-owned university with three campuses, three polytechnics, three colleges of education, one federal college, 357 post primary schools and 1103 primary schools as of 2003, an international airport at Osubi, and one domestic airport at Warri (Delta State Government, ND).

For the research, the communities selected in Delta State were Abari, Oko-Amakom and Uzere communities. Abari is a riverine community in Ndokwa-East LGA of Delta State. The people are agrarian and farm along the River Niger making the community and its members highly vulnerable to impact of climate change, particularly sea level rise. Land ownership in the community is by individual male ownership. Female ownership is through land tenure by an inheritance system or purchase and non-indigenes also have purchase rights. The land is endowed with secondary forest resources and rivers which supports fishing activities. The population of Abari is estimated at over 5000 people, in a stratified ratio of children, youth and adults of 3:2:1 and gender ratio 1:1. There are approximately 200 households with an average of 7 persons per household.

Abari has suffered environmental impacts that can be attributed to climate change. This includes annual flooding with severe cases occurring at three-year intervals as well as river level rise, river bank erosion and landslides, which occurred in September 2008 and in April 2010. Recent damage includes:

- Loss of farmland because farming activities are mostly done along the river bank;
- Boats lost and buried;
- Houses, valuable market stalls, NDDC school projects were destroyed and projects were abandoned;
- Loss of community lands;
- Fog appearances due to temperature variation in the early morning hours occurs causing poor visibility leading to transportation accidents and deaths; and
- Occurrence of wind/high storms before the rains.

The community of Oko-Amakom is in the eastern region of Oshimili South LGA of Delta State. The population is estimated to be over ten thousand people in a stratified ratio of children, youth and adults 3:2:1 and a gender ratio of 1:1. There are approximately 800 households, with an average of 10 people per household. This community suffers from the increasing severity of flooding which occurs annually from late July to November from the overflowing River Niger. The inhabitants, who are mostly farmers, depend on natural flood plain irrigation, but now suffer heavy losses as the much needed flood irrigation has become a hazard to crops. The satellite image for Oko-Amakom is shown in Figure 5.

Figure 5. Satellite image of Oko-Amakom community

Source Google satellite imagery, 2010

Uzere community is an Isoko-speaking community in the northern region of Isoko South LGA. It's *lingua franca* is Isoko, pidgin and English. There is an estimated 20,000 people in this community, made up of women (30%), men (20%), and youth/children (50%). There are approximately 2,500 households, with an average of seven to eight people per household. Uzere is prone to various climate change-related events such as river bank overflow, flooding, erosion, thunder storms, periodic heat and winds. Flash floods have ravaged the community in recent times and made the Oko-Amakom community highly vulnerable to impacts of climate change.

Bayelsa State

On October 1, 1996, Rivers State became Bayelsa State. The name, Bayelsa, is an acronym of three former Local Government areas – Brass, Yenagoa and Sagbama. Bayelsa State borders with Delta State to the north, Rivers State to the east and the Atlantic Ocean to the west and south. Many communities are almost or completely surrounded by water, making them inaccessible by road (Nigeria Exchange, n.d.). The entire state is formed of abandoned beach ridges and due to many tributaries of the River Niger. The lower delta plain believed to have been formed during the Holocene of the quaternary period by the accumulation of sedimentary deposits. Sedimentary alluvium is the major geological characteristic of the state, (Online Nigeria, 2003).

Bayelsa State covers a total area of approximately 21,110 km^2 (Bayelsa State Government, 2011). More than three quarters of this area is covered by water, with a lowlands stretching from Ekeremor to Nembe. The area lies almost entirely below sea level with a maze of meandering creeks and mangrove swamps. The network of several creeks and rivers in the south, all flow into the Atlantic Ocean via the major rivers such as San Bartholomew, Brass, Nun, Ramos, Santa Barbara, St. Nicholas, Sangana, Fishtown, Ikebiri Creek, Middleton, Digatoro Creek, Pennington and Dobo, (Bayelsa State Union of Great Britain and Ireland, n.d.).

The climate is tropical. The quantity of rainfall in Bayelsa State varies from one area to another. The state experiences equatorial type of climate in the southern most part and tropical rain towards the northern parts. Rain occurs generally every month of the year often with heavy downpours. Precipitation in the state is high but this decreases from north to south. Akassa town in the state has the highest rainfall record in Nigeria. The amount of rainfall is adequate for all-year-round crop production (Online Nigeria, 2003).

Mean monthly temperature is in the range of 25°C to 31°C, with the average daily temperature of 30°C. Mean annual rainfall measures 2400 mm (Bayelsa State Government, 2011). Together with a relatively high relative humidity, these climatic conditions create a humid sub-equatorial climate, so the State lies within tropical mangrove swamp forest vegetation belt. The vegetation consists of abundant red and white *Rhizophora* spp. found near the coastlines. Further inland other tree species like the Iroko, Lagos mahogany, iron wood, African walnut, Opepe, Black Afara, Silk cotton tree and Melina tree are found.

Non-timber forest products (NTFPs) include bread fruit, ube, udara, kolanut, bitter kola, tawain, arigogo, groundnut, raffia palm, enge, aziza, alligator pepper (fesari) piassava, cane plant, indian bamboo, snail, crabs, edible worm, rabbit, snakes, antelope, periwinkle, crayfish, edible frog, cricket, giant snail, cricket, etc. These NTFPs constitute the rich biodiversity which supports the livelihood of the local people (Bayelsa State Union of Great Britain and Ireland, n.d).

Based on physiographic differences, several soil types have been identified in Bayelsa State including:

- the soils of the high-lying levees such as sandy loam, loamy sandy, and silt loamy soils as well as sands;
- the soils of the low-lying leaves e.g. the fine texture, red silty or clay loamy soils;
- the meander belt soils;
- the silted river belt soils e.g. peat for clay water bogged soils found mainly in the beds of dead creeks and streams;
- the basin soils e.g. silky clay loam or sandy loam which are inundated by water for most of the year; and
- the transition zone soils e.g. silt and sandy silt which are known to be under the daily influence of tidal floods and fresh waters.

The texture of the majority of the soils ranges from medium to fine grain (Online Nigeria, 2003).

Test results for Bayelsa soils (Omange et al. 1988), show that silts and clay fraction varies from 5% to 97% with majority falling within the range of 23% to 73%. The soils range from fine silts to coarse sandy clay soils.

Almost 97% of the communities in Bayelsa State are rural. A combination of physical and ecological characteristics has implications for the viability and sustainability of income generating activities and livelihood support systems. The communities are highly susceptible to climate change and the state ranks among the lowest in poverty indices.

Apart from having arable farmlands and rich biodiversity, Bayelsa State is a major oil and gas producing area, contributing over 30% of Nigeria's oil and gas production. There is a proposed network of associated gas pipelines from the Nembe creek oilfields to the LNG plant at Bonny. The major oil exploration and production companies operating in the state are

Shell, AGIP, and Chevron Texaco. The Kolo Creek gas turbine project owned by the Bayelsa State government supplies electricity to Yenogoa, the state capital, and surrounding towns and villages. Bayelsa State is presently the only state in Nigeria that provides electricity for itself without additional supply from the national grid. In addition to oil and gas, the state has large reserves of clay, sand and gravel of importance to the industrial sector (Bayelsa State Union of Great Britain and Ireland, 2003).

Bebelebiri community is an Izon (Alisa) speaking community. Other languages used are pidgin- English and English. The population is estimated to be about 3000, with women constituting 30%, men 20%, and youth/children 50%. There are approximately 100 households with an average of seven people per household. It is a riverside community made up of plank houses in a clustered pattern. Bebelebiri, like other communities, is prone to various climate change related events such as sea level rise, flooding, erosion and heat. The inhabitants have ranked flooding as a major environmental hazard facing them. The satellite image for Bebelebiri is shown in Plate 24 in Appendix A.

Ebedebiri is a community in Sagbama LGA, bounded in the north by River Forcados and Uduophori (Delta State), in the south by Bolu-Orua , in the west by Olu-Orua and in the east by Angiama. The population is estimated to be 2500, with the percentage of women being 25%, men 15%, and youth/children 60%. There are approximately 200 households with an average of 12 people per household. The major occupation is subsistence farming and fishing, with most of the indigenes living in other communities in a search for other livelihoods. This is also a riverside community made up plank houses in clustered pattern. The only means of transportation out of the community to other communities is by dugout canoes. The community has lost about 100m of land to the river due to flooding and erosion. The community members had migrated to their present location because of landslides into the river. If the trend of landslides continues, a second migration may soon occur and the present community may no longer exist. Land ownership is by community and individual male, female or non -indigenes who can afford land for domestic or commercial use. The soil has potential for agriculture and can also support livestock. The appearance of fog is no longer restricted to the harmattan period only. Now, there are big storms and strong winds before the rainy season and excessive heat can occur anytime. The satellite image for Ebedebiri is shown in Plate 26 in Appendix A.

Odi is a community in Kolokuma/Opokuma LGA and it is also an Izon (kolokuma) speaking community. In addition, pidgin English and English are spoken. The estimated population is 10,000 people: made up of 30% women, 20%, men and 50% youth/children. There are about 350 households with an average of seven people per household. There exist visible signs of flooding and gully erosion along the river bank signifying the occurrence of landslides along the river shore. During the time of visit, 50 % of the community land was covered with water. According to community representatives, devastation of this magnitude occurs every four years, with the result being seasonal migration, which definitely affects the socio-economic status of the community. The satellite image for Odi is shown in Plate 27 in Appendix A.

Rivers State

Rivers State was created on the 27th of May 1967 when the eastern region of Nigeria split, during the regime of General Yakubu Gowon (nigeriagalleria.com, n.d.). Named after the many rivers that border its territory, it was part of the Oil Rivers Protectorate from 1885 till 1893, when it became part of the Niger Coast Protectorate. In 1900, the region was merged with the chartered territories of the Royal Niger Company to form the colony of Southern Nigeria. Until 1996, the state contained the area which is now called Bayelsa State. Located by the geographical coordinates 4°45'N 6°50'E and 4.75°N 6.833°E, Rivers State covers a total area of 11,077km^2, bounded on the south by the Atlantic ocean, to the North by Imo, Abia and Anambra states, to the East by Akwa Ibom State and to the west by Delta and Bayelsa States. The state is home to a variety of ethnic groups including Abua, Andoni, Etche, Ibani, Ikwerre, Kalabari, Ogba/Egma/Ndoni, Okrika and Ogoni. The capital city is Port Harcourt (Rivers State Government, 2011).

The surface geology of Rivers State includes recently deposited sediments like clays, peat, silts sands and gravels transported by the Niger River tributaries and other rivers such as the Andoni, Bonny and New Calabar. The relief of Rivers Sate shows 3 main divisions: coastal sand ridges zone, the mangrove swamps found in Bonny, AkukuToru, Abualdual, Asari, Toru, Degema, Okrika, OguBolo, Andoni and Opobo LGAs, and the fresh water zone, 20m above sea level, extending northwards from the mangrove swamps. This lower Niger flood plain has a greater silt and clay foundation and is more susceptible to perennial inundation by river floods. The flood plain is a homo-clinal geomorphic structure whose trends westwards and southwards are broken in many places by small hogback ridges and shallow swamp basins (Online Nigeria, as cited in Aisuebeogun, 1995).

Fluvial marine sediments, mangrove swamp alluvial soils, and fresh water brown loams/sandy loams are the three major soil groups found in Rivers State. They are organic in nature and sandy in texture. The mangrove swamp alluvial soils are found in the northern part of the coastal sediments zone, brownish on the surface, sometimes with an unpleasant odour. The value of rich organic matter content of the top soil is reduced by the corresponding high salt content. Omange et al., (1988) shows that the soils of Rivers State are identical to samples from Bayelsa State as indicated by test results summarized as follows; silts and clay fraction varies from 5% to 97% with majority falling within the range of 23% to 73%. The soils range from fine silts to coarse sandy clay soils. The liquid limits vary (0-71) % with a mean value of 40%, plasticity index (0-39) % with a mean of 24%.

The climate can be described as a tropical monsoon with heavy, lengthy rainy seasons and brief dry seasons that commences in December and hardly extends beyond January. The harmattan, which influences many cities in West Africa, is less pronounced in Rivers State. The heaviest precipitation occurs during the month of September where there is on average approximately 370mm of rainfall. Temperatures are relatively constant throughout the year (Rivers State Government, RULIN BNRCC Report Final Jan 9 2012(1).docx 2011).

The vegetation types are divided between the upland area and the riverine area. The upland area originally occupied by rainforest has been drastically modified by human activities. Economic trees, particularly oil palm, have been preserved (Rivers State Government,2011). The riverine area is divisible into three main zones namely, the beach ridge zone, fresh water zone and the salt water zone. The beach ridge zone is vegetated mainly by fresh water swamp trees, palms and shrubs on the sandy ridges and mangroves in the intervening valleys or tidal flats. The saltwater zone is the tidal flat or swamps vegetated by the red stilt rooted mangrove (*Rhizophora racemosa*) and two other species of mangrove. The freshwater zone is mainly the Upper and Lower Delta floodplains of the Niger, where there are fresh water forest trees which are the edaphic variants of the rainforest. The Abura tree, oil palm, raffia palm, shrubs, lianas, ferns and floating grasses and reeds are the typical vegetation.

Due to its tropical climate, numerous rivers and arable land, the predominant occupation of the natives is agriculture especially fishing and farming. The presence of oil and gas has a major influence on commerce and industry. The state has other natural resources including clay, timber, and sand beaches. The capital city Port Harcourt is one of Nigeria's biggest commercial and industrial centres as it hosts the second busiest seaport in Nigeria. The state has a population of about 5 million people who have a rich cultural heritage (Sofiri , n.d.). The three communities of Ndoni, Rukpokwu and Rumu-Orosi were selected for the study in Rivers State.

Ndoni, located in Onne LGA, is an Igbo speaking community. The population is estimated to be 10,000 people (made up of female 60% and male 40%) in a secondary ratio of children, youth and adults 3:2:1. There are approximately 400 households, with an average of 10 persons per household. Environmental issues affecting the community are sea level rise, sea surge, flooding, excessive heat, landslides and erosion. The community in the past has experienced flooding that has covered 75% of the landscape. The satellite image for Ndoni is shown in Plate 25 in Appendix A.

Rukpokwu, located in Obiakpor LGA of Rivers State is bounded in the north by Igwuruta, Rumuodomaya in the south, Aluu in the west and Eneka in the east. It is located between latitude 004^o 08.187 North and 006^o 10 .251' East. The population is estimated to be about 8,500 people, with women comprising 30%, men 20% and youth/children 50%. There are an estimated 900 households with an average of 7 people per household. Over the years, the community has, experienced excessive rains, flooding, erosion, industrial hazards, drought (due to prolonged excessive heat) and pollution of water sources.

The community of Rumu-Orosi, also called Rumuigbo, is an Izon speaking community in Port-Harcourt LGA in Rivers State. It is located between latitude 03^0 02.127' North and 006^0 10.251' East. The population is estimated to be 12,000 people (female 60% and male 40%) in secondary ratio of children, youth and adults 3:2:1. There are approximately 900 households with an average of 10 persons per household. Rumu-Orosi is affected by various climate-related events such as flooding, excessive heat, wind and erosion. Migration of citizens occurs during serious flooding.

6. METHODOLOGY

Due to the crosscutting nature of the impacts of climate change, a multidisciplinary team of researchers was involved in the study. Researchers and development practitioners were engaged in the study. The project was implemented by a team of nine experts from Agricultural Economics, Climatology, Agricultural Extension, Agronomy, Soil and Environmental Chemistry, Nutritional Biochemistry, Fisheries, Forestry and Wildlife as well as development practitioners. To reduce the security risk (i.e. kidnapping and physical assault are quite high in the region), a non-governmental organization (NGO) or community-based organization (CBO) was selected from each rural community to make all the necessary entry arrangements for the research team. They also helped to facilitate the PRA exercises.

Sampling Technique

The three states, Bayelsa, Delta and Rivers, described as the core Niger delta states, were selected purposively. Respondents were selected by systematic sampling. This involved selection of alternate households, which is particularly suited for communities where exact population sizes are not known.

Gender mainstreaming

In compliance with the national policy on gender (MWASD, 2007) the selection process gave equal opportunity for men and women to participate. Data collected on human characteristics, adaptation, vulnerability, biodiversity, impact of climate change were disaggregated by gender and the focus group discussion were based on men and women groupings.

Table 1. Data type, collection, sources and method of analysis by objectives

Objectives	Type of data	Sources of Data	Data collection procedure	Method of Analysis
Objective 1: Trend analysis and evaluation of the changes in major climate variables such as temperature, rainfall, and any seasonal changes to establish *a priori* evidence for existence of climate change in the Niger delta	Monthly time series data were collected for 1971 to 2009 temperature and rainfall in Warri and Port Harcourt (time series data on temperature, etc. were not available for Yenogoa)	Monthly time series data 1971-2009 were collected from National Meteorology Agency (NIMET)	**Secondary Data:** Monthly Time series data for 1971-2009 for temperature and rainfall for a period of 30 years were collected	The trend analysis involved a simple regression analysis of the form: Yi = f(T) -----(1) Where Yi is the climate change related hazards, that is, temperature, or rainfall, T is the time in months and f is the notation for function.
Objective 2: Evaluate gender-disaggregated impact of climate change hazards on the biodiversity resource base through local knowledge and perceptions of impact on forest resources, wildlife, plant species, fisheries, water resources and farm lands in the Niger delta communities	Local knowledge and perceptions of land use, forest, livestock, wildlife, fisheries and water, resources, plant and animal diseases, plant species, as well as livelihood capitals for men and women in the Niger delta communities	Indigenous knowledge and perceptions of land use and conservation, forest, livestock, wildlife, fisheries and water resources, plant and animal diseases, plant species etc., were obtained from books, records of oil companies operating in the area	1.Participatory Rural Appraisal (PRA) 2.Structured questionnaire survey	Descriptive statistics, such as frequencies, percentages and presentation in tables, graphs charts etc., as applicable. Where expedient, colours were used to create effect and difference

Objectives	Type of data	Sources of Data	Data collection procedure	Method of Analysis
Objective 3: Evaluate impact of climate change on livelihood assets disaggregated by gender	Gender-disaggregated information on livelihoods, biodiversity and dependence on natural capital; and vulnerability to impact of storms, sea levels, sea surges, flooding	Both primary and secondary data were collected on livelihood assets that were impacted by climate hazards. The use of GPS to collect information on global position of the communities	1. PRA 2.Structured questionnaire survey 3. Sustainable Livelihood Analysis (SLA) made up of (Natural, Financial, Physical and Human capital)	Vulnerability score, descriptive statistics, such as frequencies, percentages and presentation in tables, graphs charts etc., as applicable
Objective 4: Evaluate the determinants of adaptive capacity for translation into development policy for the Niger delta region	Data on adaptation strategies, indicators of adaptive capacity and benefits/gains from adaptation strategy	Both primary and secondary data were collected. The primary data were collected by use of structured questionnaire survey, PRA and SLA	1. PRA 2.Structured questionnaire survey	Descriptive statistics, such as frequencies, percentages and presentations in tables, graphs charts etc as applicable. The use of Binary Logit model to identify the determinants of adaptive capacity
Objective 5: Identify adaptation options, through a participatory process, that will ensure that all people including poor and vulnerable groups such as women, displaced children, orphans and vulnerable children, and physically challenged people within the Niger delta will benefit from the adaptation process	Local knowledge, perceptions and preferences on adaptation options	The data were collected by use of structured questionnaire survey, PRA, and SLA	1. PRA 2.Structured questionnaire survey	percentages, averages, median, mode, range, etc.

Data Collection Procedures

Questionnaire Survey

Objective 2 to Objective 5: the multidisciplinary team of experts developed data collection instruments and collated and interpreted results for the various areas of specialization and objectives. One hundred respondents were randomly selected from communities adjacent to the three state capital cities and six rural communities with a history of flooding and/or any other climate change-related hazards. Respondents were selected by gender so there were 55 men and 55 women. A total of three states, nine communities, and 990 respondents were selected for the study. After removing the questionnaires that were not properly completed, 956 questionnaires were used for analysis.

Participatory Rural Appraisal (PRA)

Objective 2: to Objective 5**:** PRA exercises were facilitated by nine NGOs with close supervision by two team members in the selected communities. The PRA tools such as focus group discussions, transect walk, seasonal calendars, social maps, etc., were employed where necessary. The Agricultural Economists and Extension experts monitored the process. A total of 674 community members participated in the PRA exercises in the communities.

Sustainable Livelihood Analysis (SLA)

Objective 3**:** Based on the five types of sustainable livelihood capitals, five assets/capitals were identified as follows:
Climate vulnerability assessment is a complex exercise as it touches on social, cultural and economic factors which need to be combined with physical aspects of climate change. According to Sullivan & Huntingford (2009), many of the changing climate drivers of concern have a hydrological basis, including floods, drought, and tidal waves and humidity levels, the latter of which affect the incidence of disease vectors. Vulnerability assessment needs to be able to capture all of these variables. SLA was employed to identify the components of respondents' livelihood assets/capitals and their exposure and vulnerability to hazards related to climate change. SLA identifies ways to make communities sustainable and improve their ability to recover from the stresses and shocks that are experienced with climate change hazards.

SLA involves the use of a sustainable livelihood framework (SLF). The SLF is an analytical tool that presents the main factors affecting people's livelihoods, and typical relationships among them. The components of SLF include:

1. Vulnerability context
2. Livelihood assets
3. Policies, institutions and processes
4. Livelihoods strategies and outcomes

Vulnerability context

The vulnerability context frames the external environment in which peoples' livelihoods and the wider availability of assets are fundamentally affected, both positively and negatively by the trends and shocks of climate change, over which people have limited or no control (Song Ha Nguyen et al., 2006).

Livelihood assets

Assets are made up of different kinds of capital: natural, financial, physical, human and social.

Natural capital: Described as natural resources and stocks from which resource flows and services useful for livelihoods are derived. Examples include mangroves, forests, land, water, fauna, and flora. Within the SLF, the relationship between natural capital and the vulnerability context is particularly close. Many of the resources that livelihoods depend on are directly affected by climate change.

Natural capital for this study consists of land, water and biological resources such as trees, pasture, and biodiversity. The productivity of these resources may be degraded or improved by human management. This study considered the following natural capital: land resources, water resources, fish stock, crayfish, raffia palm, wild fruits-bush mango, spices, medicinal plants, edible worm, giant snails, timber, fuelwood and economic trees, such as *Alvingia gabonasis.*

Financial Capital: The medium of exchange critical to the successful utilization of the other factors/assets. The financial capital represents financial resources that people use for the achievement of their livelihood objectives. The main sources of financial capital are available stock and regular inflow of cash.

Financial capital for this study consists of stocks of money or other savings in liquid form. In this sense it does not include financial assets only but should also include easily disposable assets such as livestock, which in other senses may be considered as natural capital. It includes income levels, variability over time, and distribution within society of financial savings, access to credit, and debt levels. For this study the following financial assets were considered: income from natural resources, income from forest resources, income from crop production, income from livestock production, income from fisheries, level of savings and access to credit facilities.

Physical capital: Refers to human-made assets and other forms of physical or hard capital that make up the built environment. Physical capital comprises the basic infrastructure and producer goods needed to support livelihoods. Infrastructure is a public good that is used without direct payment, consisting of facilities that help people to meet their basic needs and to be more productive. Producer goods are also classified as physical capital.

Physical capital for this study **c**onsists of assets that are created by economic production. It includes infrastructure such as roads, irrigation works, electricity, reticulated equipment and housing. For this study physical capital considered included roads, electricity, infrastructure, buildings (residential, commercial, educational and communication installations).

*Human capital***:** This is perhaps the most important factor. Human capital represents the skills, knowledge, availability of labour and good health that together enable people to pursue different livelihood strategies and achieve their livelihood objectives. At the household level, human capital is a factor of the amount and quality of labour available and this varies according to household size, skill levels, leadership potential and health status.

Human capital for this study is the quantity and quality of labour available. At the household level, it is determined by household size, but also by education, skills and health of household members. For this study the following human capital was considered: death in the community, ownership of land, skilled labour, out-migration, in-migration, number of mud houses with thatched roofs, number of cement block houses with zinc, meat/fish/egg consumption, starch/yam/garri consumption, fruits and vegetables consumption, health of household members, skin diseases, respiratory problems and miscarriages.

Social Capital: The social resources upon which people draw in pursuit of their livelihood objectives. These are developed through formal and informal networks and connections and relationships of trust, reciprocity and exchange.

Social capital for this study refers to any assets such as rights or claims that are derived from being in a membership of a group. This includes the ability to call on friends or kin for help in times of need, support from trade or professional associations (e.g. farmers' associations) and political claims on chiefs or politicians to provide assistance as well as youth, men and women community committees. For this study, the social assets considered were community development organizations, role of community development organizations in decision making, membership of community development organizations, cooperatives and associations.

Policies, Institutions and Processes

These include ways in which human behaviour is influenced in relation to their use or access to livelihood assets. Some of these include laws and policies imposed by policy makers that are aimed at achieving behavioural change such as discouraging deforestation and encouraging reforestation and inculcating the culture of tree planting into children in primary and secondary schools.

Livelihood Strategies and Outcomes

Livelihood strategies involve development of long term action plans by communities to enable them to achieve their livelihood goals. The livelihood outcomes are the expected changes in livelihoods of people as a result of implementing the strategies.

Secondary Data

Objective 1**:** Monthly time series data were collected for temperature, relative humidity, sunshine hours and rainfall from 1971 to 2009 (a period of 39 years).

7. DATA ANALYSIS

Descriptive Characteristics Time Series Data

The trend analysis involved a simple regression analysis of the form:
Yi = f(T) -----(1)
Where Yi is the climate change related hazards, that is, temperature or rainfall, or rainfall, T is the time in months and f is the notation for function.

Binary Logit Model Analysis

Logit models are regression models in which the dependent or response variable is either 1 or 0. The dependent variable is of the type that elicits a yes or no response. The Logit regression is a univariate /multivariate which allows for estimating the probability that an event occurs or not, by predicting a binary dependent outcome from a set of independent variables. The Logistics distribution function is represented as follows:

Pi = E (Y=1/Xi) = 1/ 1+ exp [- (β + β Xi)] = 1 / 1 + exp (- Zi)
Where Pi = the probability that an event occurs or not.
Pi ranges between 0 and 1. It is non- linearly Zi (ie Xi)
Xi = Pi is not linearly related to Zi (ie X i)
Zi = β + β_2Xi, Zi ranges from -∞ to +∞
B_1 = intercept
B_2 = estimates of the regression relationship
Pi is non-linear not only in X but also in the estimates / parameters ($\beta_1$and β_2).

Determinants of Adaptive Capacity

To ascertain the variables that determine adaptive capacity, the question of whether the selected adaptation option was effective or not was asked and the responses of the respondents were used as the dependent variable. This in turn determined the choice of options. The response is either yes or no, which is dichotomous. This makes the Binary Logit Model analysis an appropriate tool for delineating the determinants of adaptive capacity. After a detailed literature review a number variables were seen to have been identified by researchers in other regions of the world that are affected by climate change or environmental degradation as determinants of adaptive capacity (IPCC, 2001; Dolan & Walker, 2004; Patwardhan, 2006). Variables were also identified during the PRA exercise conducted by RULIN team members, May to June, 2010.

Then (1-Pi) the probability of not being effective is (1-Pi) = 1/1 + exp (Zi)
Therefore Pi/ (1-Pi) = 1 + exp (Zi)/ 1 + exp (-Zi)
Pi/ (1-Pi) is the odds ratio in favour of the adaptation option being effective. Transforming the equation (4) in to natural log to obtain
Li = Ln [Pi/ (1-Pi)] = Zi = β1 + β2 Xi
The Li is the Logit it is linear in both variables and parameters and OLS procedures can be applied.
As P goes from 0 to 1, the Logit L goes from -∞ to + ∞ so while the probabilities lie between 0 and 1 the Logits are not so bound.
The Logit model specified for this study is
L = Ln [Pi/ (1-Pi)] = Zi

Where:
L = the odds ratio in favour of the effectiveness of a particular adaptation option.
Zi = is a vector of independent variables Xi
Xi is made up of the following variables:
X_1= Gender of respondents
X_2=Availability of technical skills, funds and other vital resources for the selected adaptation option.
X_3- Accessibility to selected option
X_4= culturally, socially compatible acceptability of the option
X_5=Practical feasibility
X_6=Speed of implementation
X_7=Age of participants
X_8= Years of farming experience
X_9=Income of the participants
Y= Effectiveness of the Adaptation option
LR=Likelihood ratio
LL=Log Likelihood

Model (6) was estimated for each adaptation option.

8. RESULTS AND DISCUSSION

Results for Objective 1

Trend analysis and evaluation of the changes in major climate variables such as temperature , rainfall, and any seasonal changes to establish *a priori* evidence for existence of climate change in the Niger delta.

Time series data were collected for Warri (maximum temperatures 1976 to 2009) and Port Harcourt for the period 1971 to 2009 for temperatures (minimum and maximum), for average rainfall and average temperatures for Warri and Port Harcourt.

The most pervasive of the hazards was associated with increasing temperature. Average global temperature was reported to have increased by 0.74°C between 1906 and 2005. In the Niger delta, using monthly average temperatures and rainfall data for 1976 to 2009, maximum temperatures in Warri rose by 0.0226^0C while in Port Harcourt they rose by 0.025^0C on average. Rainfall rose on average by 0.962mm and 0.498mm for Warri and Port Harcourt, respectively. The forecast values for rise in average temperatures for Warri and Port Harcourt by 2100 were 0.145^0C and 0.092^0C, respectively. The forecast changes in values for average rainfall for Warri and Port Harcourt by 2100 were -0.338mm and -4.328mm, respectively. In the presence of delayed onset of rainfall accompanied by excessive heat, crops were scorched in Oko-Amakom, Uzere, Bebelebiri and the other communities to a lesser degree. These findings are in agreement with the predictions of IPCC (2007b). Time series data were collected for Warri and Port-Harcourt as shown in Table 2.

Table 2. Time series data collected for Warri and Port Harcourt

Location	Data collected			
Warri	Average annual temperatures (1971-2009)	Average annual Maximum temperatures measurement (1976-2009)	Average annual Rainfall measurement (1976-2009)	Average annual Minimum temp.(1976-2009)
Port Harcourt	Average annual temperatures (1979-2009)	Average monthly Maximum temperatures (1976-2009)	Average annual rainfall measurement (1976-2009)	Average annual minimum temperatures for Port-Harcourt. (1976-2009)

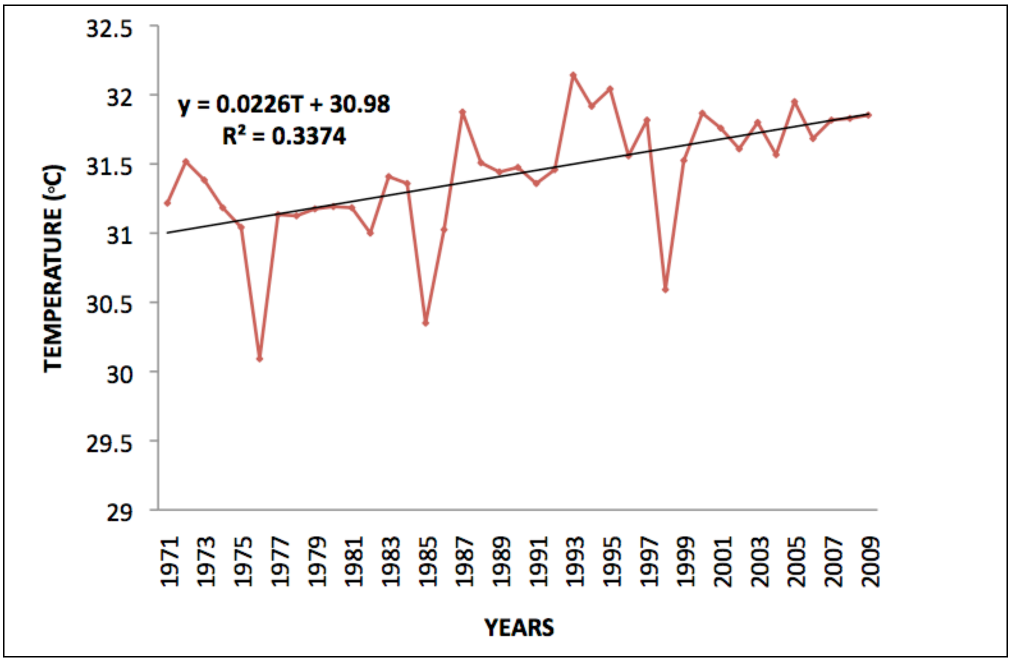

Figure 6: Average annual temperatures for Warri (1971-2009)

Trend Analysis

<u>Temperatures</u>

The trend line estimated for average annual maximum temperatures in Port Harcourt was:
y = 0.025T + 30.77 ……………………….. (1)
The trend line had a positive slope of 0.025 indicating that over the time period 1971 to 2009 mean temperature rose by 0.025 ^{o}C per unit change in time.
The trend line estimated for average annual minimum temperatures in Port Harcourt was:
y = 0.008T + 22.47……………………….(2)
The estimated slope was 0.008 indicating an increase by 0.008 ^{o}C per unit change in time.
The estimated trend line for average annual temperatures in Warri was:

$y = 0.0226T + 30.98$ ………………………… (3)
The trend line had a positive slope of 0.0226 indicating that over the time period 1971 to 2009 mean temperature rose by 0.0226 °C per unit change in time.

In all, temperatures have gone up over the 40 year period.

Figures 6, 7 and 8 show increasing trends for temperatures for Port Harcourt and Warri in line with IPCC predictions for temperatures in the coastal communities. Nigeria has not been left out of global warming and so will not be left out of the debilitating consequences of global climate changes.

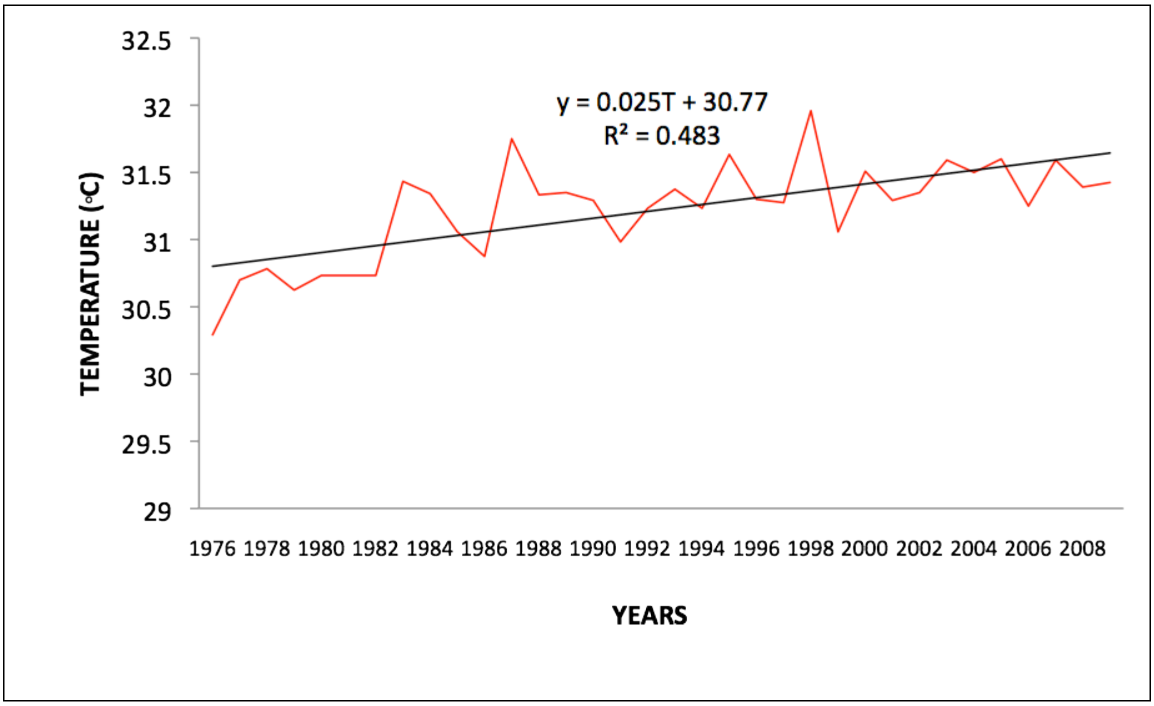

Figure 7. Average annual maximum temperatures for Port Harcourt

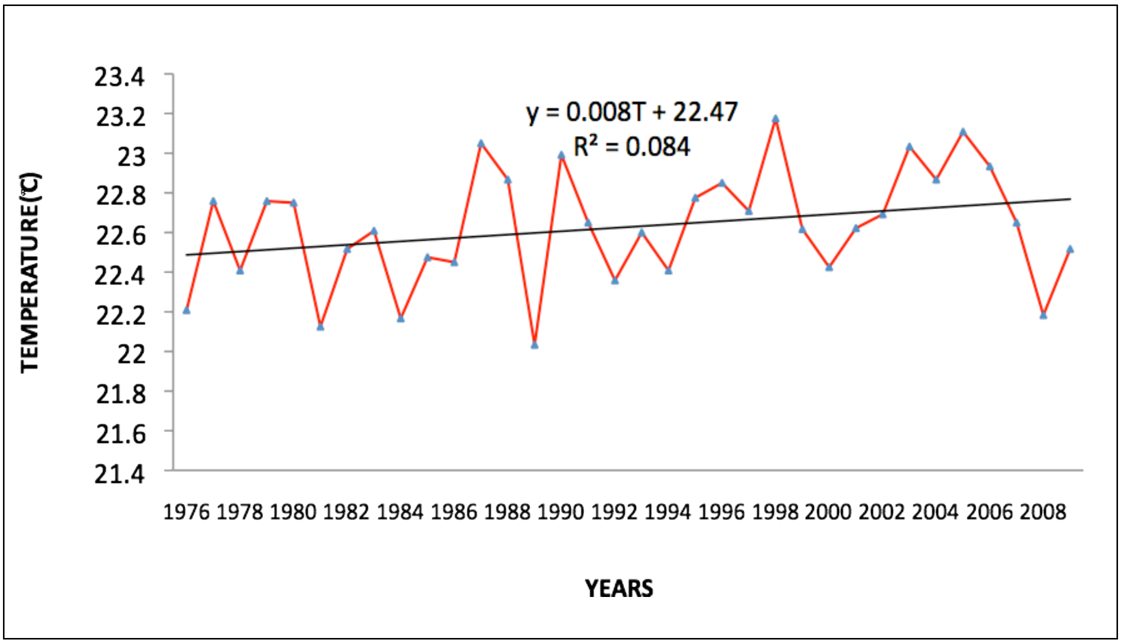

Figure 8. Average annual minimum temperature trends for Port Harcourt (1976-2009).

<u>Rainfall</u>

The trend line estimated for average annual minimum Rainfall in Port Harcourt was:
y = 0.498TR + 181.1……………………….. (4)
With a slope of 0.498, the estimated trend line is positive and the average annual rainfall increased by 0.498mm in the period 1976 to 2009 per unit change in time. The plot of the trend values is shown in Figure 9.

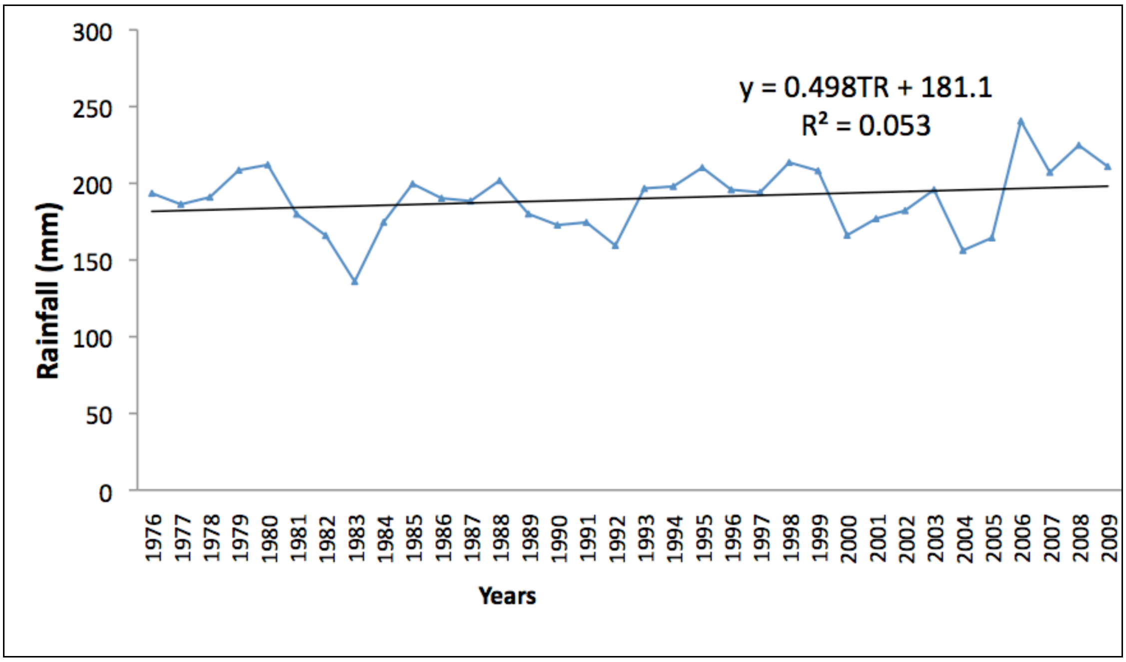

Figure 9. Average annual rainfall for Port-Harcourt (1976-2008)

Figures 10 and 11 show the seasonal rainfall patterns for Port-Harcourt and Warri. In both locations, rainfall in January showed an increasing trend, while for February and March rainfall showed a declining trend over the period 1976 to 2009.

The estimated trend line for the average annual volume of early rains for Port Harcourt in January, February and March were:

y = 0.3025x + 16.657……………………January...PH….. (5)
y = -0.947x + 73.064……………………February...PH….. (6)
y = -1.1834x + 127.52……………………March… PH...(7)
y = 0.2219x + 17.413…………………….. January…Warri... (8)
y = -1.2044x + 69.128 …………………….. February …Warri... (9)
y = 0.2448x + 127.82…………………….. March …Warri… (10)

The slopes of the trend lines for Port Harcourt indicate that rainfall increased in January by 0.3025mm, declined by 0.947mm in February and by 1.1834mm in March for every unit change in time. For Warri, the slopes of the trend lines were 0.2219mm for January, -1.2044mm for February and 0.2448mm for march per unit change in time (one year).

These findings support the respondents' perceptions of increasing early rains and declining early rains. For the Niger delta communities, the rainy season commences in the month of April every year. Depending on the respondents' perception, early rains could be rain in the month of January, February or March. The slope of the trend lines in Figure 10 depicts an increase in rainfall in the month of January 1976 to 2009 in Port Harcourt. Rain in the month of February 1976 to 2009, which is also early rain, depicts a downward sloping trendline while March 1976 to 2009, also considered as early rain, showed a downward sloping trend line. Hence, early rains are shown to be both increasing and decreasing. This evidence has helped to resolve the seemingly complex riddle of respondents' reports of increasing early rains (66%) and decreasing early rains (61%) which also corroborate the predictions of IPCC (2007b) for coastal and island communities.

The situation is similar to rainfall patterns reported in Warri, where rainfall in January and March had a positive slope while February had negative slope, shown in Figure 10.

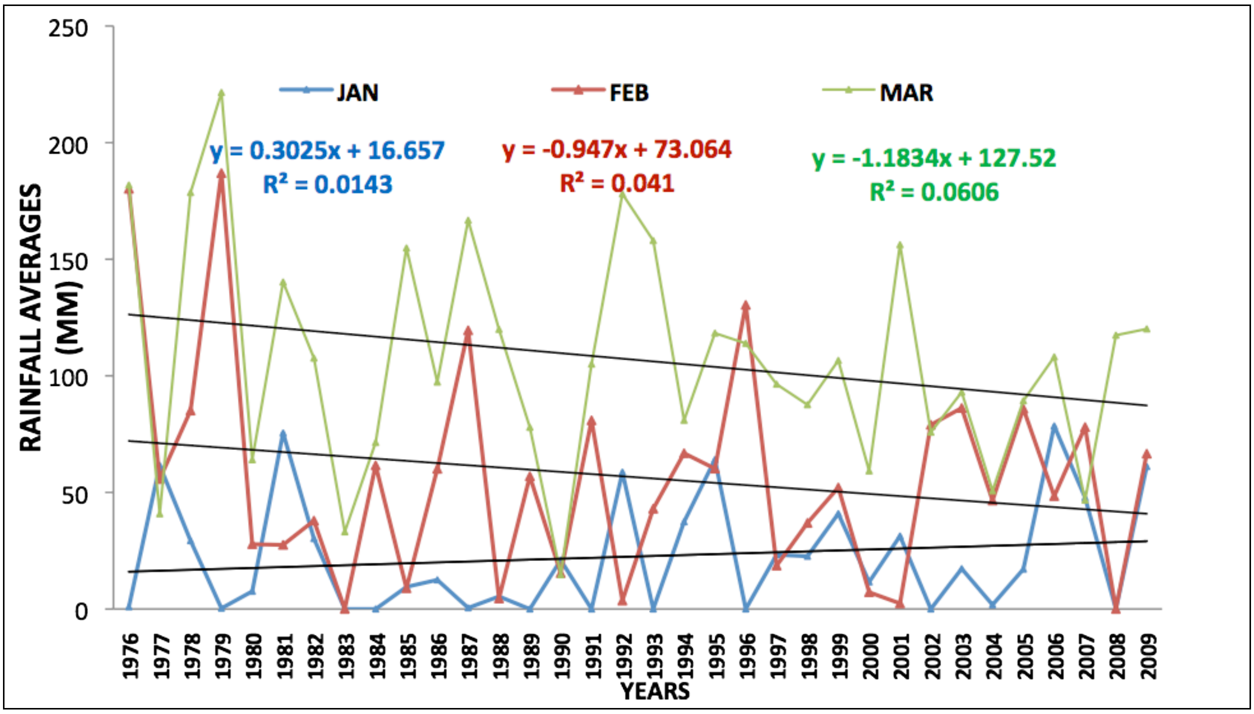

Figure 10. Seasonal analysis for early rainfall pattern for Port Harcourt

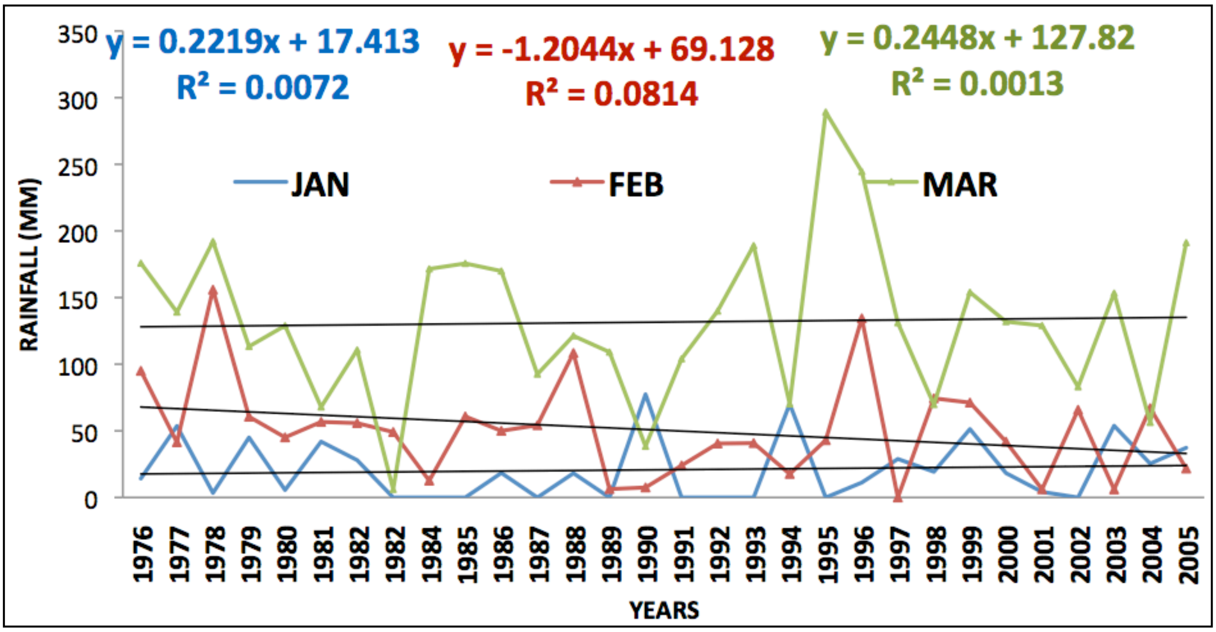

Figure 11: Seasonal analysis for early rainfall pattern in Warri

The slopes of the trend lines for Port Harcourt indicate that rainfall increased in June and July by 0.9231mm and 4.957mm, respectively.

y = 0.9231TR + 273.95……………………….June…PH………………(11)
y = 4.957TR + 269.8……………………….July…PH………………(12)
y = 4.957TR + 269.8……………………….July….Warri…………..(13

Figures 12 and 13 show increasing rainfall in the peak months of June and July in Port Harcourt over the past 30 years, while Figures 14 and 15 show increasing precipitation rates in the peak months of July and September respectively over the past 30 years in Warri. On the other hand, results show that soil erosion, river bank erosion, weed infestation on farms, pest infestations, disease infestation, premature ripening of fruits due to scorching heat and drought events have also been observed to be on the increase. Flooding has also increased even when the aggregate level of rainfall is on the decline. Rainfall intensity, water levels of rivers and streams have increased and have in recent times overflowed their banks into the communities leading to flooding of farm lands, homes, commercial premises and washing away of transport infrastructure, such as roads and bridges. Mendelson et al. (2006) showed that rainfall has declined for 11 African countries. This supports the findings of this study.

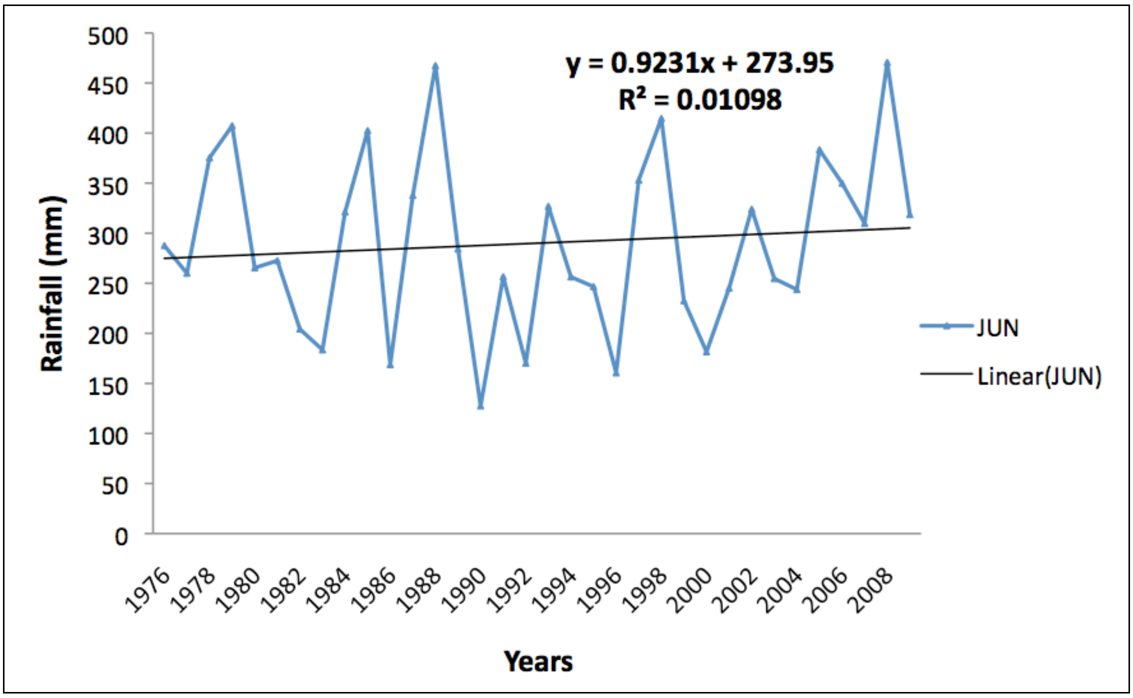

Figure 12. Trend of rainfall in Port Harcourt for the month of June

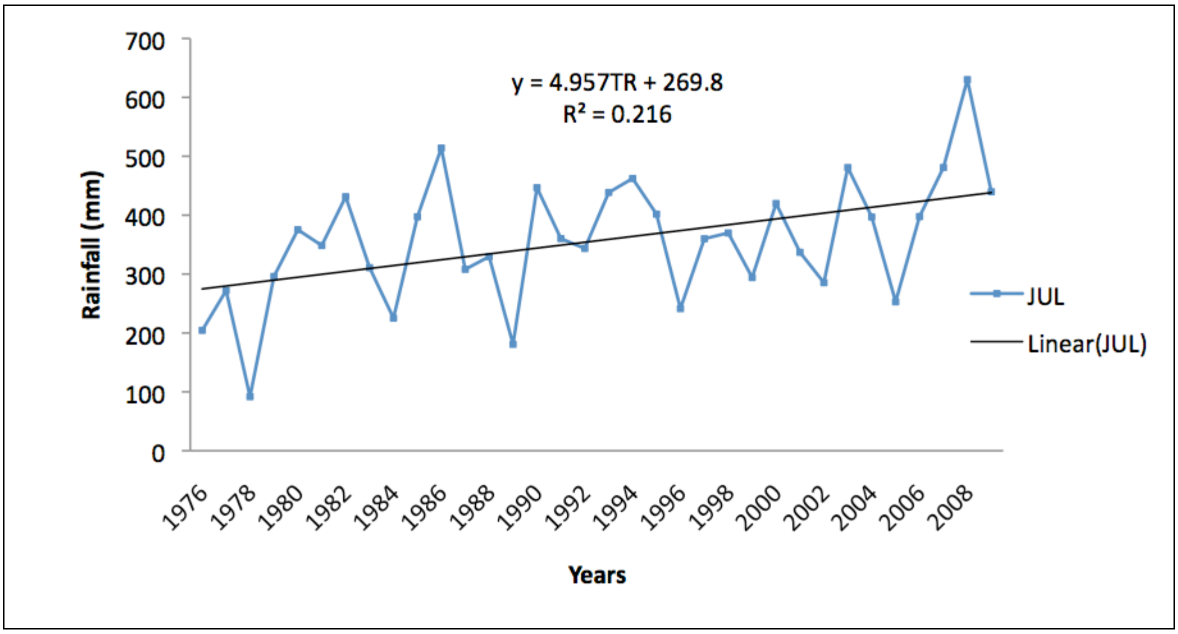

Figure 13. Rainfall trend in Port Harcourt for the month of July

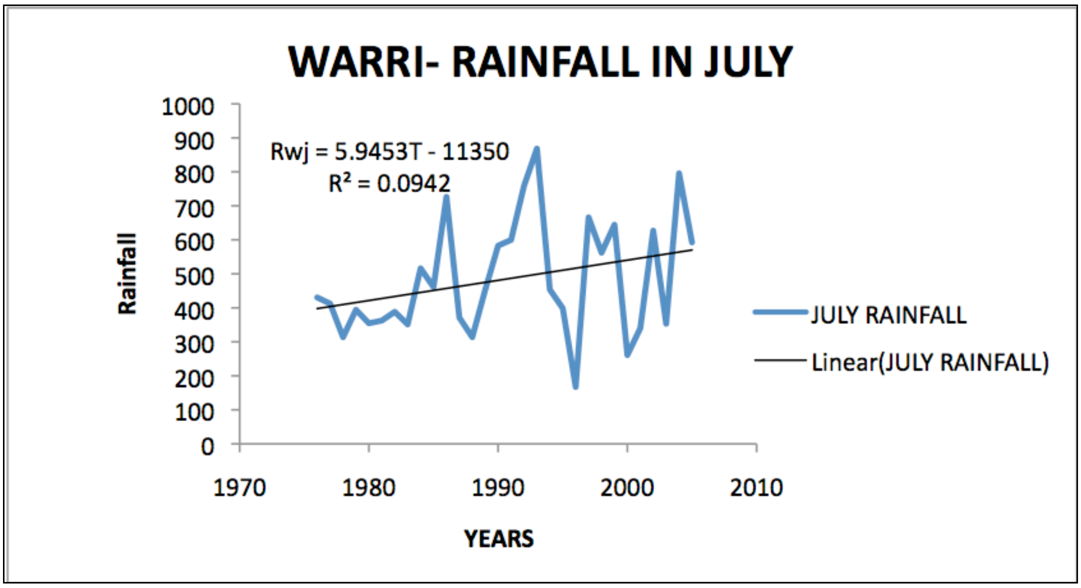

Figure 14. Rainfall trend for the month of July in Warri

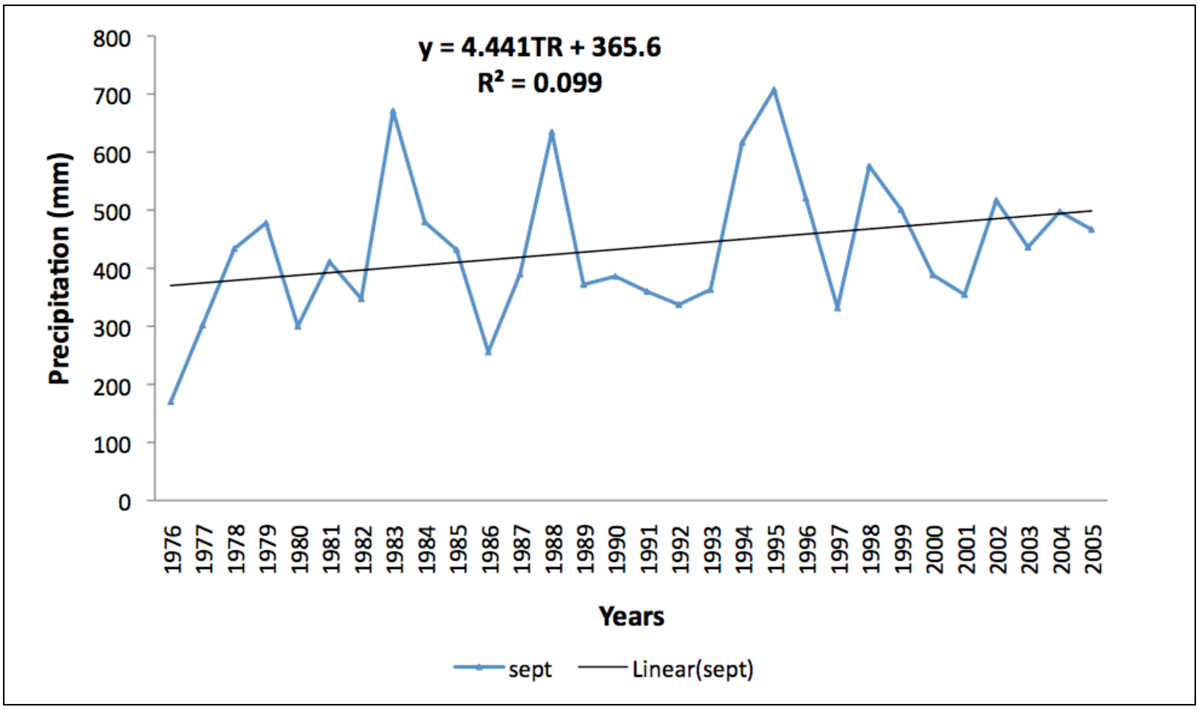

Figure 15. Average annual Rainfall trend for the month of September in Warri

Plant growth cycles and duration are related to temperature. Increasing temperatures will, in some cases, speed up crop development. With annual crops, the time between sowing and harvesting will shorten. This could impose adverse effects on productivity as senescence will occur sooner.

Results for Objective 2

Objective 2 is to evaluate the gender-disaggregated impact of climate change hazards on the biodiversity resource base through local knowledge and perceptions of impact on forest resources, wildlife, plant species, fisheries, water resources and farm lands in the Niger delta communities;

Socio-Economic and Biophysical Characteristics of the Study Area

Information used for this objective was collected by both structured questionnaire survey and PRA exercise. A total of 956 questionnaires were found useful for analysis and reaching conclusions. The respondents were distributed by gender of men: women in the ratio of 57:43. The number of respondents is high enough to eliminate bias and ensure a robust output and reliable conclusions. Table 3 shows the distribution of respondents by gender, state and community.

Table 3. Distribution of the respondents for questionnare survey by gender

States/Community	Men	%	Women	%	Total	%
A. Bayelsa State	32					
• Bebelebiri	68	68	32	32	100	100
• Ebedebiri	66	66	34	34	100	100
• Odi	55	51	52	49	107	100
Sub-total	189	62	118	38	307	100
B. Delta State						
• Abari	64	57	49	43	113	100
• Oko-Amakom	66	65	36	35.3	102	100
• Uzere	60	57	46	43	106	100
Sub-total	190	60	131	40	321	100
C. Rivers State						
• Rumuigbo	71	71	29	29	100	100
• Rukpokwu	58	48	62	52	120	100
• Ndoni	42	39	66	61.6	108	100
Sub-total	171	53	157	47	328	100
Grand total	550	58	406	43	**956**	100

The PRA exercise was conducted in nine communities and a total of 674 participated. Of these 322 men and 352 women participated. Table 4 shows the distribution of respondents by gender, state and community. A total of 1630 community members participated in providing information for this research work.

Table 4. Distributions of participants at the PRA by gender

State/Community	Men	Women	Total
Bayelsa			
- Bebelebiri	30	29	59
- Ebedebiri	64	33	97
- Odi	8	27	35
Sub-total	**102**	**89**	**191**
Delta			
- Abari	21	30	51
- Uzere	18	20	38
- Oko-Amakom	41	21	62
Sub-total	**80**	**71**	**151**
Rivers			
- Rukpokwu	20	7	27
- Ndoni	90	168	258
- Rumu-Orisi	30	17	47
Sub-total	**140**	**192**	**332**
Grand Total	**322**	**352**	**674**

Source: RULIN Survey, 2010

Age Distribution of Respondents

The results show that 77.8% of men and 89% of women with an average of 78% of all the respondents were over 40 years old and so were well positioned to recall notable changes in climatic conditions in the past 30yrs. The age distribution of respondents is shown in Table 5.

Table 5. Distribution of respondents by age

Age group(years)	% Men	% Women	Pooled Data
20-30	3.8	7.2	5.4
31-40	17.4	19.7	16.6
41-50	35.0	44.6	39.9
51-60	24.9	40.2	23.4
61-70	11.4	3.5	8.2
71-80	7.3	4.5	6.3
81-90	0.2	0.2	0.2
Total	100	100	100

Source: RULIN Survey, 2010

Distribution of Respondents by Farming Experience

The information in Table 6 shows that 77.3 % of respondents had farming experience of at least 11 years. This is important to ensure that all respondents will recognize a change when it happens as well as differentiate a temporary variation in weather from a continued in weather over long term or change in climate.

Table 6. Distribution of respondents by farming experience

Experience (years)	Men	Women	Pooled Data
1-5	7.9	12.8	10.6
6-10	12.6	11.4	12.0
11-15	21.6	16.9	19.5
16-20	18.2	20.8	19.2
21-25	13.0	13.6	13.1
26-30	14.3	13.3	13.8
31-35	3.2	6.1	7.3
36-40	4.3	1.7	4.3
41-45	1.3	1.7	-
46-50	3.6	1.4	0.1
51-55	-	-	-
56-55	-	0.3	-
TOTAL	100	100	100

Source: RULIN Survey, 2010

Distribution of Respondents by Marital Status

Results show that 77.8% of men and 75.4% of women (76.9 % of total respondents) are married. The indication is that a very high proportion of respondents are mature and responsible enough to describe the impact of climate change on their households, provide cogent information with which to assess their vulnerability as well as being able to indicate suitable adaptation measures. The distribution of respondents by marital status is shown in Table 7.

Table 7. Distribution of respondents by marital status

Marital Status	Men (%)	Women (%)	Pooled Data (%)
Divorced	5.5	5.2	5.3
Married	77.8	75.4	76.9
Single	13.1	13.3	13.2
Widow	2.4	4.7	13.3
Cohabiting/Others	1.3	1.5	1.3
Total	100	100	100

Source: RULIN Survey, 2010

Distribution of Respondents by Educational Status

The data on the distribution of educational status show that 91% of men and 91.6% of women with an average of 91.6 % of all respondents have at least primary education. The implication is that a good proportion of the respondents have the capacity to read and comprehend the issues raised in the questionnaires without requiring much assistance or being dependent on the field officers for interpretation. The distribution of respondents by educational status is shown in Table 8.

Table 8. Distribution of respondents by educational status

Educational status	Men (%)	Women (%)	Pooled Data (%)
No Formal education	8.9	7.9	8.4
Primary	24.5	29.6	27.05
Secondary	45.5	40.6	43.05
Tertiary	21.1	21.9	21.5
	100	100	100

Distribution of Respondents by Household Size

Results show that the household size of male households in the study area lies between 6 and 9 which is the modal class. The average household size is 6 for the communities studied. The distribution of respondents by household size is shown in Table 9.

Table 9. Distribution of respondents by household size

Household size	Men (%)	Women (%)	Total (%)
2-5	40.5	47.5	43.4
6-9	49.5	48.0	48.9
10-13	7.9	4.2	6.3
14-17	1.9	0.3	1.2
18-21	0.2	0	0.1
	100	100	100

Distribution of Respondents by Occupation

The distribution of respondents by major occupation shows that households involved in the study were involved in a number of different occupations. Farming was the major occupation, at 42.5% and secondary (minor) occupations were at 39.9 %. This was followed by 17.2 %

and 27.9 % that had trading as primary (major) and secondary (minor) occupations, respectively. Out of 42.5 % who claimed to be farmers in the survey, 59.9 % were crop farmers, 5 % were livestock farmers, 21.2 % were fishers, 3.8 % were integrated farmers and 5.3 % were capture fishers. This implies a high level of dependence on the rich biodiversity of the Niger delta region. The implication of this for vulnerability to climate change is significant, as the changes in the climate variables will have direct impacts on households' income and livelihoods. In this regard men and women are likely to suffer differential impacts as the distribution of men and women in the various occupations differ somewhat. The distribution of respondents by occupation is shown in Table 10.

Table 10. Distribution of respondents by occupation

Major occupation	**Men (%)**	**Women (%)**	**Total (%)**
Farming	44.4	39.7	42.5
Trading	14.4	20.9	17.2
Civil Servant	33.3	28.6	31.3
Artisans	5.5	5.9	5.6
Collection forest products	0.7	0.5	0.6
Other	2.5	4.2	2.8
Minor occupation			
Farming	38.0	42.4	39.9
Trading	26.4	29.8	27.9
Civil Servants	4.9	7.1	5.9
Artisans	2.5	1.5	2.1
Collection of Forest Products	2.7	2.7	2.7
Other	25.5	16.3	21.5
Total	100	100	100

Distribution of respondents by income from major occupations

The majority (27.9%) of respondents shown in Table 11 have an annual income greater than N500, 000 (US$ 3,333). Incomes of respondents seem to be evenly distributed. The average incomes of respondents from major occupation were ₦405,169 for women, ₦368,654 for men and ₦384,780 as the average (this is equivalent to US $2,532, US $2,304 and US $2,404 (exchange rate: US $1.00=₦160 (CBN, 2011)). This amounts to approximately US $6.94, US $6.31 and US$6.59 per day for women, men and all, respectively with the income of women being greater than the average income.

These numbers are deceptive if the income distribution is skewed in favour of the rich. Therefore in order to determine if there is income inequality, the share of income ratio of the poorest 10 percentile and 95 percentile were computed. The annual income of the poorest 10 percentile for women, men and all were ₦ 60,000, ₦ 65,000 and ₦60,000, respectively. The corresponding income share ratios were 0.0423, 0.0388 and 0.0194, for women, men and all, respectively. The results suggest that the poorest 10% of women respondents earned lower income than men and the average daily income was US $1.042(₦166.67), which just exceeded the poverty line of US $1.00 a day. The 95 percentile annual incomes for women, men and all, on the other hand, were ₦1,440,000, ₦1,000,000 and ₦1,000,000, respectively and the corresponding income share ratios were 1.0155, 0.598 and 0.598, for women, men and all, respectively. These suggest that the poorest 95% or the richest 5% of women respondents earned higher income than men and the average daily income of the 95 percentile of the pooled data was US $17.12(₦6,250), which is above the poverty line of US $1.00 a day. It is thus obvious that the incomes of respondents were highly skewed in favour of the richest. The level of inequality is high as the incomes in the Niger delta communities are concentrated at the 95th percentile. These results have implications for vulnerability, adaptive capacity and adaptation to climate change.

Table 11. Distribution of respondents by income from major occupation

Income from major occupations	Men (%)	Women (%)	Pooled Data (%)
Less than 100,000	18.9	18.7	18.8
100,000-199,999	14.7	13.3	14.1
200,000-299,999	8.9	11.3	10.0
300,000-399,999	17.8	16.1	16.5
400,000-499,999	11.4	14.1	12.6
More than 500,000	28.7	26.3	27.9
Total	100	100	100

Livelihoods and Dependence on the Ecosystem

The ecosystem of the Niger delta sustains a wide variety of livelihoods based on production and collection of crops, livestock, and forest products upon which respondents depend for livelihood. The level of dependence of households on the ecosystem is depicted by Table 12. The high level of dependence on the ecosystem is indicates the high level of vulnerability to climate change impacts. In particular, the communities in the Niger delta have over 50% of their land covered by water due to their contiguity to the coast. The implication is that any events of flooding resulting from sea surge or sea level rise exposes a great number of households and communities to adverse effects of climate change related hazards including loss of farmlands, crops, landed properties, public goods and inundation of some communities. The experience in Abari, Ndoni, Uzare and Ebedebiri are examples of this.

The results in the table show that cassava, yam, maize, vegetables (leaf), pepper, okra, cocoyam, plantain/banana and oil palm are the major crops cultivated. Livestock activities are at the homestead level and goat rearing and poultry-raising are the most important. Capture fishery is also important in the region albeit its position as a secondary source of income for a number of respondents. Oil palm, timber, fuelwood, wild fruits, snails, rabbits, spices, chewing sticks, raffia palm collected from the environment are important sources of income for a number of the respondents, particularly women.

Table 12. Level of dependence of respondents on the ecosystem

Crops	Men (%)	Women (%)
Cassava	93.0	91
Yam	82	80.5
Vegetable	78.6	76.6
Okra	77.7	76.6
Maize	70.7	68
Pepper	70.5	76.1
Plantain/banana	55.9	59.1
Cocoyam	50.6	48.8
Oil palm	43.2	44.3
Melon	33.5	37.2

Crops	Men (%)	Women (%)
Groundnut	24.9	27.1
Potato	23.1	25.1
Cowpea/beans	17.95	20.4
Rice	8.8	11.3
Cashew	8.6	8.9
Kola nut	6.4	6.7
Cocoa	3.9	3.9
Livestock/fish		
Goat	44.9	50.5
Sheep	31.0	36
Poultry	29.3	31.3
Fish	20.5	23.9
Pig	5.3	4.1
Rabbit	3.5	3.9
Cattle	0.0	0.0
Forest product/wild life		
Oil palm	44.7	44.3
Wild fruits	35.3	35.7
Timber	37.2	33.5
Fuel wood	32.4	29.8
Raffia palm	27.8	27
Giant snails	18.9	26.4
Edible snails	23.3	25.1
Spices	23.3	20.4
Medicinal plants	14.3	13.8
Chewing stick	13	11.3
Variety of leaves	7.3	9.1
Sea animals	8.4	8.9
Kola nut	8.4	8.4
Rabbit	23.6	8.1
Saw logs	8.8	7.4
Tree barks	5.7	7.1
Cane rats	8.8	4.4
Monkeys	3.3	4.2
Various roots	3.9	3.9
Edible worms	3.9	3.7
Various climbers	4.8	3.5
Crocodiles	2.2	3.2
Iguanas	2.0	2.7
Monitor Lizards	1.8	2.5
Tortoise	1.8	2.5
Sea birds	0.0	0.0
Python	0.0	0.0

Perceived causes of global warming and climate change in the Niger delta

According to the perception of the respondents, continuous cropping with associated land clearing is the highest contributor to global warming and climate change in the Niger delta. Continuous cropping occurs because of the lack of arable land. Land is in short supply because of the land tenure system that is by inheritance, which also denies women in many Niger delta communities the right to own land. Land availability is also affected by frequent oil spills and water logging and swampy land that is not conducive for agricultural production and urbanization. Continuous cropping is followed by bush burning, practiced by 13.9% of the respondents, deforestation at 13.3%, the use of pesticides/aerosols and herbicides at 10.3% and 10.1% respectively. Table 13 shows the various human activities that contribute to increased carbon emissions and the percentage contributions. Other causes are cement production, 8.3%, industrialization, 6.9% and urbanization 6.8%. A small proportion of the respondents (0.05%) however believe that climate change is caused by the “gods” who should be appeased to avoid further disruptions and hazards in the future. The people in Oko-Amakom community in this light hired rainmakers to cause the rain to fall as they watched their crops scorch under the intense heat in May/June 2010 with no rain was in sight. The rainmakers however failed to bring the rain.

Table 13. Human activities contributing to climate change as perceived by Respondents

Activities	Extent of activities as % (% of total when occurrence is often)	Contribution (%)
Bush burning	6.2	13.9%
Continuous cropping	71.2	15.8
Over-grazing	4.7	1.04
Urine dropping from ruminants animals	5.5	1.3
Swamp rice production	7.4	1.7
Burning of fossil oils	9.4	2.1
The use of fertilizers	20.1	4.5
Deforestation	59.6	13.3
The use of herbicide	45.6	10.1
The use of insecticides/pesticides	46.3	10.3
Urbanization	31.1	6.9
Industrialization	30.7	2.8
Cement production	37.1	8.3
Gas flaring	18.4	4.1
Others	0.2	0.05
Total	449.6	1.00

(Source: RULIN field survey, 2010)

Perceptions of the Indicators of Climate Change and the Direction of Change

Respondents had some knowledge of what climate change is. Over 70% were aware of changes in the climatic variables, but they were unable to express their feelings about the unfolding events as the years rolled by. The majority of the respondents perceived that there have been changes in their agricultural products as well as a decline in the availability of forest products. They also observed that the changes in output and availability in forest products had some relationship with the changes in climatic variables and events in the past 30 years. Some of these climate events and variables were increased with the early rains that were not sustained, as well as the increase in occurrence of smothered crops by excessive heat, increase in the occurrence of shifts in the start and end of the rainy seasons. The communities however attributed these changes to God the Creator and saw themselves incapable of doing anything. Table 14 shows the respondents perception of direction of change.

Temperature and rainfall are both important variables that determine agricultural productivity. Current research confirms thresholds for these climatic variables above which crop yields decline (Fan & Juzhong, as cited in Challinor et al., 2005; Proter & Smenor, 2005). Results of this study show that approximately 40 % of respondents engage in farming. Recent climate changes in the communities are having a negative impact on agricultural productivity in the Niger delta. According to respondents' perceptions, shown in the table, the occurrence of heavy rains that are not sustained (68.8%), crops smothered by heat (85.3%), irregular rainfall pattern (68.8%) are all on the increase, while occurrence of longer rainy season is decreasing. Analysis of rainfall and temperature data collected from the NIMET show results that corroborate respondents' perceptions.

Table 14. Perceived indicators of change of climate phenomenon in the last 30 years

Climate change events	**Increasing (% of respondents)**	**Decreasing (% respondents)**	**No change (%)**	**Respondents' perception**
Uncertainties in the onset of the farming seasons				
a. Early rains not sustained	68.4	26.2	5.4	Increased
b. Crops smothered by Excess heat	85.3	7.0	7.7	Increased
c. crops planting and replanting	73.6	13	13.4	Increased
d. shift in the start or end of rains	68.8	8.9	22.3	Increased
Extreme weather events :				
a. thunder storms	82.1	7.8	10.2	Increased
b. heavy winds	80.3	10.1	9.6	Increased
c. floods	93.2	6.1	0.7	Increased
d. more frequent draught	68.3	26.8	4.9	Increased
e. excessive heat	86.6	8.6	4.8	Increased
f. heavy rainfall	89.0	7.4	3.6	Increased
g. sea level rise	54.3	7.3	38.3	Increased
h. sea surge	84.5	7.5	8.0	Increased
i. erosion	76.8	6.5	16.7	Increased
j. higher temperature	87.6	9.5	2.9	Increased
k. erratic rainfall pattern	78.5	18.6	2.9	Increased
l. less rain	61.7	19.5	18.8	Increased
m. delayed onset of rainfall	61.1	18.7	20.2	Increased
n. earlier onset of rainfall	66.0	23.6	10.5	Increased
o. short rainy season	72.1	15.4	12.5	Increased
p. longer rainy season	44.3	45.0	10.7	Decreased
Crop pest and diseases	77.0	9	14	Increased
Animal diseases	86.1	11.2	2.6	Increased
Weeds	78.8	8.1	13.1	Increased
Land degradation				
a. Sheet erosion	77.8	9.7	10.4	Increased
b. coastal erosion	81.8	7.8	10.4	Increased
c. Rill erosion	69.5	13.0	17.5	Increased
d. Gully erosion	58.5	14.6	26.9	Increased

Climate change events	Increasing (% of respondents)	Decreasing (% respondents)	No change (%)	Respondents' perception
e. Wind erosion	66.9	15.3	17.8	Increased
f. Deposit of eroded materials	78.1	15.1	6.8	Increased

(Source: RULIN field survey, 2010)

Impacts of Climate Change on Agriculture and Biodiversity

The major climate change hazard identified by the Niger delta communities in the study are:

1. Increasing temperature is the most pervasive. This concurs with the average global temperature reported to have increased by 0.74°C between 1906 and 2005. The IPCC (2007) has predicted an additional 1.8-4.0°C in this century, as the eight out of the ten hottest years occurred in the decade 2000-2009, while 2005 was the hottest year ever, it was followed by 1998, 2002, 2003, 2006, 2007, 2004, 2001, 2008 and 1997 in descending order (highest temperature first). The NIMET data on mean temperatures in Warri, Port Harcourt and Asaba corroborate these as they were hotter than other years.

2. In the presence of delayed onset of rainfall accompanied by excessive heat 87.6%, crops were scorched 86.6% in Oko-Amakom, Uzere, Bebelebiri and the others to a lesser degree, causing farmers to replant. These findings are in line with the predictions by IPCC (2007) which says the impact of the observed temperatures and expected temperature rise in the century will depend on how much and how soon greenhouse gasses are curbed and level of change will vary from region to region.

3. Another pervasive hazard is variability in rainfall patterns, including differences in timing, intensity and volume. According to the IPCC (2007a) data, precipitation levels are on the downward trend and patterns of precipitation change are more spatially and seasonally variable than temperature changes. The perception of the respondents is in line with trends computed from NIMET time series data in Figures 9 to 15 on rainfall. The predictions by IPCC for tropical regions (IPCC, 2007c) suggest that "even in areas where mean precipitation decreases, precipitation intensity is projected to increase but there would be longer periods between rainfall events". This seems to corroborate the observations of respondents in the Niger delta region. Observations show that changes are occurring in amount, intensity, frequency and type of precipitation.

4. Flooding is another pervasive of the hazard of climate change. This derives from overflow of the rivers, the Atlantic Ocean, River Niger and other rivers in the region. IPCC (2007b) predicted that there will be increases in the occurrence of both floods and droughts. This has occurred in Oko-Amakom, by the bank of the River Niger.

5. Another important hazard is the sea level rise (SLR). The major factors that have contributed to global sea level rise including the melting glaciers, Greenland ice sheets as the earth warms and increasing sea temperatures. This leads to increased sea water level which overflows to low lying coastal areas causing floods, soil and river bank erosion and intrusion of salt water into fresh water sources.

6. Lastly, other hazards include sea surges, which occurred in Rukpoku, Rumu-Orosi, Ndoni, Odi, and Uzere within the last 30 years, and windstorms in Abari.

Perceived Impacts of Climate Change on Agriculture and Biodiversity

The results from survey show that the changes in climate related hazards over the past 30 years have affected agricultural productivity and the stock of aquatic life adversely. Yield and output from crops, NTFPs, fish stocks (population) in rivers/streams, fishery production have been observed by respondents to have declined over the years and food insecurity is thus imminent in the affected communities.

The major impacts of climate-related hazards on crop production include loss of soil nutrients due to seeping, soil compaction due to the presence of clay in some areas, changes in farming practices, flood and excess heat, water logged soil, low yield, low output, migration from farm lands, invasion of pests, scorched crops due to excessive heat experienced since late 2009, overturning of boats and loss of lives were recorded in the past 30 years. All stakeholders in the community are affected while the women, who are mostly farmers, are the most vulnerable.

The major fish species that are common in the wild in the Niger delta region include catfish (*Synodontis* sp) and tilapia. Fish production has been adversely affected, as fisher folks have lost their lives, livelihoods and fishing tools in storms, faced declining fish populations and increased disease outbreaks in fisheries. Tables 14 and 15 show the respondents' perceptions and assessment of effects of climate change on agriculture and biodiversity.

Fisheries have been adversely affected by hazards of climate change such as flooding, sea surge, sea level rise, erosion, turbidity, drought and excess heat. The impacts of these hazards on fisheries include increased turbidity, destruction of natural habitat, water hyacinth bloom (hyacinth prevents light, oxygen penetration). Water hyacinth also disrupts navigation, reduces fish catch, alters fish migration and causes the disappearance of some economically valuable fish species. The fishermen and women are most vulnerable to these impacts.

Forest products are important sources of livelihood for Niger delta communities. The impact of climate hazards on forests include heat stress, decreased biodiversity, death, migration and loss of plant and animal species, gradual disappearance of some forest species such as antelopes, lions, bush pigs, muturu cattle, loss of timber species, medicinal plants, ornamental trees. Forests also show low yields and structural damage due to silt deposits and oil spills. Women, whose livelihoods depend on the collection of forest products, such as ogbono (*Irvingia gabonesis*), snail and medicinal leaves are vulnerable. Also, men whose livelihoods depend on timber and other economic trees are vulnerable. In summary, average yield of crops, animal products and forest resources have witnessed a decreasing output during the last 30 years.

It is no longer easy to predict the onset and cessation period of rains. This claim was confirmed by the findings of Omotosho (1992) that the prediction of onset and cessation of rain determines the cultural practice of the farmers. It has been observed that high temperatures cause evaporation to occur more rapidly with drying occurring faster resulting in rapidly occurring moisture stress (MacCracken, 2004). It has also been observed that many terrestrial, freshwater and marine systems are already being affected by regional increases in temperatures (IPCC, 2007b). The implications of all of these hazards and impacts on food security are significant.

Table 15. Perception of impacts of climate change on agriculture and biodiversity

Items	Direction of impact (%)			
	Increase	Decrease	No change/same	Don't know
Trends in the yield of crops during the last 30 years	5.3	65.2	17.3	12.1
Trends in the quantity of livestock/fish stock produced during the last 30 years	12.1	46.4	13.1	28.2
Trends in the availability of forest resources during the last 30 years	2.8	61.4	11.2	24.6

(Source: RULIN Survey, 2010)

Results for Objective 3

Objective 3 was to "Evaluate the impact of climate change on livelihood assets disaggregated by gender".

Assessing vulnerability to climate change using the sustainable livelihood framework

Vulnerability context

The external environment in which the respondents' livelihoods and the wider availability of assets are fundamentally affected and over which they have no control are discussed in this section. Table 16 shows the analysis of vulnerability using information gathered from respondents and secondary sources to describe and to delineate trends, shocks and seasonality of the outcome of the impacts of climate hazards and events.

Table 16. Vulnerability context

Trends	Shocks	Seasonality
Trends in temperature show that there has been an increase in temperature over the past 30 years	(a) Crop and livestock, livestock production shocks that have led to loss of income, loss of harvest, poor yield and impending food insecurity (b) Human health shocks as malaria and skin infections increased (c) Fish and aquatic life shocks as fish population migration increased (d) Economic shock as farmers' incomes decline	1(a) seasonality of production and prices (b) seasonality of health status (c) seasonality of availability of fish and aquatic products (d) Seasonality of farmers' income
Trends in rainfall show an increase in intensity of rainfall but decrease in the frequency with variable time of onset and cessation	2(a) Crop production shocks (b) Economic shocks	2(a) seasonality of production and prices (b) seasonality of food availability (c) seasonality of employment opportunities (d) seasonality of incomes
Average yield of crops has decreased	4(a) crop production shocks (b) economic shocks	4(a) seasonality of food availability (b) seasonality of food availability (b) seasonality of production and prices
Average quality of livestock produced has declined	5(a) livestock production shocks (b) human health shocks as protein availability declined	5(a) seasonality of production and prices
Availability of forest resources during the last 30years has declined	6(a) forest resources shocks as they are getting depleted	5(a) seasonality of forest product availability
Increases occurrence of storms, heavy winds, sea level rise have increased over the past 30 years	7(a) crop and livestock production shocks (b) economic shocks (c) Natural shocks	7(a) seasonality of food availability and prices

The vulnerability context table shows that the livelihoods of the households in the Niger delta communities are complex and precarious. The trends show that temperatures, variable rainfall, flood incidence, storms, heavy winds, heat waves, and sea level rise are on the increase and community members have no control over these changes. They are also unsure of what action to take.

Vulnerability to Impacts of Climate Change on Livelihood Capitals/Assets

The level of vulnerability of various livelihood assets varied by asset type and by gender. The livelihood assets are discussed in this section by type.

Natural Capital

Natural resources stocks that constitute important sources of resource flows and services are derived for livelihoods in the Niger delta. This is particularly so for women who derive income from gathering forest products. For men, availability of timber has declined and they have to travel longer distances into the swamp forest to obtain mature trees. The majority of the men also declared an increase in fish stock albeit a narrow marginal difference from those who observed a decline (41%). This may due to the fact that many men fishers have motorized boats with which they could go further into the sea to fish.

Table 17. Respondents' Perception of the Impacts of Climate Change on Natural Capital (Men)

Livelihood capital	**Direction of Impact**		
Natural capital	**Increase (%)**	**Decrease (%)**	**No change (%)**
Land resources	43.7	49.9	6.4
Water resources	44.7	49.8	5.5
Fish	49.5	44.8	5.8
Cray fish	43.4	49.2	7.4
Raffia palm	38.8	44.5	10.7
Wild fruits-bush mango	42.4	43.2	14.4
Spices	36.4	44	19.6
Medicinal plants	43.5	41.2	15.3
Edible worm	40.5	36.5	23.1
Giant snails	46.5	33.6	19.9
Iguana, crocodile, monkeys, tortoise, python	34.2	43.2	22.6
Timber	42.1	46.8	11.1
Economic trees	38.0	48.5	13.5
Fuel wood	40.8	45.2	14.0
Oil palm	39.1	45.5	15.4
Chewing sticks	38	40.3	21.7
Rattans and ropes	38.9	34.4	26.7
Loss of forest	44.5	36.9	18.6
Sea birds	42	34.2	23.9
Mushrooms	38.3	40.1	21.6
Roots and tree barks	46.5	36.2	17.3
Water hyacinth	59.0	24.6	16.4
Others			

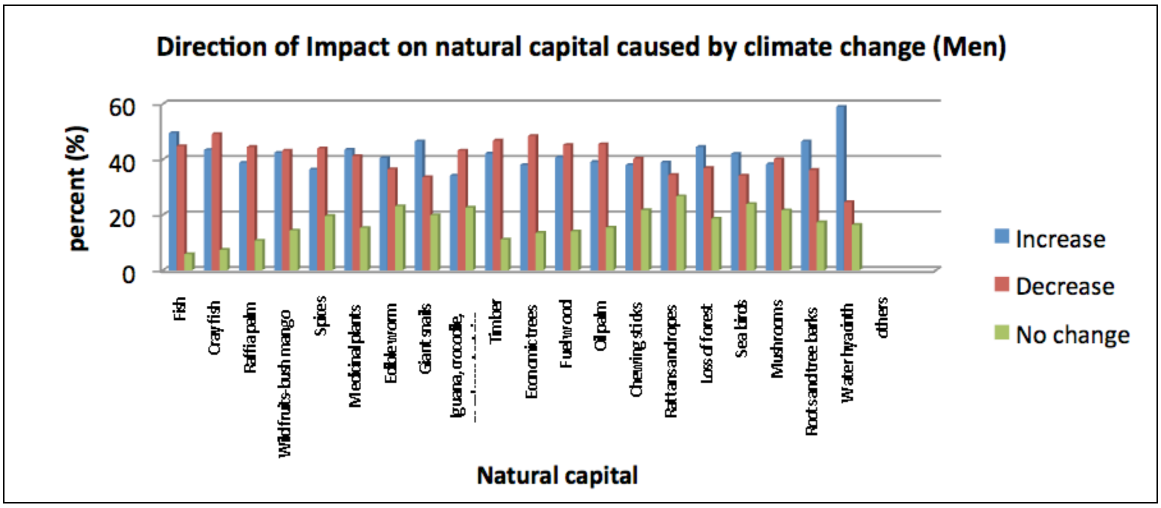

Figure 16. Direction of impact on natural capital by climate change as perceived by men

<u>Financial Capital</u>

The importance of financial capital cannot be overemphasized as it represents the media of exchange critical to the successful utilization of other assets. The findings show that a majority of respondents observed a decline in their financial assets over the past 30years. Tables 18 and 19 show the percentage of respondents who observed increases, decreases and no change on their financial assets.

Table 18. Respondents' perception of the impacts of climate change on livelihoods (women)

Livelihood asset.	**Direction of Impact**		
Financial capital	**Increasing**	**decreasing**	**No change**
Income from natural resources	24.7	67.4	7.9
Forest resources	22.8	68.5	8.7
Income from crop production	30.4	60.4	9.2
Income from livestock production	26.4	58.9	14.7
Income from fisheries	29.3	63.3	7.4
Savings	28.9	60.0	11.1
Credit facilities	28.0	53.1	18.8
Others			

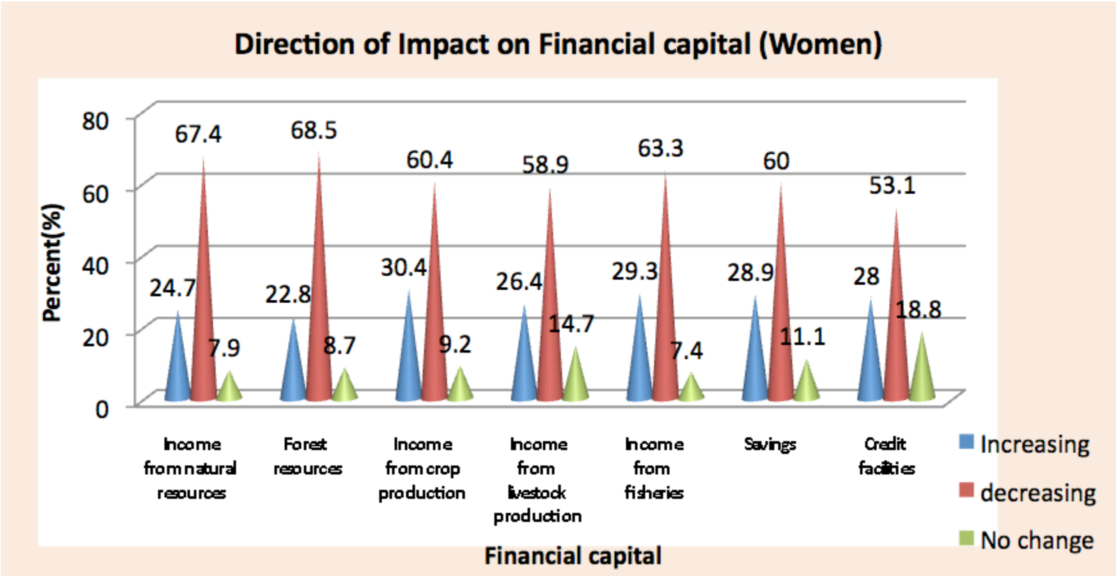

Figure 17. Direction of impact on financial capital by climate change as perceived by women

The women seem to have been affected most as 67.4% observed a decline in income from forest products and 68.5% observed a decline in income from natural resources, while 60.4% and 61% of the men observed a decline in the income obtained from forest products and natural resources respectively. This is expected, as women depend more on natural capital than do men.

Table 19. Respondents' perception of the impacts of climate change on livelihoods (men)

Livelihood capital	**Direction of change**		
Financial capital	**Increasing**	**Decreasing**	**No change**
Income from natural resources	32.7	61.9	5.3
Forest resources	34.0	60.4	5.6
Income from crop production	37.3	58.3	4.4
Income from livestock production	36.1	54.1	9.8
Income from fisheries	39.3	53.9	6.7
Savings	32.4	57.2	10.4
Credit facilities	33.6	47.4	18.9
Others			

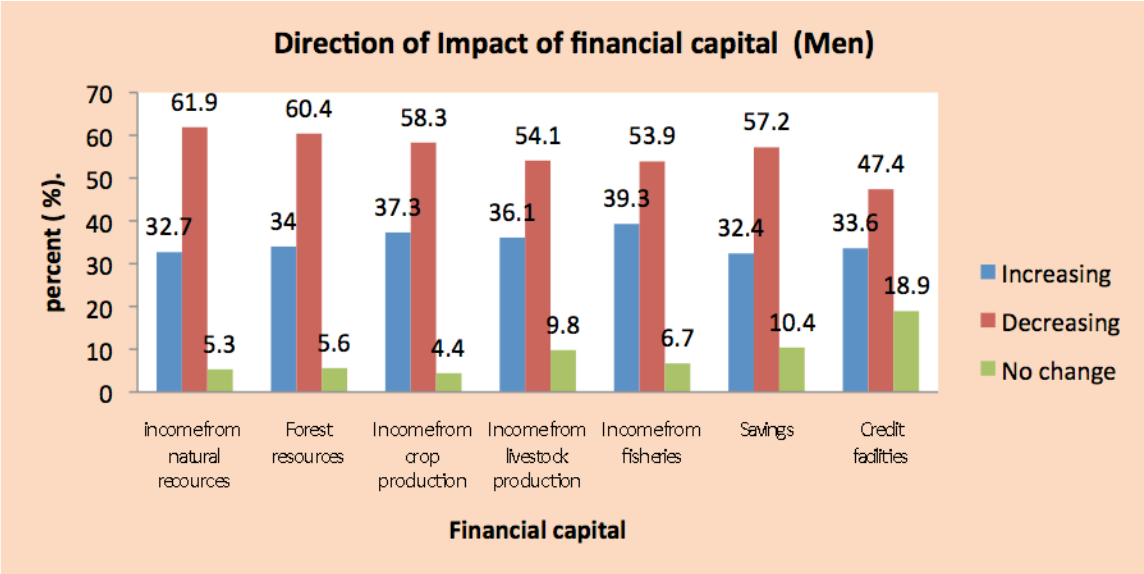

Figure 18. Direction of impact on financial capital caused by the impact of climate change as perceived by men

Though a lower percentage of men observed a decrease in income from natural resources and forest products, these sources remain the highest decreases for men. For the men and women, incomes from crop production livestock production, fish and aquatic life savings and credit facilities all were observed to have declined. The sale of NTFPs such as wild fruits, *Alvingia gabonesis* (Ogbono), raffia palms, spices, medical plants, edible worms, giant Africa snails, fuel wood, oil palms, mushrooms, rattans and crops. The men and women depend on the land resources, water resources for farming and fishing activities. The men depend on the natural capital to obtain timber, oil palms and wild animals. The women also depend on the natural capital to provide their households with water and fuelwood their major energy source.
The findings show that in the past 30 years a majority of the respondents have witnessed a decline in the availability of natural capital. The results in Table 20 show the direction of change in the flow of resources and services from natural resources from which men and women in the Niger delta derive their livelihoods,

Table 20. Respondents' perception of the effects of climate change events on livelihoods (women)

Livelihood capital	Direction of change		
Natural capital	**Increase**	**Decrease**	**No change**
Land resources	33.2	58.7	8.1
Water resources	33.3	57.9	8.8
Fish	29.0	62.9	8.1
Cray fish	33.9	54.3	11.8
Rafia palm	30.2	54.3	15.5
Wild fruits eg.bush mango	30.8	53.4	15.8
Spices	32.3	50.9	16.8
Medicinal plants	33.7	48.2	18.1
Edible worms	34.7	39.2	26.1
Giant snails	37.2	38	24.8
Iguana, crocodile, monkeys, tortoise, python	24.3	44.3	26.6

Livelihood capital	Direction of change		
Natural capital	Increase	Decrease	No change
Timber	27	51.7	21.3
Economic trees	29	53.9	17
Fuel wood	30.7	53.3	17
Oil palm	34.7	51.0	14.3
Chewing sticks	29.5	48.0	22.5
Rattans and ropes	24.1	47.7	28.2
Loss of forest	33.3	41.5	25
Sea birds	26.7	42.9	30.4
Mushrooms	33.9	43.7	22.4
Roots and tree bark	33.2	40.9	25.9
Water hyacinth	51.6	26.5	21.9
Others			

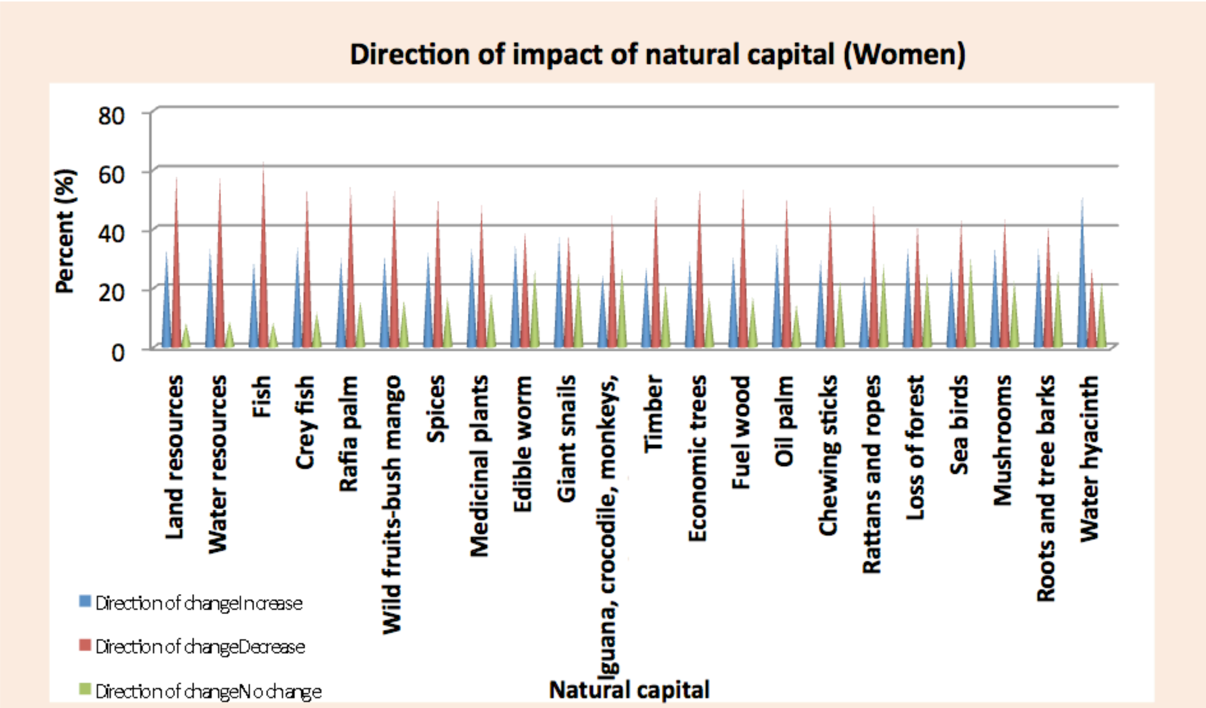

Figure 19. Direction of impact on natural capital by climate change as perceived by women

It is interesting to note that both men and women found that water hyacinths have increased. Water hyacinth has become an obstruction in most rivers in the Niger delta region. Water hyacinth has economic value as it has potential for paper production, fibre boards for ceiling houses etc. These uses could be harnessed for mitigation of the impacts of climate change.

<u>Physical Capital</u>

The physical capital which makes up the built environment has increased over the past 30 years.

Respondents have observed an increase in availability of physical structures such as, built roads, social/economic infrastructure, residential buildings, commercial buildings, educational buildings, electrical and communication installations. The most affected of these are educational buildings, with both men and women saying around 70%. The direction of change for physical capital is shown in Tables 21 and 22. Damage to physical assets was particularly visible in Abari in Delta State, Odi and Ebedebiri in Bayelsa.

Table 21. Respondents' Perception of the Impacts of Climate change on livelihoods (women)

Livelihood Capital	Direction of Change		
Physical Capital	**increase**	**Decrease**	**No change**
Roads	59.9	26	17.1
Electricity	53.5	25.5	21
Infrastructure	43.3	34.3	22.3
Buildings – Residential	57.7	29.2	13.0
Buildings – Commercial	57.8	28.4	13.8
Buildings – Educational	68.6	22.8	9.3
Communication	55.5	30.5	14
Installations	44.7	22.6	32.7
Other			

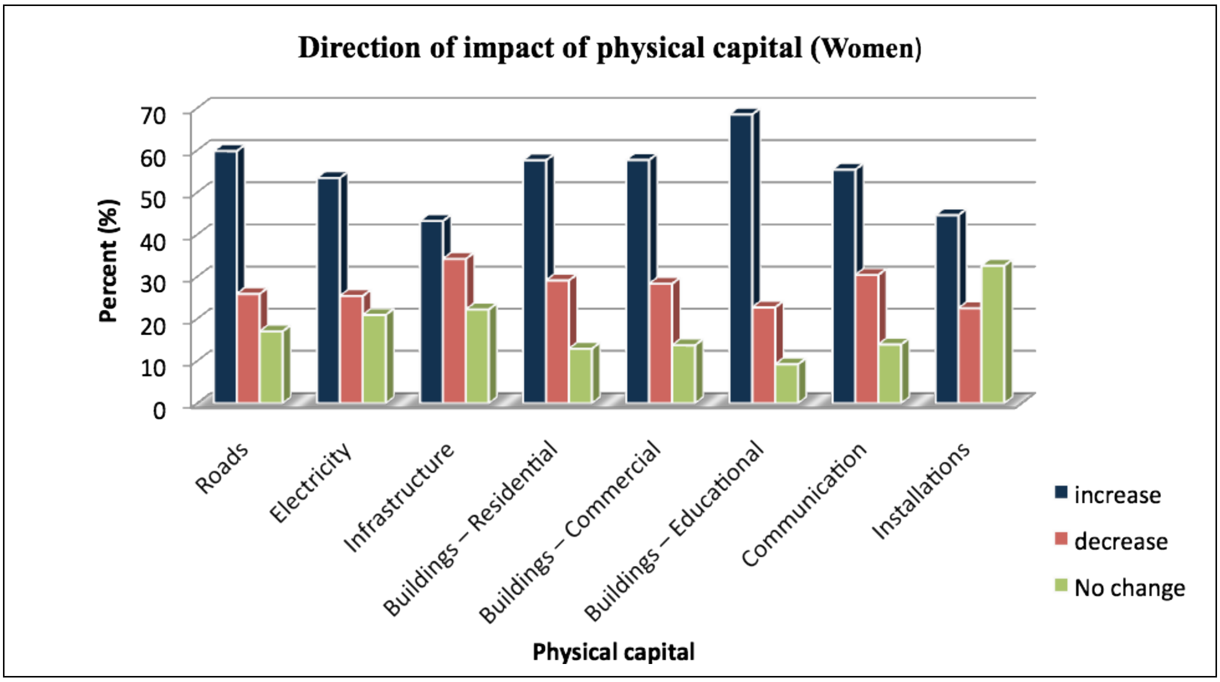

Figure 20. Direction of impact of climate change on financial capital as perceived by the men

Table 22. Respondents' perceptions of the impacts of climate change on livelihood (men)

Livelihood Capital	Direction of Change		
Physical Capital	**Increase**	**Decrease**	**No change**
Roads	55.5	28.8	15.7
Electricity	54.5	28.8	19.2
Infrastructure	52.1	30.6	17.3
Buildings – Residential	64.5	25.6	9.9
Buildings – Commercial	61.5	27.3	11.1
Buildings – Educational	70.5	20.1	9.4
Communication	65.5	20.6	13.9
Installations	60.3	17	22.7
Others			

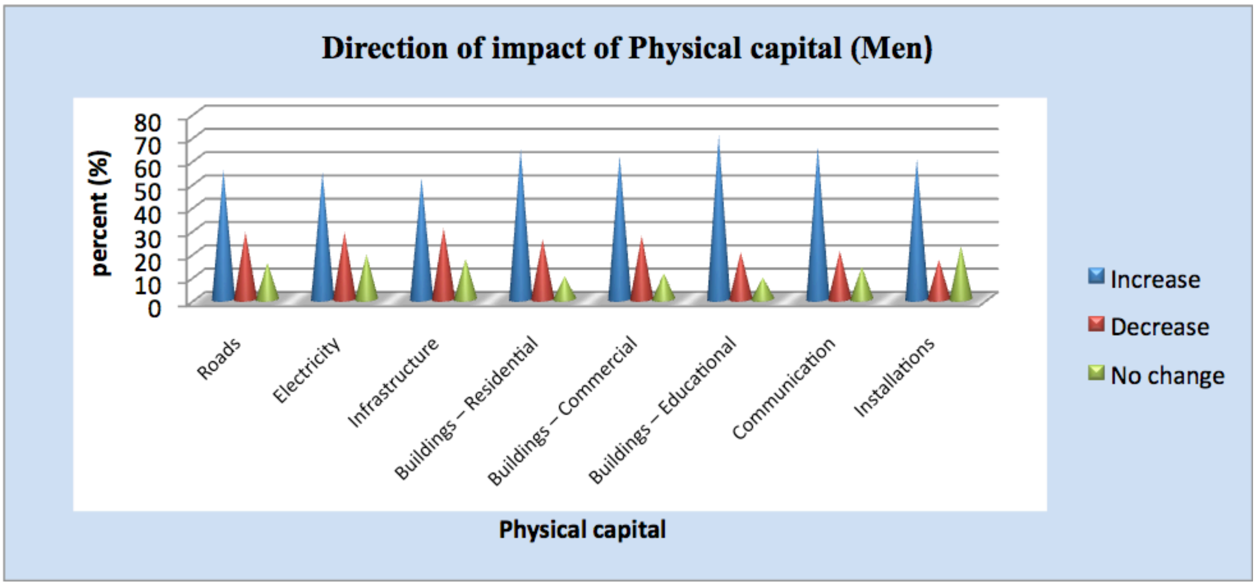

Figure 21. Direction of impact of climate change on physical capital as perceived by men

Human Capital

Human capital is represented by skills, knowledge, labour and health which together enable people to pursue different livelihoods strategies to achieve their livelihood objectives. The respondents in this study have observed increases in the impacts of climate change on human capital, which varied for men and women. The ownership of land, skilled labour, permanent and temporary migration has increased for men. Also in the past 30 years, living standards have improved for men, as there are more houses made of cement blocks with zinc roofs and the consumption of meat, fish, eggs as yam and Garri, vegetables and fruit have increased.

The health status of men and women has also been adversely affected by climate change: skin diseases, respiratory problems, water borne diseases, such as malaria, have all increased (see Table 23 and Figure 22).

Table 23. Respondents' perception of the impacts of climate change on livelihoods (women)

Livelihood capital	Extent of change		
Human capital	**Increase**	**Decrease**	**No change**
Death in the community	69.3	21.3	9.4
Ownership of land	38.1	50.2	11.7
Skilled labour	27.8	53.6	8.6
Permanent migration	64.4	28.4	13.2
Temporary migration	60.9	26.3	12.8
Mud house with thatched roof	41.3	49.1	9.5
Cement block house with zinc	67	26.6	6.4
Meat, fish, egg consumption	51.9	43.3	4.8
Starch, yam, garri consumption	61.2	31.3	7.6
Fruits and vegetables consumption	40.3	47.6	21.1
Health of household members	40.8	49.8	9.4
Skin diseases	62.3	28.0	9.7
Respiratory problems	61.1	25.3	13.6
Malaria	64	27.1	8.9

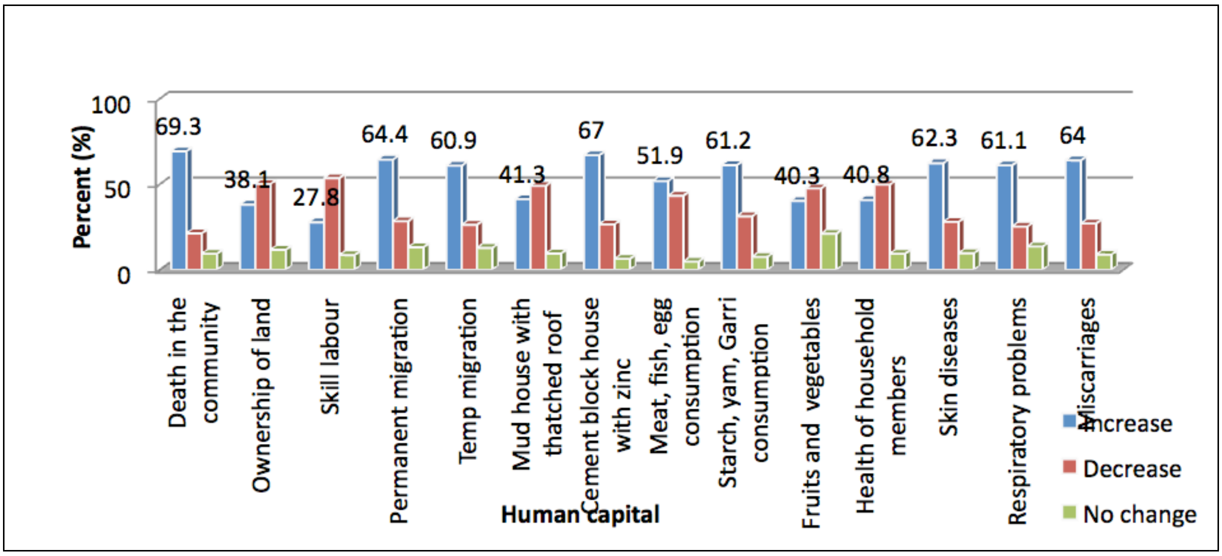

Figure 22. Direction of impact of climate change on human capital as perceived by women

Table 24. Respondents' Perception of the Impacts of Climate change on livelihoods (men)

Livelihood capital	Direction of change		
human capital	**Increase**	**Decrease**	**No change**
Death in the community	76.4	16.7	6.9
Ownership of land	52.5	32.0	15.4
Skilled labour	47.8	36.3	15.9
Permanent migration	56.7	18.1	25.2
Temporary migration	50.7	17.1	32.2
Mud house with thatched roof	38.2	44.3	17.5
Cement block house with zinc	69.8	16.1	14.2
Meat, fish, egg consumption	59.2	26.9	9.7
Starch, yam, garri consumption	66.7	22.8	10.6
Fruits and vegetables consumption	53.3	32.0	14.6
Health of household members	54	39.3	6.6
Skin diseases	72.5	21.7	5.8
Respiratory problems	72.5	21.7	5.8
Miscarriages	73.2	16	10.8

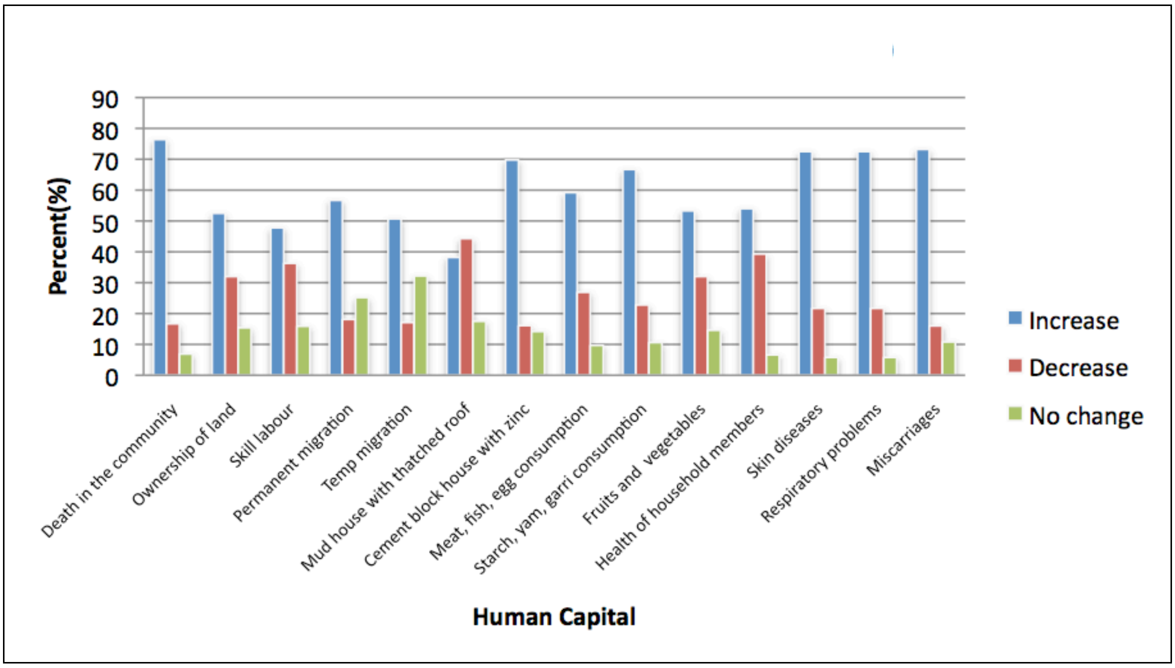

Figure 23. Direction of impact of climate change on human capital as perceived by men

The women on the other hand reported a decline in land ownership due, in part, to loss of land from flooding and erosion. They also reported a decline in the availability of skilled labour, and a decline in the health of household members. Though 51.9% reported an increase in consumption of meat, fish and eggs, more women (61.2%) reported an increase in the consumption of starch such as yam and garri, which are low in protein and considered the stomach-filling foods. The consumption of fruits and vegetables declined for women. In times of hardship, efforts carbohydrate sources such as cassava products and yam substitute for the vitamin-rich fruits and vegetables. In doing so, they compromise the health of the family. The percentage of women and men who reported changes in human capital are shown in Tables 23 and 24.

Social capital

The social capital which people draw upon in pursuit of their livelihoods has increased in the Niger delta in the past 30 years. Social capital has developed over the years for both men and women through social networking and memberships in groups. In the Niger delta, it has become a norm for every community to have a community development committee (CDC) to oversee issues of physical, social, economic and sometimes political development of their respective communities. Their roles in decision and policy making have also increased over the years. Sharing of responsibilities in social and political matters as well as in conflict resolution in the communities has increased, all of these have given voice to more community members and given them opportunity to participate in designing their own development process. Cooperatives and associations for women and men have increased. These have been the means of accumulation of savings and leveraging funds by households to meet some of their financial needs.

The results show that although there has been an increase in the social capital over the years for both men and women, the increases were higher for men. As shown in Tables 25 and 26, an increase in membership to CDC increased by 79% for men and 65% for women. An increased sharing of responsibilities was by 51% of the women and 71% of men. This suggests that there are gaps in responsibility sharing and decision making in the Niger delta. The gender gap is not far-fetched as there still exist negative socio-cultural stereotypes which tend to exclude women from decision making process in many communities.

Table 25. Respondents' Perception of the Impacts of Climate change on livelihoods (women)

Livelihood capital	Direction of change		
Social capital	**Increasing (%)**	**Decreasing (%)**	**No change (%)**
Community development organizations	64.6	21	14.4
Role of community development organizations in decision making	52.2	28.3	19.5
Membership of community development organizations	65.2	24.1	10.7
Sharing responsibility	51.7	34.6	13.7
Cooperatives	59.3	20.4	20.4
Associations	59.2	21.2	19.6

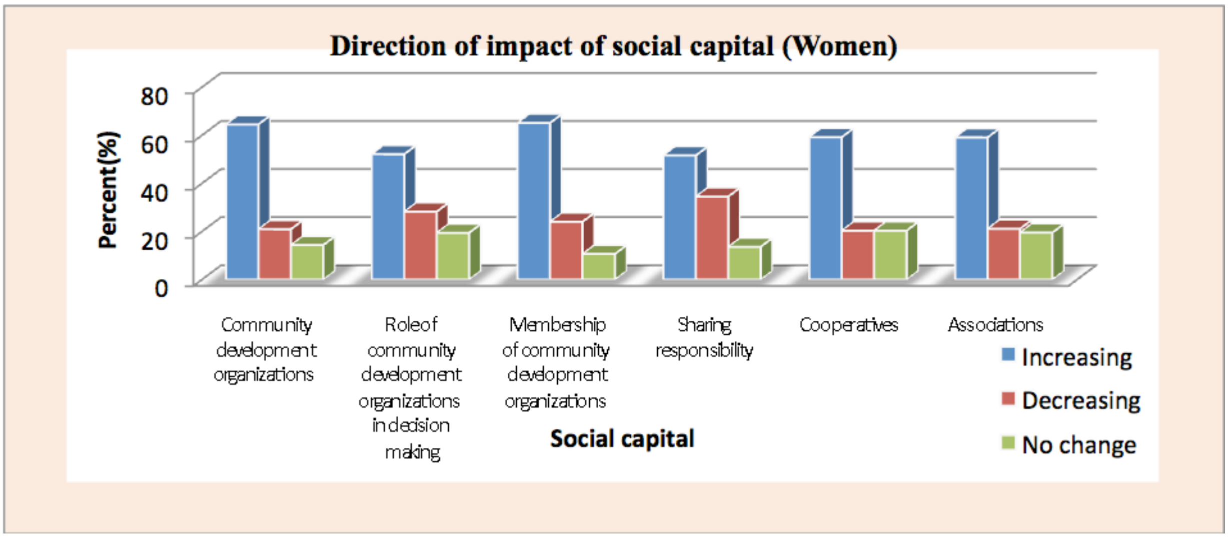

Figure 24. Direction of impact of climate change on social capital as perceived by women

Table 26. Respondents' Perceptions of the Impacts of Climate change on livelihoods (men)

Livelihood capital	Direction of change		
Social capital	**Increasing (%)**	**Decreasing (%)**	**No change (%)**
Community development organizations	73.5	12.6	13.8
Role of community development organizations in decision making	71.1	20.4	8.6
Role of community development organizations in decision making	79.0	15.2	5.9
Sharing responsibility	70.9	29.9	10.1
Cooperatives	73.9	15.2	10.9
Associations	77.4	11.4	11.1

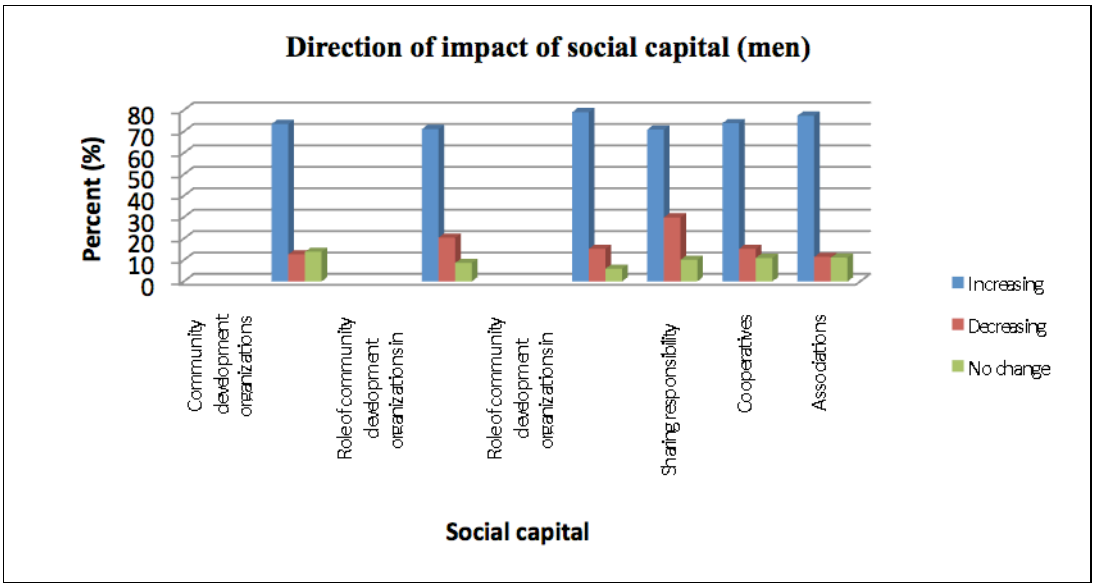

Figure 25. Direction of impact on social capita by climate change as perceived by men

The costs of impact of climate change on the Niger delta communities in a 'do nothing scenario'

Climate change comes at a high price for the Niger delta and will lead to economic losses in all sectors. The cost of adaptation may be high but the cost of the impacts on flooded farmlands, houses, roads, PHCN poles damaged physical structures, loss of human lives, loss of crops and livestock will be much higher.

To evaluate the level of vulnerability of the various households to climate change, respondents were asked to estimate their losses to climate change impacts. The findings are summarized under the five livelihood capitals (natural, financial, human, physical and social capital). The results showed that in the past 30 years, livelihood capitals valued at ₦ 484,892,225 (US$ 3,232,614) were lost to climate change in the Niger delta. When disaggregated by gender, the men lost ₦ 223,446,113 (US$1,742,970) and the women lost ₦ 257,566,547 (US$1,717,110). This implies that the women are more vulnerable than men. The losses according to livelihood capitals are shown in Table 27 and Figures 26a and b. The highest losses were recorded in natural capital for both men and women while the women recorded losses valued at US$1,021,620 the men recorded US$ 786,740 showing that the women are more vulnerable in terms of natural capital. Women depend to a great extent on collection of forest products, crop farming and fishing and on the rich biodiversity of the Niger delta for food, spices, and medicinal plants. As expected, climatic hazards that adversely affect the ecosystem and the rich biodiversity of the Niger delta will affect them more severely.

Table 27. Monetary losses incurred by respondents due to climate change hazards

Type of livelihood capitals	Losses by women (N)	Losses by men (N)	Total (N)
Natural	153,243,006	118,007,131	271,249,137
Financial	54,419,630	56,693,953	111,113,583
Physical	22,859,674	25,996,278	48,855,952
Human	27,045,237	22,748,751	49,793,988
Total	257,566,547	223,446,113	481,012,660
US $ Equivalent (atN150=US $1)	$1,717,110	$1,489,640	$3,206,751
Present Value of losses	₦311,655,521	₦270,369,796	₦582,025,318

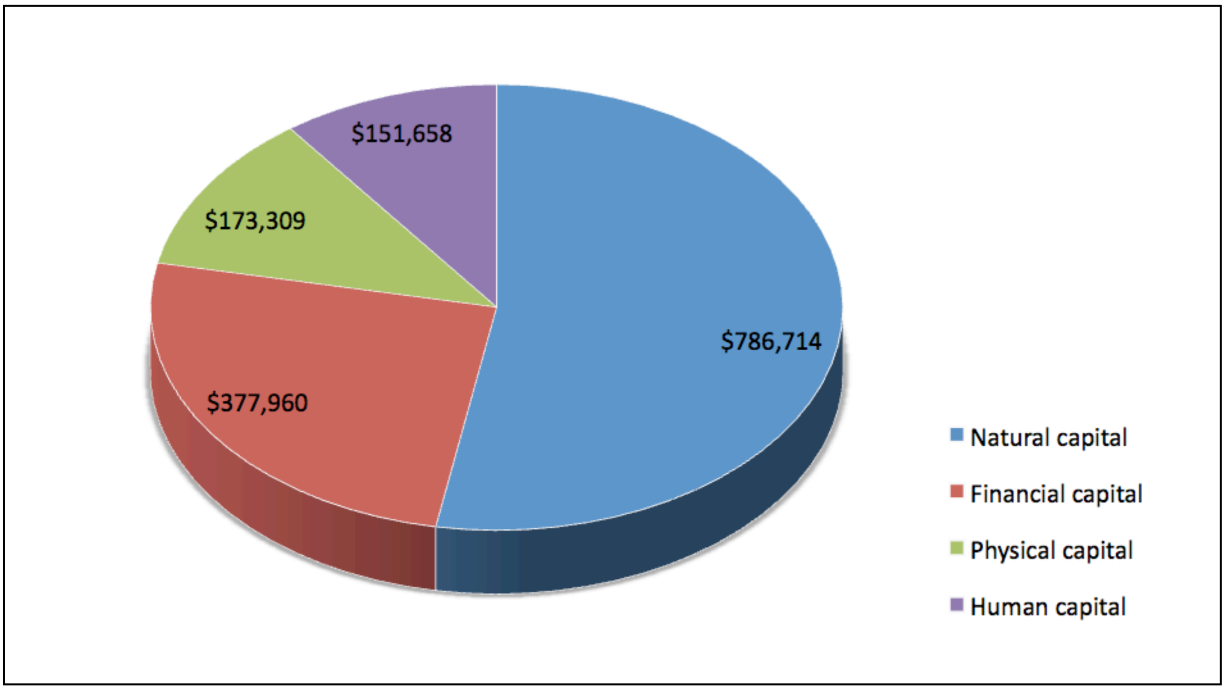

Figure 26a. Monetary value of losses due to climate change hazards (men)

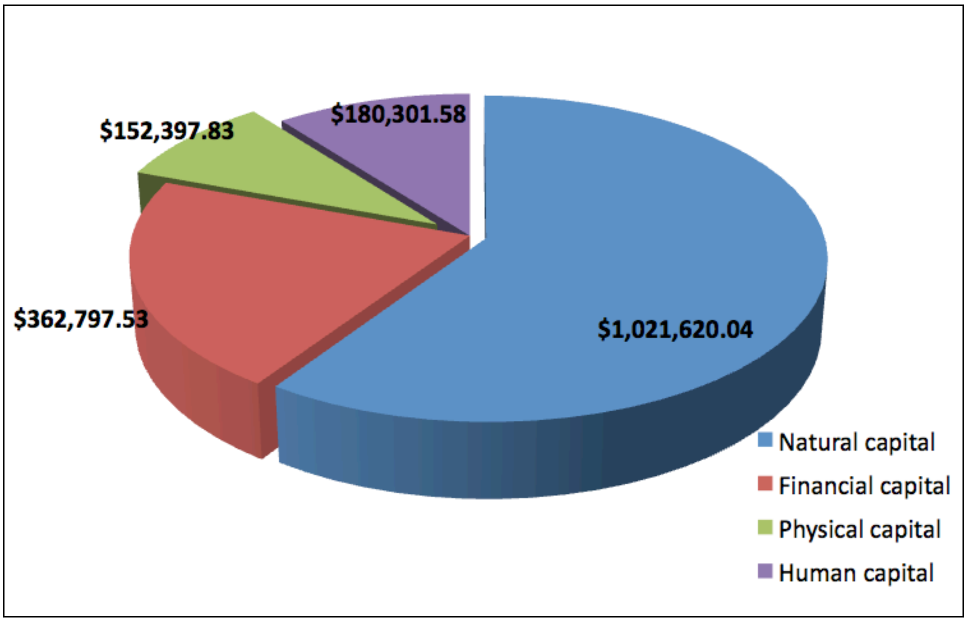

Figure 26b. Monetary value of losses due to climate hazards (women)

Results for Objective 4

Objective 4: Evaluate the determinants of adaptive capacity for translation into development policy for the Niger delta region.

The ability of members of a community to cope and adapt to environmental change can become a measuring of adaptive capacities to future climate change. To effectively measure the vulnerability of the Niger delta communities to climate change, the determinants of adaptive capacity with social systems that interact and co-evolve with changes in the physical environment must be identified and considered. For this study, after the literature review and information gathered from the PRA exercises, a number of variables were selected and inputted into the binary logit model. The variables included: gender of respondents (X_1), availability of technical skills, funds and other vital resources for the adaptation option selected (X_2), accessibility to selected options (X_3), cultural, social compatibility and acceptability of the option (X_4), practical feasibility (X_5), and the speed of implementation (X_6) (the relative time to implement the adaptation option). The variables X_1-X_6 are binary variables. The remaining variables include age of participants (X_7), and years of farming experience (X_8). The regression results are discussed here according to adaptation options as follows:

1. The use of wetlands as an adaptation option: gender, availability, cultural compatibility/acceptability, speed of implementation and age were significant and all but speed and age had a positive relationship with adaptive capacity to wetlands as an adaptation option while age and implementation time had negative relationship with adaptive capacity. The likelihood ratio was highly significant indicating the likelihood of adaptive capacity increasing or otherwise when these variables change.
2. For irrigation: gender, cultural compatibility/acceptability, speed of implementation and age were statistically significant. As observed earlier, the gender, cultural compatibility/acceptability, speed of implementation was positively signed while the speed of implementation and age were negatively related. The likelihood ratio was highly significant.
3. Construction of drainage systems: availability of technical skill, funds/other vital resources, accessibility of these resources and age were statistically significant while the variables have signs similar to those already discussed is subsections 1 and 2. The likelihood ratio was highly significant.
4. Use of weather forecast/early warning systems: gender, availability, speed of implementation and farming experience were statistically significant. Unlike in the previous cases, availability was highly statistically significant and negatively signed. This does not corroborate with prior expectations. The likelihood ratio was highly significant.
5. Use of resistant crop varieties: gender, availability and farming experience were statistically significant, which corroborated prior expectations.
6. Change from crops to livestock production: availability, accessibility, speed of implementation, age and years of farming experience were statistically significant. The variables had signs similar to the variables in the wetlands option. Availability and accessibility were positively signed while speed of implementation and age were negatively signed. The likelihood ratio was highly significant.
7. Migration from region at risk of climate change impacts: availability and income were statistically significant and both variables were positively signed.

8. Expansion of cultivated land area: gender, accessibility, feasibility, speed of implementation and age were highly significant in explaining the effectiveness of this option to improve adaptive capacity.
9. Afforestation: accessibility and feasibility were the only significant variables. They were both positively related to adaptive capacity.
10. Change from livestock to crop production: gender, speed of implementation, years of farming experience and income were significant and positively related to adaptive capacity.

In summary, the results from the study have provided empirical evidence that gender, availability of technical skills and other vital resources, cultural compatibility and acceptability of adaptation, feasibility of the adaptation option, speed of implementation, age of the farmer, years of farming experience and income are all determinants of adaptive capacity. Even though each adaptation option had its own set of determinants, the results corroborate the report of working group II of the third assessment report of IPCC (2001) and the Tearfund (2009) reports. These reports identified available technology, available resources and their distribution, the stock of human capital, approximating technical skills, stock of social capacity including property rights and public perception as determinants of adaptive capacity to climate change hazards. It is clear that the availability of physical and economic capacity is imperative to reduce climate related hazards.

Another important result from this study is the implication of gender equity as an important determinant of adaptive capacity. For instance gender equity was found to be positively related to adaptive capacity in the use of wetlands for irrigation, use of weather forecasts and early warning systems, of resistant varieties, expansion of cultivated farmland and change from livestock to crop production. All of these adaptation options with the exception of weather forecast are land based and hence dependent on access to land. Women in the Niger delta have limited access to land as in many cultures women cannot hold title to land and rarely obtain land through inheritance which is the major means of transfer of land ownership in these communities. Therefore in developing adaptation options for Niger delta communities' gender must be mainstreamed into policy, programmes and budgets at local, state and national levels.

Table 28. Determinants of adaptation options capacity

Adaptation Options	Constant	X1	X2	X3	X4	X5	X6	X7	X8	X9	LR	Pseudo R^2	LL
Use of wetlands	1.852	1.01	7.14	1.14	3.7	-	-2.19	-0.45	-0.03	-0.000	192.25	0.61	-61.72
Probability P>Z	(0.396)	0.05 **	0.40 **	0.52 ^{NS}	0.03 ^{NS}	-	0.01 ***	0.24 ^{NS}	0.24 ^{NS}	0.49 ^{NS}	0.000 ***		
Irrigation	1.26	1.55	2.45	6.20	3.85	-	-1.71	-0.55	-0.02	-0.0002	245.7	0.696	-53.7
Probability P>Z	0.40	0.005 ***	0.53 ^{NS}	0.125 ^{NS}	0.001 ***	-	0.000 ***	0.019 **	0.49 ^{NS}	0.718 ^{NS}	0.00 ***		
Construction of drainage	-0.31	0.98	3.01	5.42	-	-	-0.39	-0.06	0.06	0.00005	182.33	0.78	-25.82
Probability P>Z	0.87 ^{NS}	0.27^{NS}	0.03 **	0.000 ***	-	-	0.48 ^{NS}	0.09 *	0.12 ^{NS}	0.63 ^{NS}	0.63 ^{NS}		
Use of weather forecast	3.59	1.37	-4.56	-	-	-	-0.93	-0.93	-0.04	-0.04	182.33	0.46	-60.82
Probability	0.005 ***	0.008 ***	0.000 ***	-	-	-	0.03 **	0.14 ^{NS}	0.067 *	0.44^{NS}	0.000 ***		
Use of resistant varieties	0.302	1.18	8.34	-	1.38	-	-1.19	-0.02	-0.03	-0.00004	383.09	0.61	-124.63
Probabilities	0.84^{NS}	0.001***	0.00***	-	0.23^{NS}	-	0.13^{NS}	0.16^{NS}	0.08*	0.29^{NS}	0.000***		
Change from crops to livestock	3.07	0.28	2.65	2.11	-	-	-0.91	-0.05	0.02	0.00001	62.81	0.32	-67.98
Probabilities	0.002***	0.55***	0.039***	0.052**	-	-	0.08*	0.029**	0.36^{NS}	0.22^{NS}	0.000***		
Migration from climate risk region	-1.20	0.31	8.14	-	-	-	0.185	-0.23	0.004	0.00002	510.98	0.84	-48.44
Probabilities	0.38 ^{NS}	0.62^{NS}	0.000***	-	-	-	0.67^{NS}	0.41^{NS}	0.89^{NS}	0.05**	0.00***		
Expansion of Cultivated land	-16.06	-2.81	-1.39	5.08	2.88	8.50	3.74	0.12	-0.020	-0.00001	922.73	0.96	-21.11
Probabilities	0.00***	0.04**	0.511^{NS}	0.06**	0.18^{NS}	0.00***	0.002***	0.014***	0.60^{NS}	0.49^{NS}	0.000***		
Afforestation	-3.07	0.11	4.37	-	-0.13	5.73	5.73	0.02	-0.06	-0.000009	74.24	0.58	-27.39
Probabilities	0.38^{NS}	0.91^{NS}	0.007***	-	0.96^{NS}	0.00***	0.000***	0.61^{NS}	-0.17^{NS}	0.17^{NS}	0.000***		
Change from animal to crop production	2.09	1.24	-	-	-	-	-	-0.02	-0.04	0.000007	32.77	0.14	-100.50
Probabilities	0.07*	0.02**	-	-	-	-	-	0.20^{NS}	0.04	0.10*	0.00***		

(*10% level significance, ** 5% level significance,***1% level significance, ^{NS} No significance)

Results for Objective 5

Objective 5: Identify adaptation options, through participatory processes, that will ensure that all people (including poor and vulnerable groups such as women, displaced children, orphans and vulnerable children, and physically challenged people) within the Niger delta will benefit from the adaptation process.

Adaptation options

The nine communities involved in this study were involved in participatory rural appraisal (PRA) exercises and Focus Group Discussions. The PRA exercise gave men, women and youth in each community the opportunity to discuss the problems posed by changing climatic conditions and possible adaptation options. These communities were already experiencing flooding and had adaptation measures in place. These were found to be inadequate to deal with the impacts from increased intensity of flooding and temperatures, however. Through a participatory process, it was recognized that the communities needed more technologically advanced methods of adaptation.

The adaptation options selected by communities during PRA are listed by state and community in Table 29.

Table 29. Identified adaptation options by state and community

State/community	Adaptation Options
Bayelsa state	
1. Bebelebiri	River shore protection, construction of a 70 metre bridge, construction of concrete walkway around the community, tree planting to contribute/aid carbon sequestration, capacity building programmes on climate change adaptation strategies, construction of ponds to trap fish, development of community legislation on environmental degradation.
2. Ebedebiri	Construction of culverts or channels, early planting and harvesting of improved varieties, sand-filling to reclaim land now under water, restoration of power supply, construction of shoreline protection and drainage systems and establishment of skill acquisition centres for youth and women, tree planting for carbon sequestration, micro credit facilities, use of improved varieties of seeds, maintenance of environment, migration.
3. Odi	Construction of culverts, more sand filling, river shore protection, use of agro-support services, construction of higher institutions to generate more skilled labour, factories for employment of young graduates, periodic capacity building programme on project maintenance culture.
Delta state	
1. Abari	Construction of fish traps, the use of bamboo stakes to divert excess water and runoff to prevent damage to crops, early planting and early harvest using improved varieties, sand filling of lands to prevent erosion and loss of soil nutrients and for land reclamation, digging of earthen ponds to prevent fish escape, practice of irrigation, use of sandbags on the river banks, 4.5km tarred road, afforestation for carbon sequestration, skills acquisition centre for youth and women, construction of drainage systems, river embankments, piling and construction of market stalls.

State/community	Adaptation Options
2. Oko-amakom	Construction of wooden bridges, minor erosion control strategies, early planting and early harvesting before the annual flood arrives, agricultural inputs supply, micro-credits, higher institutions for improved skills and to attract development, skill acquisition centres for out of school youth, tree planting for carbon sequestration, periodic capacity building programme on climatic adaptation strategies, development of a community leader ship structure, tarred road, maintenance culture to be adopted by the community.
3. Uzere	Construction of water channels to farmlands, early planting and early harvest of improved varieties, the use of water cans for irrigation, construction of artificial lakes, fencing of ponds, fish traps, planting of cover crops to protect the land from direct rays of the sun, erosion, request oil companies to stop gas flaring, land reclamation, tree planting for carbon sequestration and community wood lots, use of sand bags as barriers, use of water cans for irrigation, construction of culverts, drainage systems to channel water to its right course during rainy season and flooding, improved seeds and micro credit to boost agriculture, construction of a 70 metre bridge.
Rivers state	
1. Rukpokwu community	Construction of culverts, channels to farmland, capacity building on adaptation measures and other climate issues, skill acquisition centres for youth and women.
2. Ndoni community	Continuous sand filling for land reclamation, river shore protection, micro-credit, higher institution for training of skilled persons, river slope protection, micro credit, higher institutions for training, river slope protection, equip community members with modern climate change adaptation strategies, modern market stalls, development of high sense of project and environmental maintenance, agro services, factories to boost the economy by providing employment and trading opportunities, banks.
3. Rumu-orusi	Construction of culverts, water channels in the community and farmlands, higher institutions for training, factories for income and employment generation, capacity building for climate change adaptation measures and other issues, micro-credit, agro-services, community legislation, maintenance of projects.

Developing adaptation options for the Niger delta

The adaptation options identified during the PRA exercise were compiled along with other adaptation options found in the literature. These were used in the questionnaire survey and ranked as shown in Table 29. The construction of concrete flood barriers was selected by 94% of respondents followed by financial support for orphans and widows (93%), construction of coastal protection (92%), the inclusion of climate change issues in Government budgets at all levels (90%), information on climate events/hazards and ways to respond (69%). Other adaptation options identified for the Niger delta include construction of shore protection and sand filling to reclaim the land close to the sea shores or river banks (89%), training on how to respond to climate change (85%), housing programme for displaced farmers (84%), financial support for the physically challenged people (82%), cash for victims of extreme flooding events (80%) and resettlement of communities from hazard risk regions (78%). The identified options are shown in Table 30. The people of the Niger delta understand the need to adapt to climate change as only 3% of respondents felt that there was no need to take action.

In response to the question of who should be responsible for adaptation to climate variability and change, the majority felt that the state Government, the Federal government, and the local government authorities, individual households, oil companies, community development committees and the private sector, in descending order, should be responsible for driving the process of adaptation to climate change impacts.

Table 30. Adaptation options identified by respondents

Adaptation Measures	Frequency	Percent of total respondents	Preference Ranks
Construction of concrete flood barriers	896	94	1
Financial support for widows and orphans	885	93	2
Construction of coastal protection	883	92	3
Include climate change issues in Government budget	857	90	4
Early warning information on climate events and how to respond	850	89	5
Construction of shore protection/ sand filling	849	89	6
Training on how to respond to climate events	810	85	7
Housing programme for displaced households	803	84	8
Health facilities	792	83	9
Financial support for physically challenged people	787	82	10
Cooperatives	778	81	11
Cash transfer gift for victims of extreme flooding events	761	80	12
Early warning/ response systems	754	79	13
Resettlement of community by government	749	78	14
Scholarships for children, orphans	740	77	15
Credit and loan scheme	702	73	16
Insurance	701	73	17
Social security programme	667	70	18
Maintenance of water resources	656	69	19
New laws and regulations against forcing factors	621	65	20
Community development committee	618	65	21
Improved stoves	575	60	22
Sharing responsibilities	568	59	23
Resettlement by oil companies or other	563	59	24
Communication networks	515	54	25
Youth Association	486	51	26
Change system of land tenure	479	50	27
Men’s Association	467	49	28
Women’s Association	409	43	29
Permanent migration	356	37	30
Reduction in quality of food consumed	284	30	31
Reduction of number of times food is consumed daily	191	20	32
Do nothing	24	3	33

9. CONSTRAINTS TO ADAPTATION IN NIGER DELTA

Constraints to adaptation in Niger delta

Considering the magnitude of the impacts of climate change in the Niger delta, adaptation is expected to be fraught with myriads of challenges. The results of this study identified factors which respondents considered as constraints to the adoption of the various adaptation options identified. Fifteen of these were rated as critical from the perception of the respondents. The most critical was the governments' unresponsiveness to climate risk management. This is not surprising as the Niger delta communities expect governments at all levels to drive the process of adaptation to climate change impacts.

The next most critical constraints, in descending order, were:

- lack of access to credit facilities,
- limited income,
- the lack of "Government presence",
- lack of information as to what to,
- inadequate knowledge on how to or build resilience,
- limited availability of land for farming,
- limited access to weather forecast technology,
- poor information and absence of early warning systems,
- high cost of farmland, poor access to information, and
- low availability and access to improved farm inputs such as improved cultivars, seeds and insecticides.

Others constraints include the tenure system, which is based on an inheritance structure that fosters land fragmentation and discrimination against women and the communal system of land ownership which discriminates against women because of many socio-cultural stereotypes. The next category of constraints was classified as high and include, in descending order: scarcity of farm labour as many youth and able bodied men have migrated to other locations with better economic security, high cost of fertilizers, non-availability of processing facilities, high cost of irrigation facilities and traditional beliefs and practices on commencement of farming seasons. None of the constraints were considered modest, low or not important. The constraints are shown in Table 31.

Table 31. Constraints to adaptation

Constraints to Adaptation	Rank of extent of problem by respondents				
	Not important	Low	Modest	High	Critical
	1	2	3	4	5
Limited availability of land for farming	1.2	8.5	16.1	29.6	44.6
High cost of farmland	5.8	8.9	13.1	29.5	42.8
Inherited system of land ownership	8.3	7.5	23	23.9	37.3
Communal system of land ownership	5.8	10.2	26.9	24.5	32.5

Constraints to Adaptation	Rank of extent of problem by respondents				
	Not important	Low	Modest	High	Critical
	1	2	3	4	5
Poor access to information sources	3.4	3.6	14.7	35.8	42.5
Lack of access to credit facilities	1.1	1.5	14	31.9	51.6
High cost of irrigation facilities	4.7	4.8	22	34.4	34.1
Non-availability of farm inputs e.g. improved seeds	2.1	5.9	15.7	34	42.3
High cost of fertilizers and other inputs	1.1	2.3	18.4	45.7	32.4
Inadequate knowledge of how to cope or build resilience	0.9	4.8	10.8	37.8	45.7
High cost of improved varieties	0.9	4.6	22.3	43	29.2
Non-availability of farm labour	1.3	1.8	12.3	51.9	32.7
High cost of farm labour	4.7	7	10.6	36.8	40.9
Lack of access to weather forecast technologies	2.2	5.2	12.4	37.4	42.9
Government irresponsiveness to climate risk management	1.3	6	6.5	27.8	58.5
Unavailability of storage facilities	1.3	6.7	11.3	41.3	39.4
Limited income	0.6	7.2	11.6	32.7	48
Unavailability of processing facilities	0.7	8.9	13.8	44.1	32.4
High cost of processing facilities	2	7.3	13.4	45.9	31.3
Traditional beliefs/practices e.g. on the commencement of farming season etc.	5.1	11	14.2	39.1	30.7
Poor agricultural extension service delivery	1.5	6	19.1	42.7	30.8
Lack of capacity of extension service to build resilience of farmers on climate change	1	6.7	19.1	40.8	32.4
Poor information and absence of early warning systems	0.8	6.9	13.9	36.8	41.5
Lack of information on what to do	0.9	7.4	16.1	29.6	46
Absence of government	2.1	9.3	18.6	23.4	46.6

10. CLIMATE CHANGE ADAPTATION ASSESSMENT SUMMARY

Assessment of Climate Change Hazards, Impacts, Vulnerability and Adaptation

Table 32. Impact-Vulnerability-Adaptation Matrix

Climate Change Hazards	**Climate Change Impacts**	**Vulnerability Assessment**	**Adaptation Options**
Increased rainfall intensity leading to flooding	Flooded farm lands	Critical. Local economy is agro dependent. Crops are lost to floods.	• Relocating farms away from river banks • Use of drip irrigation
	Shortage of food production	Food insecurity, drop in nutrition, has health implications. Critical.	• Disbursement of grants for improved agricultural inputs • Create access to microcredit for affected households • Intensified role of extension workers • Mechanized farming • Promoting home gardening practice
	Loss of agro- investment	Critical. Loss of income as there will be no return on investments. The women are more impacted	• Relocating farms away from river banks • Use of drip irrigation
	Shortage of income	Critical poverty level increases contrary to the objectives of the MDGs	• Train farmers on alternative agricultural and nonfarm enterprises with grants to launch out into the new enterprises
	Loss of employment for traders/youth	High poverty level increases contrary to the objectives of the MDGs	• Relocating farms away from river banks • Use of drip irrigation
	Increase in food prices	Critical. Inability for the poor to purchase food items. Increase in malnutrition-related illnesses. Women are more impacted	• Temporary importation/introduction of food subsidy
	Spread and increase in incidence of diseases	Critical. Expected outbreak in incidence and severity of diseases and new illnesses.	• Proper waste disposal, management/recycling • Sewage treatment rather than open discharge • Health/sanitation education campaign • Providing enabling environment for health workers to be resident in rural communities
	Loss of aqua-cultural products	High. Both the men who are more involved in fishing and the women who are traders of aquaculture	• Digging of artificial ponds before flooding to hold back schools of fishes

Climate Change Hazards	Climate Change Impacts	Vulnerability Assessment	Adaptation Options
		products are impacted	• Construction of diversion trench and fencing to prevent fish escape • The use of bamboo nets and stakes as fish traps • Consumption of iced fish as alternative • Fish processing and canning industries will secure jobs and income • Drying of produce using electric ovens
	Pollution on contact with exposed garbage	High. Both sexes are at risk exposure. The men are more impacted	• Proper waste disposal, management/recycling. • Sewage treatment rather than open discharge • Health/sanitation education campaign • Separated disposal and composting of organic waste.
	Loss of properties	High. The men are more impacted	• Relief funds • Change of building patterns from mud to block • Building structures with high elevation
	Damage to road infrastructure	High. All community members are affected	• Reconstruction with enforced materials
	Hunger/malnutrition	Critical. The women and children are more impacted	• Change in diet. • Nutritional education
Delayed onset of rainfall	Distortion of tradition planting season	Critical. The whole community is affected	• Reliance on artificial irrigation system (preferably drip irrigation)
	Reduction in length of growing season	Critical. The whole community is affected	• Planting early maturing, hardier varieties • Selecting and planting cultivars with genetic capacity for particular habitats
	Shortage of food production	Critical. Food insecurity, drop in nutrition has health implications	• Introducing dry season farming • Promoting homestead farming practices
Excessive heat/drought (Oko-Amakom community)	Scorched crops (crop wilt)	Critical. Poor yield. Loss of agro investment	• Artificial irrigation • Sinking solar powered boreholes • Planting heat resistance varieties • Research for hardier varieties
	Decrease in plant productivity	High. Both men and women are affected	• Artificial irrigation • Planting heat resistance varieties

Climate Change Hazards	Climate Change Impacts	Vulnerability Assessment	Adaptation Options
			• Research for hardier varieties
	Food scarcity	Critical. Poor nutrition especially amongst women and children	• Artificial irrigation • Planting heat resistance varieties • Research for hardier varieties • Promoting home gardening practice
	Post-harvest damage to crops	High. Women who are traders are more affected.	• Building food preservation centres in strategic locations • Construction of link roads to interior farming communities • Setting up agro-product transport schemes
	Loss of investment	Critical. Both men and women are affected.	• Provision of microcredit
	Heat rashes	High. The men are more impacted	• Use of solar powered/energy efficient air conditioners • Planting shade trees around residential areas
	Heat stress on livestock/fisheries	High. Both men and women fisher folks are affected. Household protein consumption is reduced	• Planting shade trees around fishponds, poultry's etc.
Excessive rainfall	Flash floods	High. All community members are affected. More properties are lost by the men	• Drainage construction • Early warning information on weather predictions/forecast should be assessable to all via mobile phones
	Erosion	High. All community members are affected. More properties are lost by men	• Planting economic trees with around neighbourhoods • Drainage construction
	Loss of properties/homes	High. More properties are lost by men	• Change from mud to block houses
	Land slide (Abari community)	High. More properties are lost by men	• Concrete barriers/ embankment projects • Tree planting
	Destruction of make-shift business centres	High. The women who do more of the trading are more impacted	• Early warning information on weather predictions/forecast should be assessable to all via mobile phones
Sea level rise	River level rise	High. All riverside community members are affected	• Massive tree planting along shorelines
	Land slide/loss of river banks (Abari community)	High. All community members are affected	• Massive tree planting along shorelines
	Loss of shore line	High. All community members are affected	• Massive tree planting along shorelines • Dredging and sand filling.

Climate Change Hazards	Climate Change Impacts	Vulnerability Assessment	Adaptation Options
	Loss of settlement/displacement	Critical. All community members are affected	• Massive tree planting along shorelines • Resettlement
	Emigration	Critical. Youth and women are affected. The youth migrate to towns and take up high risk jobs like bike riding, prostitution	• Resettlement
	Alien species invasion	High threat to native species. All community members are affected	• Biological control measures • Exploiting economic potentials abound in alien species such as the water hyacinth
	Clearing of vegetation for new settlements	High. Hunters and herbalists are disadvantaged	• New housing schemes should employ high rise apartment buildings
	Loss of biodiversity	Critical. Reduced dependence on forest resources. The women are more impacted	• Establishment of conservation centers • LULUCF projects
Strong winds	Destruction of roofs of buildings	High. The men are more impacted	• Tree planting for wind breaks
	Destruction of poles supporting power lines.	High. All community members are affected	• Use of underground power transmission lines • Domestic solar energy system
Heavy fog	Poor visibility	High. Motorists whom are predominantly men are affected	• Solar street lights • Regular routine road maintenance
	Accidents/loss of lives	High. Men are more impacted	• Solar street lights
Irregular rainfall patterns	Inability to predict planting and harvest seasons traditionally.	Critical. Drop in crop production. Both men and women are impacted equally	• Regular communication of weather forecasts to farmers via info-tech
	Poor productivity	Critical. Both men and women are strongly impacted	• Introduction of dry season agriculture using artificial irrigation, hydroponic farming
	Loss of investment	Critical. Both men and women are affected	• Early warning information on weather predictions/forecast should be assessable to all via mobile phones

Table 33. Policies, Programs, Adaptation Options Addressed, Implementing Agency and Cost

Proposed CCA Policies	Proposed CCA Programs	CCA Options Addressed by Proposed Policies and Programs	Implementing Agency(s)
Immediate Needs			
Declare emergency in affected communities	Emergency relief fund/interventions	Social security programme	SG, FG, LGA, Donor agencies, NGOs
Early warning systems	Weather forecast and warning/advise	Early warning Information on climate event and how to respond	NIMET
Awareness campaign/ advocacy	Awareness campaign/ advocacy for behaviour change	Training on how to respond to climate events	Ministry of Information, Government agencies, Donor agencies, NGOs
Create access to microcredit for affected households	Disbursement of grants for improved agricultural inputs.	Credit and loan scheme	Private sector organisations, banks, oil companies, SG, FG, LGA, Donor agencies, NGOs
Alternative agriculture	Intensified role of extension workers	Training on how to respond to climate events	Ministry of Information, Government agencies, Donor agencies, NGOs
Create budget head for climate related hazards	Create budget head for climate related hazards	New laws and regulations	Ministry of Finance, SG, FG, LGA,
Reorientation/training	Train farmers on alternative agricultural and non-farm enterprises with grants to launch out into the new enterprises	Training on how to respond to climate events	Ministry of Information, Government agencies, Donor agencies, NGOs
Long Term Needs			
Resettlement	Relocating farms away from river banks and other locations of high risk.	Housing programme for displaced households	Ministry of housing, Ministry of Water resources, SG, FG, LGA
Resettlement	Relocate households from hazard prone locations	Housing programme for displaced households	Ministry of housing, Ministry of Water resources, SG, FG, LGA
Tree planting	Massive tree planting along shorelines and everywhere	New laws and regulations against forcing factors	Ministry of Environment, Ministry of Agriculture
Tree planting	Operation plant 2 trees to replace 1 felled	New laws and regulations against forcing factors	Ministry of Agriculture. Ministry of Environment,

Proposed CCA Policies	Proposed CCA Programs	CCA Options Addressed by Proposed Policies and Programs	Implementing Agency(s)
			Ministry of Information, Government agencies, Donor agencies, NGOs
Concrete barriers/ embankment projects	Concrete barriers/ embankment projects	Construction of shore protection/ sand filling	Ministry of Environment, Ministry of Works, SG, FG, LGA
Dredging and sand filling	Dredging and sand filling	Construction of shore protection/ sand filling	Ministry of Works, Ministry of Environment, Ministry of Water resources, SG, FG, LGA
Drainage construction	Drainage construction	Drainage construction	Ministry of Works, Ministry of Environment, Ministry of Water resources, SG, FG, LGA
Biological control measures	Biological control measures	Maintenance of water resources	Ministry of Water resources, SG, FG, LGA
Alternative agriculture	Introduction of dry season agriculture using artificial irrigation, hydroponic farming	Training on how to respond to climate events	Ministry of Agriculture,
Develop technology to use water Hyacinths	Use water hyacinths for paper, ceiling boards, etc and save the trees	Maintenance of water resources	Ministry of Water resources, SG, FG, LGA

11. CONCLUSIONS AND POLICY IMPLICATIONS

The Niger delta region has had its share of negative impacts of climate change. The uncertainties that have added to the climate change challenge in the region and the vulnerability of livelihoods are evident. The communities studied in the Niger delta have experienced increasingly early rains that are not sustained, crops that are exposed to increasing temperatures causing farmers to plant and replant their crops within one cropping season. There has also been an increase in the irregularity in the start-up and end of rains. Extreme climatic events have also been on the increase, such as thunder storms, heavy winds, floods, flash floods, more frequent drought events even in locations very close to the River Niger, excessive heat as temperatures rise and erratic rainfall. Coastal erosion has also led to the loss of farmlands and houses to the Forcados River in Abari. The experiences in the Niger delta corroborate the predictions of the IPCC (2001, 2007) and DIFD (2009).

This study has established that individual households and entire communities are highly vulnerable to the impacts of climate change. It is obvious that the response to climate change in the Niger delta region is belated, which has had dire consequences. From the outcome of farming activities and harvests from crop production, it is evident that food insecurity and hence a food crisis is imminent in the Niger delta communities.

Recommendations

Based on the findings of this research the following recommendations have been made.

1. The establishment of climate change information systems by the Government. These will provide awareness campaigns for members of the public, provide weather forecast/early warning information services and provide training on how to adapt to climate change.

2. Economic trees should be replanted by those who fell them. The principle of 'plant two trees in the place of one felled tree' should be inculcated into Nigerians by moral persuasion and should be backed by law. Over the years, resources available in the wild have been exploited and the rate of natural replacement has been slower than the rate of exploitation.

3. The development of a national policy on climate change to guide the response to the unfolding evidence of impact of climate change by all stakeholders is critical at this time.

4. One of the greatest challenges for this research was the absence of relevant gender disaggregated data on the different indicators of climate change. There is therefore a need to setup, equip and finance research and development units in NIMET, Ministry of Environment, all other ministries (particularly the line ministries), support Universities and research institutes to generate statistical information. Relevant and credible data are required to enhance evidence based policy making. This is essential if Nigeria is to make any reasonable progress in its response to climate change.

5. The determinants of adaptive capacity must be targeted in budgeting and in programming and policy making.

Issues and way forward

1. Time is short for this type of project. The time is not enough to adequately assess impact on livelihood of communities.
2. There is need to incorporate the sustainable livelihood approach through action research. A period of 2 to 3 years would be needed to do this.
3. Communities expect researchers and government to come up with workable solutions. This can only be achieved by working in the communities on field trials. Hence, there is need for more projects like BNRCC.
4. The greatest challenge to this research was transportation. These constraints must be considered in future research projects.

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Appendix A. Photos

Photographs showing impacts of climate change related hazards in the sampled locations.

Plate 1. Flooded commercial fish pond in Uzere
(RULIN field survey, 2010)

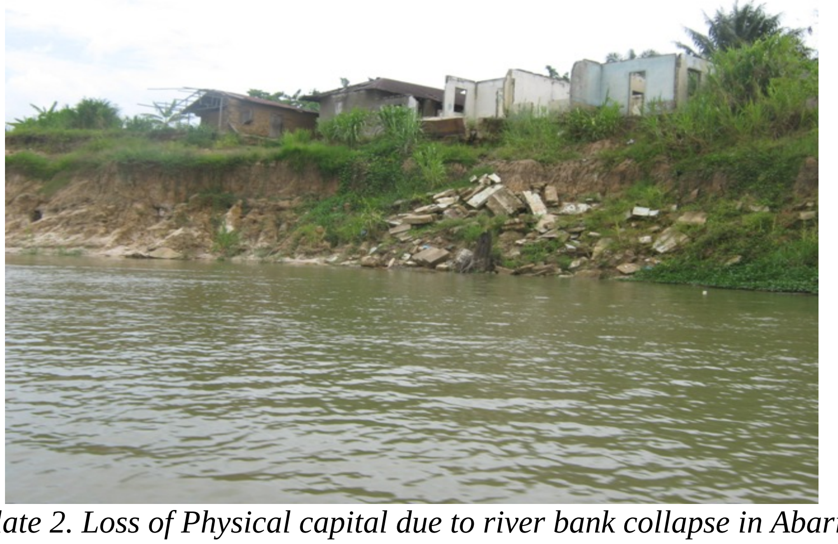

Plate 2. Loss of Physical capital due to river bank collapse in Abari
(RULIN field survey, 2010)

Plate 3. A building under construction abandoned by the owner due to river bank erosion
(RULIN field survey, 2010)

Plate 4. Residents of one of the respondents in Uzere
(RULIN field survey, 2010)

Plate 5. Mud house ravaged by strong winds in Ndoni
(RULIN field survey, 2010)

Plate 6. Poor tuber formation of potatoes in Oko-amakom
(RULIN field survey, 2010)

Plate 7. A woman showing poor crop production of groundnut with empty pods in Oko-Amakom (RULIN field survey, 2010)

Plate 8. Research team leader, Rosemary Okoh, hopping over flooded roads leading to residents' homes in Oko-amakom (RULIN field survey, 2010)

Plate 9. Chairman, CDC, Abari community pointing to where the river bank was 30 years ago (*RULIN field survey, 2010*)

Plate 10. Little boy cools off the heat of the day in the flood that has taken over his residence (RULIN field survey, 2010)

Plate 11. Primary school in Uzere overtaken by the flood (RULIN field survey, 2010)

Plate 12. Poor growth of yam plants by the riverside in Oko-Amakom (RULIN field survey, 2010)

Plate 13. Members of research team on their way to Abari community in Delta state. Boat is the only means of access to the location (RULIN field survey, 2010)

Plate 14. Poor development of groundnut caused by drought in Oko-Amakom (RULIN field survey, 2010)

Plate 15. Poor development of yam tubers by draught/excessive heat followed by flood in Oko-Amakom (RULIN field survey, 2010)

Plate 16. Effort to save poorly developed cassava from flooded farm land in Uzere (RULIN field survey, 2010)

Plate 17. Gender mainstreaming in dialogue session during PRA activity in Uzere (RULIN field survey, 2010)

Plate 18. Gender mainstreaming in interview session during PRA activity (RULIN field survey, 2010)

The following photographs show vulnerability of some of the sampled communities in the Niger delta region.

Plate 19. Flooded Cassava farm

Plate 20. Flooded farm land and farmer attempting to save his harvest

Plate 21. Sea level rise in Rumu Orusi

Plate 22. Flooded homes in Bebele biri

Plate 23. Abandoned house surrounded by standing water with algae and mosquitoes

Plate 24. Satellite photograph of location of Bebelebiri community.
Source Google satellite imagery, 2010

Plate 25. Satellite photograph of location of Ndoni community.
Source Google satellite imagery, 2010.

Plate 26. Satellite photograph of location of Ebedebiri community.
Source Google satellite imagery, 2010.

Plate 27. Satellite photograph of location of Odi community.
Source Google satellite imagery 2010.

Appendix B. Logical Framework

Objective	Methodology (Data analysis)	Sample size (if applicable)	Data required	Timeline	Team Member responsible	Deliverable	Outcome
Objective 1:Trend analysis and evaluation of the changes in major climate variables such as temperature, rainfall, and any seasonal changes to establish a priori evidence for existence of climate change in the Niger delta	The trend analysis, descriptive statistics	39 year period of monthly time series data	Time series data	April2010-April2011	Team members	Inception reports, progress reports, draft final reports and the final reports	Level of change in major climate change variables
Objective 2: Evaluate gender disaggregated impact of climate change hazards on the biodiversity resource base through local knowledge and perceptions of impact on forest resources, wildlife, plant species, fisheries, water resources and farm lands in the Niger delta communities;	Simple statistical tools were used. These include-percentages, averages, median, mode, range and trend analysis for prediction of future changes, vulnerability/ risk scores.	1630 participants	Land use, forest, livestock, wildlife, fisheries and water, resources, plant and animal diseases, plant species, as well as livelihood capitals for men and women in the Niger delta communities pictographs, video documentations.	April2010-April2011	Team members	Inception reports, progress reports, draft final reports and the final reports.	% level of impact of climate change related hazards on land use and conservation, wildlife, forest resources, livestock, plant species etc.

Objective	Methodology (Data analysis)	Sample size (if applicable)	Data required	Timeline	Team Member responsible	Deliverable	Outcome
Objective 3: Evaluate impact of climate change on livelihood assets disaggregated by gender;	Computation of losses incurred in climate related hazard events, vulnerability concept table	1630 participants	Gender disaggregated data on livelihoods, bio-diversities and dependence on natural capital, Vulnerability to impact of storms, sea levels, sea surges, flooding, their intensities and duration, pictographs, video documentaries.	April2010-April2011	Team members	Inception reports, progress reports, draft final reports and the final reports.	Number of men and women whose livelihoods are differently affected by climate events in the Niger delta, % changes in men's and women's livelihoods
Objective 4: Evaluate the determinants of adaptive capacity for translation into development policy for the Niger delta region;	PRA (gender disaggregated FGD, key informant interviews), Sustainable livelihood analysis and questionnaire survey. Simple statistical tools were used. These include- percentages, averages, median, mode, range, value of losses and benefits(if any)	1630 participants	Data on adaptation strategies, indicators of adaptive capacity, benefits/gains from adaptation strategy, documentaries	April2010-April2011	Team members	Inception reports, progress reports, draft final reports and the final reports	Number of determinants of adaption strategies identified, the community based economy of the Niger delta

Objective	Methodology (Data analysis)	Sample size (if applicable)	Data required	Timeline	Team Member responsible	Deliverable	Outcome
Objective 5: Identify adaptation options, through participatory process, that will ensure that all the people including poor and vulnerable groups such as women, displaced children, orphans and vulnerable children, and physically challenged people within the Niger delta will also benefit from the adaptation process.	PRA (gender disaggregated FGD, key informant interviews), Sustainable livelihood analysis and questionnaire survey. Simple statistical tools were used. These include- percentages, averages, median, mode, range, vulnerability /risk scores.	1630 participants	Information on adaptation options, pictographs, video documentaries.	April2010-April2011	Team members	Inception reports, progress reports, draft final reports and the final reports.	Number of adaptation options developed to ensure that all the people inclusive of vulnerable groups benefit from the adaptation process

Appendix C. Rulin Team Members (Name and Position)

Rosemary N. Okoh, Principal Researcher
Patrick N. Okoh, Team member
Michael Ijioma, Team member
Igbekele A. Ajibefun, Team member
Kelvin I. Idehen, Team member
Patrick C. Ajieh, Team member
Agatha A. Nwabueze, Team member
Joseph O. Ovharhe, Team member
Julius Emegbo, Team member
Emmanuel U. Osakwuni, Research Assistant

REPORT 3: GENDER DIMENSIONS AND INDIGENOUS KNOWLEDGE FOR ADAPTATION TO CLIMATE CHANGE IN SOUTH EAST NIGERIA

A Research Report by Women and Children Development Initiative (WACDI), Umuahia, Abia State

GENDER DIMENSIONS AND INDIGENOUS KNOWLEDGE FOR ADAPTATION TO CLIMATE CHANGE IN SOUTH EAST NIGERIA

Research Report
Women and Children Development Initiative (WACDI)

JUNE 2011

Prepared For:
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EXECUTIVE SUMMARY

Climate change is a global concern because of its multifaceted impacts on the environment, livelihoods, infrastructure and the socioeconomic and cultural wellbeing of people. Efforts are being made to fully understand its dynamic nature as well as how best to adapt to its impacts. Adaptation to the impacts of climate change requires a clear understanding of the nature and magnitude of vulnerability to climate change impacts. To ensure communities become more resilient, adaptation strategies must build on the indigenous knowledge of the people for whom the adaptation is developed. Adaptation strategies must also take into account how the impacts of climate change affect women and men differently. It is against this background that we implemented the research project, “Gender Dimension and Indigenous Knowledge Systems for Adaptation to Climate Change in Southeast Nigeria”.

The study was conducted in five selected communities in each of Abia, Anambra, Enugu and Imo States of Nigeria. Rainfall and temperature data were obtained from the Nigerian Meteorological Agency (NIMET) as well as the meteorological station at the National Root Crops Research Institute (NRCRI) in Umudike. Climate change hazards in the various communities were assessed through a guided tour of the areas of the community affected while observations were documented by photography and video. Awareness and perception of the rural populace to climate change were assessed through in-depth interviews of community leaders and by focus group discussions separated by gender. The vulnerability of different genders within the community was determined through a household survey designed to collect information from male-headed and female-headed households. Data collected were analyzed using appropriate statistical techniques that include descriptive statistics and regression analysis.

The results showed that mean annual rainfall has not changed significantly from 1970 to 2008. However, there has been a decline in rainfall in the first quarter and fourth quarter of the years over the same period. In regions with eight to ten months of rainfall, about 78% of the rains now fall within six months (May-October) of the year. This concentration of rainfall within a shorter period of time has severe negative implications for agricultural productivity because it affects soil degradation, flooding, and limits the availability of farmlands.

Temperature has increased in the time period between 1970 and 2008. High temperatures and low rainfall, especially in the first quarter which corresponds to the commencement of farming activities, leads to late planting and poor harvest.

The climate change impacts observed in the study area included sheet and gully erosion on roads, farmlands and residential areas, landslides, flooding of roads, farms and residential areas, wind damage to trees, houses, electric poles etc., and heat stress. Loss of soil and farmlands especially to gully erosion is a major challenge to the dominant livelihood activity of the region (farming). Soil degradation, reduced availability of farmlands due to extensive gully erosion, high temperatures and delayed onset of rainfall all contribute to vulnerability of farmers and rural people.

In the study area, at least 91% of the male respondents and at least 89% of the female respondents were aware of climate change and climate hazards. The level of awareness was higher among men than women in the southeast. The impact of climate change hazards is greatest on the environment and on natural resource-based livelihoods. People of the southeast of Nigeria identified unpredictable rainfall, late onset of rainfall, increased rate of flooding, high temperatures and heat

waves as the major indicators of climate change in the area. The increasing temperature and decreasing rainfall (in first quarter) confirm changes in the climate of the study area.

Determinants of vulnerability varied by gender in the different states studied. There was no difference in the vulnerability of male and female-headed households in Abia and Enugu States. Vulnerability for male-headed households was different from that of the female-headed households in Anambra and Imo States. However, while the vulnerability function was due to the sex of the household head in Imo State, it was not due to the sex of the household head in Anambra State. Consequently, our results showed that gender differences in vulnerability exist in Imo State and not in the other states.

Measures taken by communities to adapt to or cope with gully erosion include tree planting and dumping refuse in gullies. The main coping strategy for flooding is digging flood reception pits and constructing bunds to protect residential houses and intra-village roads. There is also local legislation enacted by communities and enforced by both the traditional rulers and the Town Unions.

Town Unions and Age Grade Associations are the most important socio-cultural groups that positively contribute to the development of communities. Socio-economic groups such as co-operatives, savings and credit associations concern themselves primarily with the welfare of their members.

The costs of impact ranged from N43,000 to N454,000 for erosion, N13,000 to N441,000 for flooding, N6000 to N110, 000 for heat stress, and N5000 to N817,000 for cold. The cost of adaptation is N33,000 to N190,000 for erosion, N16,000 to N164,000 for flooding, N3,000 to N66,000 for heat stress and N203 to N98,000 for cold.

ACRONYMS

BNRCC	Building Nigeria's Response to Climate Change
CBO	Community Based Organisations
FGDs	Focus group discussions
GHG	Greenhouse Gases
IDIs	In-depth Interviews
IK	Indigenous Knowledge
IKS	Indigenous Knowledge Systems
ITK	Indigenous Technical Knowledge
IPCC	Intergovernmental Panel on Climate Change
LK	Local Knowledge
NEST	Nigerian Environmental Study/Action Team
NGO	Non-Governmental Organisation
NRCRI	National Root Crops Research Institute
NIMET	Nigerian Meteorological Agency
TK	Traditional Knowledge
UNFCCC	United Nations Framework Convention on Climate Change

1. INTRODUCTION

Background of the Study

Climate change is a significant shift in the state of the atmosphere over a period of time which is usually measured in centuries. Climate variability describes the fluctuations around the mean state of the atmosphere over a given area as deduced from observations over a period of at least 30 years (Ayoade, 2008).

Climate change impact refers to adverse effects of climate change on the ecosystem, livelihoods and wellbeing of people. In south-eastern Nigeria, these impacts are expressed as:

- flooding of farmlands resulting in yield losses;
- loss of farmlands to gully erosion;
- sheet wash that removes fertile top soils;
- delayed onset of rains and unexpected cessation of rainfall that reduces crop yield causing drastic changes in land cover and biodiversity;
- sudden outbreaks of invasive pests and noxious weeds that lead to crop failure and food insecurity;
- wind damage to economic crops or infrastructural facilities; and
- inconveniencies or ill-health resulting from heat stress.

Vulnerability refers to the inability to cope with the adverse effects of climate change. When a farmer cannot cope with delayed onset of rains or sudden prolonged dry spells or unexpected early cessation of rains that leads to crop failure and food insecurity, she or he is vulnerable. Similarly, if a household is suddenly taken over by floods, forcing family members to seek refuge in the homes of friends and relatives, that household is vulnerable. Because of the high rate, frequency and intensity at which climate change is happening, it is urgent that vulnerability is reduced and the capacity to adapt enhanced.

Adaptation to climate change refers to responses or actions taken to minimize the impacts of climate change in the long term. Building the capacity of people to adapt requires understanding peoples' local and traditional knowledge and adaptation/coping skills. Indigenous knowledge refers to the knowledge, skills, practices and beliefs that enable a local community to achieve stable livelihoods in their environment. Understanding climate change from the perspective of local people will offer greater and new insights into how individuals and communities are affected and how effective strategies for adaptation and mitigation of its adverse impacts can be developed. An appropriate adaptation strategy enables both men and women to effectively adapt to the impacts of climate change.

The project, "Gender Dimensions and Indigenous Knowledge System for Adaptation to Climate Change in the Southeast Agro-ecological Zone of Nigeria", is part of the research component of the Building Nigeria's Response to Climate Change (BNRCC) project being implemented by the Nigeria Environmental Study/Action Team (NEST). The aim of the BNRCC project is to increase Nigeria's capacity to adapt to the current and anticipated effects of climate change thereby reducing the impacts of climate change on the livelihoods of vulnerable men and women. To achieve this aim, the BNRCC project involves research on Nigeria's vulnerability to climate change impacts to identity possible adaptation actions and the implementation of pilot adaptation projects in the most vulnerable communities. The experience from the research and pilot adaptation projects will guide the development of a comprehensive sustainable and gender sensitive national strategy for climate change adaptation in Nigeria to be integrated into the national policy framework.

Rationale for the Study

The Intergovernmental Panel on Climate Change (IPCC, 2000; 2007) confirms the reality of climate change, a global phenomenon that has damaging effects on human livelihoods and their support systems. Climate change also threatens the Millennium Development Goals (MDGs) of reducing extreme poverty and improving peoples' welfare. In Nigeria, the analysis of long-term meteorological data (temperature, rainfall, dust haze and hail) shows discernible evidence of climate change (NIMET, 2008). Annual rainfall has declined over both time and space with reductions of between 100-313 millimetres (mm) depending on the location and topography (IITA, 1992). The results also show fewer wet days (IITA, 1992) and higher rainfall intensities (Owonubi et al., 1992) as well as shortened crop growing periods (Audu et al., 2004). Between 1970 and 2000, many parts of the country were affected by late onset and early cessation of rainfall relative to the period 1941- 1970 (NIMET, 2008). Similarly, many parts of the country now experience warmer conditions compared to the period thirty years ago. According to a study by NEST, evidence of climate variability and climate change in Nigeria are indicated by increasing surface air temperatures, increasing heat waves which enhances disease vectors, communicable diseases and epidemics, sea level rise and associated coastal erosion, flooding, saltwater intrusion and mangrove degradation. Other evidence includes increased evaporation that leads to the drying up of streams and rivers, loss of forest vegetation which promotes soil degradation and desertification, as well as changes in seasonal patterns of climatic variables leading to reduced agricultural productivity (NEST, 2003).

Despite evidence of climate change in Nigeria, no study has sought to understand the vulnerabilities of men and women in relation to the impacts of climate change. Rain-fed agriculture is the main livelihood of people living in south-eastern Nigeria. However, in recent times farmers are unable to predict the onset and cessation of rainfall as well as the occurrence and duration of dry spells which result in crop failures. Both soil erosion, which characterizes the landscape of the land surface of south eastern Nigeria (Ofomata, 1981) and floods, a common and recurrent phenomenon in the coastal and riverine areas (NEST, 1991), are weather-related hazards. The magnitude of gully erosion and frequency of flooding has continued to increase so the impact on the wellbeing and livelihood activities of men and women is affected.

Climate change impacts will be differently distributed among different regions, generations, age classes, income groups, occupation and gender (IPCC, 2001). Men and women are not alike in terms of their vulnerabilities and their ability to prepare for or recover from shocks to their livelihoods (Adelekan, 2008). It is against this background that we investigated the gender dimensions and indigenous knowledge systems for adaptations to climate change in southeast Nigeria.

Objectives of the Study

The goal of this study was to determine gender differences in and the indigenous practices for adaptation to climate change. The specific objectives were to:

1. Analyze the trends of climatic variables in the study area;
2. Identify the major climate change hazards and describe the processes by which they impact livelihoods and welfare in the study area;

3. Determine gender differences in awareness and perception of climate variability and climate change and the impacts of associated hazards;
4. Evaluate gender differences in vulnerability to the impacts of identified hazards of climate change and variability with respect to the following indicators – economic wellbeing, dependence on agriculture, education, health and nutrition, physical infrastructure, food security, poverty, and access to resources;
5. Identify the measures taken by communities in adapting to impacts of major climate change hazards and assess differences between women and men in terms of responses and adaptation needs;
6. Determine economic, social, cultural, technological and institutional constraints to and opportunities for enhancing adaptive capacities of women and men to climate change impacts; and
7. On the basis of the identified major climate change hazards, estimate the costs of impacts and adaptation measures/coping strategies.

Scope of the Study

The study was conducted in four states in the Southeast agro-ecological zone of Nigeria. The states are Abia, Anambra, Enugu, and Imo. In each state, five communities were purposely selected based on visible physical evidence of climate change impacts such as erosion, flooding etc. In Abia, the five communities chosen were Akanu, Ekeluogo, Elu, Eziukwu, and Mgbaga.

In Anambra State, the selected communities include Ojoto, Igboukwu, Isuofia, Nri, and Oko, while in Enugu State, Ngwouno, Amuabi, Ebe, Eke and Udi were selected. In Imo State, Amucha Ebeise, Okponakuma, Okwudor, Umuoma Nekede and Mbieri were selected. Primary data were collected for the study through household surveys using structured questionnaires, focus group discussions (FGDs) with knowledgeable community members and in-depth interviews (IDIs) with community leaders. In each community, 20 male-headed and 20-female headed households were surveyed while FGDs were held with men, women, and youth groups. IDIs were conducted with men, women, and youth leaders.

2. CONCEPTUAL FRAMEWORK AND LITERATURE REVIEW

Conceptual Framework

Based on the links between climate change hazards and impacts a conceptual framework was developed (Figure 1).

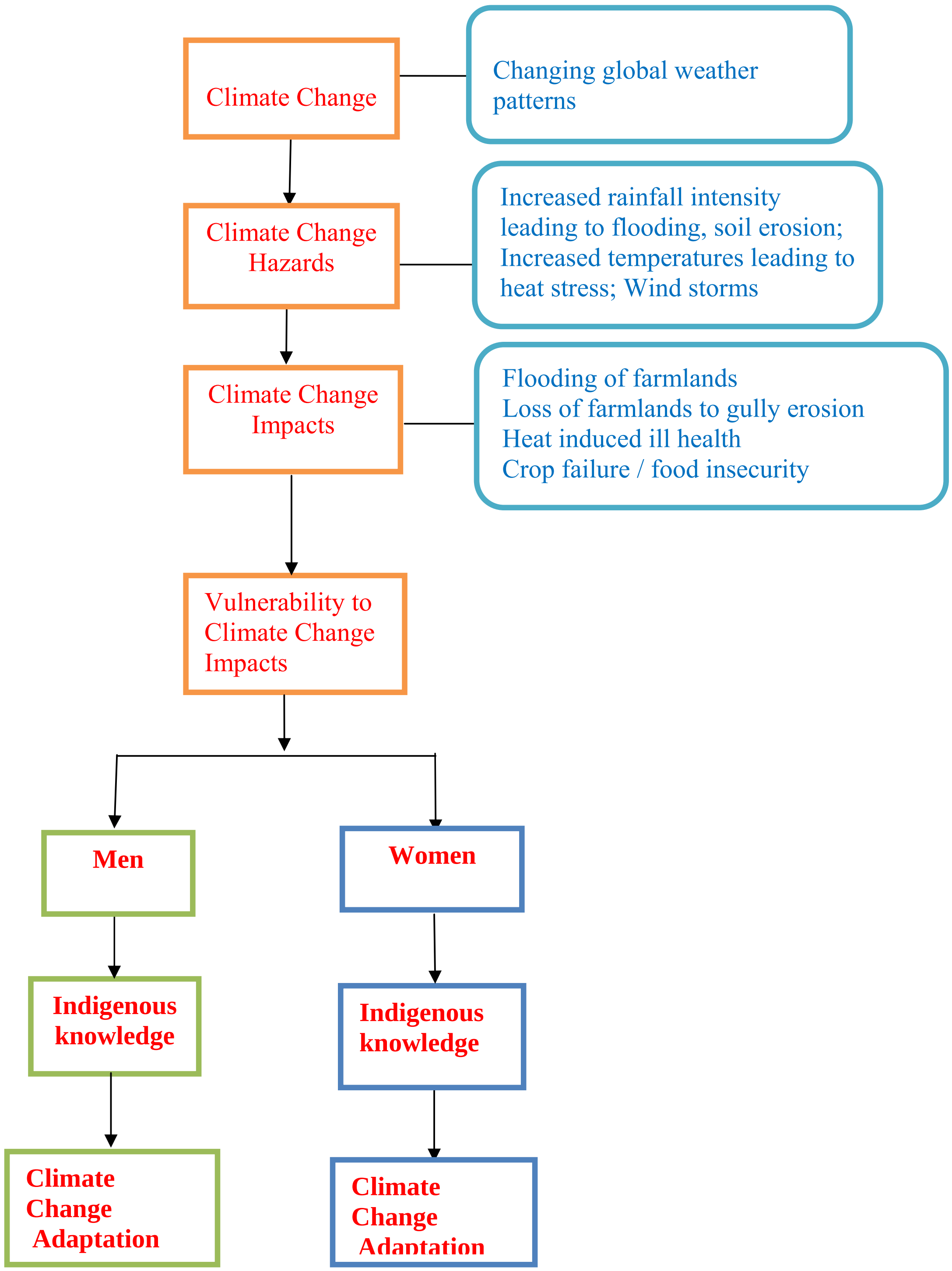

Figure 1. Conceptual Framework

Literature Review

The dynamics of terrestrial ecosystems depend on interactions between a number of bio-geochemical cycles, particularly the carbon cycle, nutrient cycle, and the hydrological cycle. Terrestrial ecological systems in which carbon is retained in biomass, decomposing organic matter and soil, play an important role in the global carbon cycle. Carbon is exchanged naturally between these systems and the atmosphere through photosynthesis, respiration, decomposition, and combustion. Human activities change these carbon stocks and exchanges between them and the atmosphere occur through land use, land-use change, and forestry, among other activities (IPCC, 2000).

Ecosystems provide many goods and services critical to individuals and societies (IPCC, 1997) which include:

- Food, fiber, fodder, shelter, medicine and energy;
- The processing and storing of carbon and nutrients;
- Assimilation of waste;
- Purification of water, regulation of water runoff and moderating floods;
- Building soils and reducing soil degradation;
- Provision of opportunities for recreation and tourism; and
- Housing the earth's reservoir of genetic and species diversity.

Climate Change

The United Nations Framework Convention on Climate Change (UNFCCC) defines climate change as direct or indirect human activity that alters the composition of the global atmosphere (UNFCCC, 1994). The most general definition of climate change is a change in the statistical properties of the climate system when considered over a period of decades or longer, regardless of cause (Houghton, 2001).

Climate forcing, which shapes the climate system, includes processes such as variations in solar radiation, deviations in the earth's orbit, mountain building and continental drift, and changes in greenhouse gas emissions. Both natural and anthropogenic factors contribute to climate change. Anthropogenic factors include an increase in carbon dioxide levels due to emissions from fossil fuel combustion, aerosols, cement manufacture, land use, ozone depletion, animal agriculture and deforestation (Steinfeld et al., 2006).

A notable contributor to climate change is the accumulation of greenhouse gases in the lower atmosphere. A greenhouse gas (GHG) is an atmospheric gas that absorbs and emits radiation within the thermal infrared range. This process is the fundamental cause of the greenhouse effect. The primary GHGs in the earth's atmosphere are water vapour, carbon dioxide, methane, nitrous oxide and ozone. The most important GHGs when ranked by their contribution to climate change are water vapour (36-72 %), carbon dioxide (9-26 %), methane (9-26 %) and ozone (3-7 %). High CO_2 concentrations results from the burning of fossil fuels and deforestation, (Denman et al., 2007) while higher atmospheric methane concentrations are due to livestock enteric fermentation, manure management, paddy rice farming, land use and wetland changes, pipeline losses and covered vented landfill emissions (Steinfeld, 2006). Agricultural activities including the use of fertilizers, lead to higher nitrous oxide (N_2O) concentration in the atmosphere. The 2007 Fourth Assessment Report of IPCC (AR4) noted that "changes in atmospheric concentrations of greenhouse gases and aerosols, land cover and solar radiation alter the energy balance of the climate system". The report therefore concluded that an increase in anthropogenic greenhouse gas concentrations is likely to have caused most of the increases in global average temperatures since the mid-20th century.

Impacts of Climate Change

Climate change impacts can be measured as an economic cost, as impacts that are linked to market transactions which directly affect GDP (Smith et al., 2001). Economic impacts of climate change are considered either non-market impacts or market impacts. Examples of non-market impacts are impacts on human health, impact on ecosystems, etc. The market sector includes agriculture (namely livestock, forestry and fisheries industries). Other sectors sensitive to climate change impacts include energy, construction, insurance, tourism and recreation industries (Schneider et al., 2007)

According to Desanker et al. (2001), in Africa, coastal facilities are economically significant and climate change would result in sea-level rise, coastal erosion, salt water intrusion and flooding. IPCC (2000) predicted an increase in heat waves; an increase in areas affected by drought, increased intense tropical cyclone activity as well as increased incidences of extreme high sea level. The physical impacts of climate change are manifested in extreme events, such as fire and increased fresh water flow, and geophysical systems, (biogeochemical cycles, glacier retreat and disappearance, geological activity, and ocean changes). Impacts to oceans are sea ice melting, sea level rise, temperature rise, acidification and oxygen depletion. Future climate change assessments using models show that the efficiency of the land and ocean carbon cycle to absorb human induced carbon dioxide (CO_2) will be reduced. The role of oceans in global warming is complex. With increasing global temperature, the water in the oceans expands in volume, and additional water enters them through glaciers and ice sheets. The Greenland and the Antarctic ice sheets are major ice masses. The estimated total ice melting rate over Greenland is 239± 23 cubic km per year. Ocean acidification is the effect of rising concentration of CO_2 in the atmosphere. Fire is a major agent for conversion of biomass and soil organic matter to CO_2 (Denman et al., 2007). Schneider et al. (2007) predict that an increase in global mean temperatures of about 0-2^{o}C by 2100 relative to the 1990-2000 periods would result in increased fire frequency and intensity in many areas.

Vulnerability to Climate Change

According to the IPCC (1997), vulnerability is defined as the extent to which a natural or social system is susceptible to sustaining damage from climate change. Vulnerability is a function of the sensitivity of a system to a change in climate and the ability to adapt the system to changes in climate. The African continent is particularly vulnerable to the impacts of climate change because of factors such as widespread poverty, recurrent drought, inequitable land distribution and high dependence on rain-fed agriculture. Many sectors of the African continent are vulnerable to the impacts of climate change including ecosystems, hydrology, and water resources, agriculture and food security, coastal systems, human settlements, industry and transportation, human health, tourism and wildlife (IPCC, 1997). Increasing costs in terms of human life, capital, flood, storms and droughts demonstrate current vulnerability. Future vulnerability depends not only on climate change but also on the type of development path that is pursued (UNFCCC, 2007).

Adaptation to Climate Change

There are two responses to global climate change namely mitigation and adaptation. Mitigation refers to intervention or policies to reduce the emissions or enhance the absorption of greenhouse gases while adaptation refers to responses to the changing climate and policies to minimize the predicted impacts of climate change (Sari Kovats, nd). Because of the speed at which change is happening due to global temperature rise, it is urgent that the vulnerability of developing countries to climate change impacts is reduced while their capacity to adapt is increased and national adaptation plans are implemented (UNFCCC, 2007). Adaptation options for ecosystems include control of deforestation, improved rangeland management, expansion of protected areas and sustainable management of forests (IPCC, 1997). Adaptation options for hydrology and water resources include water harvesting, management of water flow from dams and more efficient water usage. Adaptation measures in African coastal zones include building of sea walls and relocation of vulnerable human settlement and other socio-economic facilities. Although adaptation options, including traditional coping strategies are available, in practice, the human, infrastructural and economic response capacity to affect a timely response may well be beyond the economic means of some African countries (IPCC, 1997).

Indigenous Knowledge (IK) Of Climate Change

The increasing attention indigenous knowledge is receiving by academia and the development institutions have not yet led to a unanimous perception of the concept of indigenous knowledge. Indigenous Knowledge (IK) can be broadly defined as the knowledge that an indigenous (local) community accumulates over generations of living in a particular environment (Warren, 1991a). According to Flavier (1995), IK is knowledge that is unique to a given culture or society. None of the definitions are essentially contradictory and they overlap in many aspects. These definitions encompass all forms of knowledge – technologies, know-how skills, practices and beliefs – that enable the community to achieve stable livelihoods. A number of terms are used interchangeably to refer to the concept of IK, including Traditional Knowledge (TK), Indigenous Technical Knowledge (ITK), Local Knowledge (LK) and Indigenous Knowledge System (IKS).

IK is the basis for local-level decision making in agriculture, health care, food preparation, education, natural resource management, and a host of other activities in rural communities (Warren, 1991). IK facilitates communication and decision-making: it is dynamic, and continually influenced by internal creativity and experimentation as well as by contact with external systems (Flavier, 1995). Today, many indigenous knowledge systems are at risk of becoming extinct because of rapidly changing natural environments and fast pacing economic, political, and cultural changes on a global scale. Traditional practices disappear as they become inappropriate for new challenges or because they adapt too slowly. However, many practices disappear only because of the intrusion of foreign technologies or development concepts that promise short-term gains or solutions to problems without being capable of sustaining them. The tragedy of the impending disappearance of indigenous knowledge is most obvious to those who have developed it and make a living through it. But the implication for others can be detrimental as well, when skills, technologies, artefacts, problem solving strategies and expertise are lost. Indigenous knowledge is embodied in the lives of the rural poor; their livelihood depends almost entirely on specific skills and knowledge essential for their survival.

In the Igbo traditional society of south-eastern Nigeria, land is regarded as a powerful deity that has actual direct intervention in the affairs of people. People often refer to her as the great mother spirit who owns men, either dead or alive “ala nwe madu”, the source and custodian of public morality and the dispenser of justice (Aguwom, 2005). It is the assertion of the authors of this report, that human disregard for the basic principles of eco-theology in the tenure of land, is most likely a hidden factor underlying climate change. While humans are free to use the land resources in their trust judiciously to satisfy present needs, they are obliged to conserve these resources for future generations. It is believed that in Igbo traditional society that disregard for this divine injunction attracts punishment. In the cause of modernization/globalization and concomitant avaricious and gluttonous quest for food and wealth, there is lack of respect for the peoples' "cosmovision" (meaning the harmonious relationship between the physical, spiritual, and human worlds) which enhanced environmental sustainability in the so-called primitive world of our forefathers. Neglect of the spiritual world and bad stewardship in the tenure of the physical world is manifested in increased global air and ocean temperatures, widespread melting of snow and ice, and rising sea level. These are the symptoms of the scenario called climate change.

Need to Integrate IK in Climate Change Research

In the emerging global knowledge economy, a country's ability to build and mobilize knowledge capital is equally essential for sustainable development as is the availability of physical and financial capital (World Bank, 1997). One basic component of a country's knowledge system is its local or indigenous knowledge which encompasses the skills, experiences and insights of people, applied to maintain or improve their livelihood. Development agents such as community-based organizations (CBOs), non-governmental organizations (NGOs), governments, donors, local leaders, and private sector initiatives, need to recognize it, value it and appreciate it in their interaction with the local communities. Before incorporating it in their approaches, they need to understand it and critically validate it against the usefulness for their intended objectives. Lastly, indigenous knowledge forms part of the global knowledge system. Indigenous knowledge can be preserved, transferred, modified and adapted elsewhere.

Conventional approaches to understanding climate change are limited to identifying and quantifying the potential long-term climate impacts on different ecosystems and economic sectors. Although they are quite useful in depicting general trends and dynamic interactions, the top-down, science-driven approach often fails to address the local impacts of climate change (Nabegu, 2010). Understanding climate change from the perceptive of local people will offer new insights into how individuals and communities are affected and how more effective strategies for adaptation and mitigation can be developed. Barros (2007) and Adejuwon et al., (2007) suggested that supplementing scientific data with local knowledge could broaden the information base for sustainable environmental management in relation to climate change. Similarly, Nabegu (2010) stated that the IPCC advised that a diversity of approaches and tools be employed, including formal surveys, qualitative methods, interactive exercises, simulation modeling and local knowledge into the development of climate forecast.

Significance of IK in Climate Change

There is a growing awareness of the depth and breadth of knowledge that is present in many indigenous societies and its potential value in addressing issues of contemporary significance (Goduka, 2001). Miller (2005) emphasized the concept of "ancestor-centrism" in indigenous knowledge which is a binding force that recognizes the place of the ancestors in many unseen forces and actions that control elements of the universe resulting in new sets of relationships, which point to the essential balance and diversity that help the people to cope and adapt in their environment.

A widely held view among Africans is that activities such as agriculture can be influenced by the practice of seasonal rituals. Rituals are activities by which people urge the spiritual world to allow events to take place in the natural world (COMPASS, 1997). These rituals solicit the blessings of nature, ancestor spirits and the creator (God) in farming and farming-related activities such as preparation for planting, harvesting, transhumance practice and hunting. Elders and traditional leaders play significant roles in decision-making on agriculture and natural resources management. Old age and closeness to the world of ancestors is associated with wisdom.

Reijintjes et al., (1994) lamented that the emphasis on IK is centered mostly on the technical aspects such as traditional intercropping, agro-forestry, and ethno-veterinary medicine. Less attention is paid to the worldviews and belief systems ("cosmovisions") that form the basis of these traditional practices. Cosmovision is defined as IK embedded in the spirituality and cosmology of the people. It includes the assumed relationships between the physical, spiritual, natural and human worlds (CECIK, 1996; Haverkort et al., 1999). Any disequilibrium in this relationship will spell doom for the human race. This concept is akin to eco-theology (Ituma, 2010) which is a theological standpoint that the earth is God's sacred design and should be protected, cared for and managed in an orderly and most circumspect manner that depicts the fear of God. Secondly, it is necessary so that human actions do not create imbalance in God's design. Thirdly, a deviance from protecting God's design may result in a chaotic and disastrous existence of human life. When people disregard eco-theology or cosmovision in any environmental setting in the quest for food and money, they work against themselves, not against God.

Chukwu & Chukwu (2002) refer to the technical aspects of IK as folk science, and a combination of folk science and cosmovision as traditional wisdom. According to Haverkort (1999) peoples' cosmovisions give rise to several rituals in which the elders, the priests, soothsayers and spiritual leaders play a prominent role. Emeagwali (2003) stated that the African way of knowing seemed to be less transferable than conventional science, given its holistic, socio-cultural and even spiritual dimensions. Nagebu (2010), in a study of local knowledge in climate change assessment in the Kano region of Nigeria, found that the most significant information gathering exercise for local knowledge is oral traditions, namely the collective testimonies and recollections of the past in various forms of verbal testimonies. He advised that caution should be taken to analyze and differentiate between orally transmitted information that is myth, legend or of identified or unidentified origin. Traditional wisdom as an intellectual resource is therefore prone to erosion because of globalization/modernization trends and changes in religious beliefs. As the society changes, the younger generations tend to forget the technical and belief systems that enabled our forefathers cope with the vagaries of weather.

The Concept of Rainfall in IKS

Among the elements of climate, rainfall receives the greatest attention in indigenous knowledge systems in Africa. This is not surprising given that many indigenous Africans link rainfall with spirituality and agriculture, which are the main factors that influence their socio-economic wellbeing and survival. Rain is regarded as one of the greatest blessings of God, who is often regarded as the giver of rain. Many societies make sacrifices, offerings and prayers to God in connection with rain (Tabuti, 2005) and rain makers abound in several communities in Africa. Their duties are to solicit for the creator's help in providing rain, or in halting it if too much rain falls. Similarly, wetlands are perceived as expressions of spiritual beings in Zimbabwe (Gonese, 1999). According to Gonese, spirit mediums make decisions about the use of wetlands and many taboos exist about felling trees, and use of water. In Ghana, Tengan (1991) reported that among the Sisala of northern Ghana, the sky is closely associated with personified rain. According to them, rain as lightening is the source of 'hot death', rain as water brings coolness and fertility. The rainwater, though associated with the sky, is believed to come from the horizon, the meeting of sky and earth. Among the Burunge of Tanzania, Oestberg (1995), reported that the people believe that rain brings soil. New soil is continuously being added to the land surface by wind-transported material, by rain containing soil particles and by decaying organic material, rising up from below.

Mukamuri (1995) reported that Shona people in Zimbabwe perceived rainfall as a component of soil fertility and rain making ceremonies are central in the cosmovision of Shona people. That belief is that ancestral spirits deal with rain and other climatic influences.

Adaptation/Mitigation Strategies to Impact of Climate Change

Indigenous land husbandry practices

Land husbandry is the process of implementation and management of preferred system of land use in order to prevent degradation and improve land quality in terms of stability, usefulness and productivity for the chosen land use (Chukwu et al., 2006). Consequently, land husbandry encompasses microclimate management and ethno-engineering.

Microclimate management

Microclimate management involves all sustainable farming practices aimed at changing deliberately the flow of energy, sunlight, humidity, and other climatic conditions in a small localized area in order to forestall their adverse effects on agriculture (Stigter, 1987). This is summarized in Table 1.

Ethno-engineering

Ethno-engineering (Jodha, 1990) is a term that covers indigenous conservation practices such as terracing mountain slopes, harvesting run-off and developing small drainage systems. Reij et al., (1996) presented overviews on indigenous soil and water conservation practices from various parts of Africa (Table 2). Water harvesting is aimed at collecting and concentrating run-off for increased and more reliable crop production. Different types of water harvesting are found in different socio-cultural settings and agro-ecologies. For example, in Mali, the use of permeable ridges made of stones and alley cropping along the contour, is common. In Burkina Faso and Cape Verde, seeds are planted in water pit holes. Chukwu et al., (2006) reported the use of underground tanks to conserve rainfall in many parts of south eastern Nigeria.

Table 1. Microclimate Management Practices

Management practice	Example
Manipulation of radiation	. Shading . Cover to reduce radiation loss at night . Using solar radiation for field and storage drying
Manipulation of heat or radiation flow	. Tillage or no tillage . Mulching . Windbreaks using shelter from trees . Protection for ripening purposes . Use of warmed air for field and storage drying
Manipulation of mechanical impacts of wind and rain	. Planting in lower places where deep rooting is possible . Improving soil conditions with organic fertilizers . Protecting crops against impacts by rain or wind
Miscellaneous methods	. Fitting cropping periods to the seasons . Making use of supernatural interventions (cosmovision)

Source: Stigter (1987)

Table 2. Indigenous soil and water conservation practices in Africa

Country	Ethnic group	Major crops	Conservation practice
Sudan	Beja	Sorghum, millet	Earth bunds
Morocco	Mogouna	Barely, wheat, maize	Bench terraces
Sudan	Fur, Zaghawa	Sorghum	Earth bunds
Morocco	Berber	Wheat, barley, fruit trees, hemp	Bench terraces, stone bunds, step terraces
Niger	Hausa	Millet, sorghum	Improved planting pits
Nigeria	Kanuri	Sorghum	Earth bunds
Mali	Bambara	Millet, sorghum	Improved planting pits
Mali	Dogon	Millet, sorghum, vegetables	Micro-basins, pitting, stone bunds
Zimbabwe	Shona	Maize, millet, sorghum	Modification of contour ridges
Burkina Faso	Mossi	Millet, sorghum	Improved planting pits, stone bunds
Burkina Faso	Mossi	Millet, sorghum	Mulching, contour stone bunds
Zambia	Various	Cassava, maize	Raised-bed cultivation
Tanzania	Wasukumma	Rice, cotton, maize, sweet potatoes	Earth bunds
Ghana	Frafra	Sorghum, millet, groundnuts	Stone bunding
Tanzania	Wafipa	Maize, millet, beans	Mounds
Cameroon	Mafa, Mandara	Sorghum, millet	Bench terraces, stone bunds
Mamawi	Lomwe, Yao Chewa, Sena	Maize, sorghum	Contour bunds, strips, vegetation barriers
Swaziland	Swazi	Maize	Grass strip
Ethiopia	Oromo	Sorghum, coffee, chat	Earth bunds, bench terraces
Ethiopia	Amhara	Barely, wheat, pulses	Drainage ditches
South Africa	Xhosa	Maize	Adaptation of contour bunds
Tanzania	Wabena	Finger millet, maize, beans, potatoes	Raised-bed cultivation
Nigeria	Berom, Hausa	Vegetables, wheat, maize	Basin irrigation
Nigeria	Igbo	Yams, maize, cocoyam, vegetable	Bench terraces
Cameroon	Bamileke	Maize, cassava, yam	Ridge cultivation, hedge barriers

Source: Reji et al. 1996

3. STUDY AREA AND METHODOLOGY

Study Area

Geographically, south-eastern Nigeria is located between latitude 4^{O} 6' and 7^{O} N and longitude 6^{O} 30' and 9^{O} 15' E. The geological formations underlying the study area include the coastal Plain Sands, Bende-Ameki group, Upper Coal Measures, False Bedded Sandstones, Lower Coal Measures, Imo Clay Shales, Nkporo Shale group, Eze-Aku shales, Asu River group and Recent Alluvium. Coastal Plain Sands, which consists of unconsolidated sand materials that are sometimes cross-bedded with clay, underlies a greater part of the study area. The major landform regions of the southeast include highlands, plains, lowlands, and cuesta landforms.

The area is characterized by high rainfall and temperature conditions (Table 3). Climate influences agricultural activities in a myriad of ways and has lasting influence on crops and livestock as well as the quality of life of man and animals. Climate heavily influences such agricultural activities as plant and animal selection, storage, cultural operations, as well as the incidence of pests and pathogens. The continued dependence of agricultural production on light, heat, water and other climatic factors has made the need for studies on impacts of climate change imperative (Adiele et al., 2005). Studies on evidence of global warming in south eastern Nigeria (Audu et al., 2004), showed an increase in temperature of 0.3^{O}C between the first and second decades and the second and third decades respectively based on 30 years (1972-2001) data collected from Agromet Weather Station, NRCRI, Umudike. The study also showed a decrease of 103.98 mm in rainfall in the first and second decades, but an increase of 156.49 mm between the second and third decades, indicating that rainfall is increasing in the agro-ecological zone.

Table 3. Mean annual rainfall and temperature ranges in part of south eastern Nigeria

Location	Rainfall (mm)	Temperature (^{O}C)
Aba	2000 – 2250	26 – 27
Arochukwu	2250 – 2500	26 – 27
Okigwe	2000 – 2250	27 – 28
Owerri	2250 – 2500	27 – 28
Umuahia	2000 – 2250	26 - 27

Source: FDALR, 1985

The vegetation of the region was originally dominated by many different forest species and had high biodiversity. However, human interference has greatly modified it from coastal forest to a forest-savannah mosaic. A greater part of the study area is now covered by secondary vegetation, with the dominant plant species – Oil palm (*Elaeis guineensis*), Indian bamboo, African Oil bean (*Pentaclethra macrophylla*), *Dactyladenia barteri, Chromolaena odorata,* and a large variety of herbaceous plants including grasses. The area is characterized by a high population density as well as high population growth rate. The soils are largely composed of acid sandy soils developed from unconsolidated geological materials. Agriculture is a major livelihood activity of the region and is dominated by crop farming. Agricultural practices include vegetation clearing and tillage operations among others which exposes the soil to adverse weather conditions and results in soil degradation. Population pressure has intensified these activities on fragile soils with resulting ecological problems.

Sampling Technique

Four states in the south east agro-ecological zone of Nigeria were randomly selected for the project. The selected states include Abia, Anambra, Enugu, and Imo States. Due to budget and time constraints, five communities were purposely selected from among the communities in each state, based on physical evidence of climate change hazards. In each community, the households which formed the unit of study were first separated into male-headed and female-headed households. A random sample of 20 households was then taken for each group of households. This gave a sample size of 200 households (100 male headed and 100 female headed households for each state. Altogether, the study involved a total of 800 households – 400 male-headed and 400 female-headed households. Table 4 below shows the communities selected in each state, as well as the population figures of the local government areas (LGAs) based on the 2006 population census. These locations were selected because of the existence of climate related hazards like gully erosion, flooding and landslide.

Table 4. Communities selected for the study in different states

State	LGA	Population	Community Selected
Abia	Ohafia	245,987	Elu, Ekeluogo, Mgbaga, Eziukwu, Akanu-Ukwu
Anambra	Aguata	206,816	Isuofia
	Idemili South	206,816	Ojoto
	Anaocha	284,215	Nri
	Orumba South	184,548	Oko
	Njikoka	148,394	Enugwu-ukwu
Enugu	Udi	238, 305	Ebe, Eke, Udi, Ngwo-uno, Umuabi
Imo	Njaba	143485	Okwudor Amucha, Okponakuma
	Mbaitoli	237474	Obazu Mbieri
	Owerri-West	101754	Umuoma Nekede

From the perspective of the project team, there was equality in gender participation. On the part of the research team, focus group discussions (FGDs) with female groups and in-depth interviews (IDIs) with women leaders were conducted by the female members of the team. Similarly, FGDs and IDIs with men groups and male leaders were conducted by the male members of the team. In the communities, the women nominated the FGD participants and leaders who participated in the IDIs. They also nominated the female enumerators. In one community (Isuofia in Anambra State) the women had to retire to a closed door meeting after they had been briefed on the purpose of the project in order to agree on who the female enumerators should be.

Data Collection

The FGDs were conducted with adult male, adult women and youth groups. There were between 7-12 participants in each group. IDIs were also held with male, female and youth leaders in the community. A structured questionnaire was administered to male or female household heads by enumerators recruited from communities with the assistance of the community leaders. To ensure that the enumerators were capable of administering the questionnaires, the research team certified that they were literate and educated by ensuring that mainly teachers and some level of civil servants were recruited as enumerators. Furthermore a training workshop on the administration of the questionnaire was held in each community.

A household level survey was used to collect data in order to provide empirical evidence of gender differences in awareness, perception and vulnerability to climate change impacts and the basis for the estimation of the cost of impacts and adaptation measures. The study involved the use of primary and secondary data. Secondary data on temperature and rainfall were obtained from NIMET. For objective 2, field observations, documented in pictures and video were made. Data for objective 3, 4, 6 and 7 were obtained through FGDs, IDIs and use of a questionnaire. For objective 5, field observations were made and documented in pictures and video. Data for the second part of objective 5 were obtained through FGD, IDI, and use of a questionnaire.

Analytical Framework and Method of Data Analysis

Analytical Framework

Vulnerability and poverty are interrelated. However vulnerability is distinguished from poverty by the presence of risk and uncertainty, i.e. the fact that the level of future wellbeing is uncertain (Ersado, 2006). Vulnerability "measures the resilience against a shock – the likelihood that a shock will result in a decline in well-being" (World Bank, 2001). In spite of a lack of clear consensus on the definition of the term vulnerability (Calvo and Dercon, 2005), the literature refers to some sense of insecurity or potential harm people must be aware of. They contend that vulnerability is not the same as low welfare or exposure to risk. Vulnerability relates to dangers or threats as opposed to uncertainties in general. Accordingly, they define vulnerability as the "magnitude of the threat of future poverty" in terms of likelihood and severity.

The vulnerable are unable to stabilize consumption during idiosyncratic fluctuations to income (Bandyopadhyay & Cowell, 2007). In recent literature, household level data are used to identify the kinds of shocks that significantly affect household consumption streams and welfare. According to Bandyopadhyay & Cowell (2007), three types of shocks have been identified. One is idiosyncratic shocks that impinge directly on the income stream. Climate hazards that impinge directly on livelihoods and income fall into this category. The second is aggregate shocks which span the wider economy and are purely economic in nature. The third is household-specific shocks that involve significant changes in the household such as the loss of an income earning member of the household.

According to Ersado (2006), the insecurity of the wellbeing of the individual, household, or community in the face of a changing environment can be considered the effect of three processes – non-stochastic determinants of poverty such as the level of education of the household head, exposure to risk such as drought and flood and the ability to cope with shocks through insurance and credit markets. This study does not seek to determine vulnerable households and the severity of their vulnerability. Instead, it aims to identify those socioeconomic and demographic variables that influence vulnerability. The literature suggests that the welfare level of an individual or household is measured by the consumption level.

Income is an important determinant of consumption. As a result, exogenous shocks such as drought, flood, erosion, etc. that adversely affect the income generating process adversely affect the consumption (welfare) level of the household or individual since vulnerability is defined in terms of a decline in wellbeing or welfare. The consumption level of the household was used in this study as a proxy for vulnerability. This was used because it is practical and easily estimated from household data. Also in poor or less developed economies like Nigeria, where records are grossly inadequate and most times unavailable, households are less conservative about providing information on their consumption than on their income. The vulnerability function used in this study to achieve Objective 4 used the consumption level of the household as the endogenous variable. The explanatory variables included in the vulnerability function include farm income as an indicator of dependence on agriculture, education – measured by the number of years spent by the household head in school, health status, measured by medical expense, distance from household residence to source of portable water as proxy for physical infrastructure, value of farm output as a proxy for household food security, access to resources indicated by access to credit and farm size.

Data Analysis

The analysis of the trend of climatic variables (Objective 1) was done using the ordinary least squares regression. The data were fitted to an exponential model given below.

$$L_n y_t = b_o + b_1 T + u_t$$

Where:
- y_t = Climatic variable (temperature, rainfall in period t)
- b_o = Intercept
- b_1 = Trend coefficient
- T = Time trend
- u_t = Error term

For objective 3, frequency distribution was used to analyse and assess the levels of awareness and perception of men and women about climate change and the chi-square test was used to test for significant gender differences. The analysis for Objective 4 involved the use of the ordinary least square regression to determine the influence of dependence on agriculture, education health, poverty, access to resources and food security on economic wellbeing (vulnerability) to climate change impacts. The following proxies were used for these variables: consumption expenditure for economic wellbeing, farm income for dependence on agriculture, education measured in number of years spent in school by household head, medical expense for health, physical infrastructure represented by distance from household residence to source of portable water, value of farm output for food security, access to resources indicated by access to credit and farm size. Chow's test was used to determine the differences in vulnerability and if such vulnerability is gender related. This involves the estimation of a vulnerability function, specified implicitly as follows:

$$Y = f(X_1, X_2, X_3, X_4, X_5, X_6, X_7, X_8, X_9, X_{10})$$

Where

- Y = total household expenditure
- X_1 = age of household head
- X_2 = income of household head
- X_3 = level of education of household head.
- X_4 = household dependency ratio (ratio of children < 15 years to adults > 15 years).
- X_5 = amount of credit received
- X_6 = land holding (ha)
- X_7 = Value of farm output
- X_8 = land ownership statues (1= permanent ownership, 0 = use right only).
- X_9 = distance from residence to portable water source (km).
- X_{10} = medical expenses

The age of the household head is expected to be negatively related to vulnerability, i.e. the older the household head, the less vulnerable the household. Climate change is a long term phenomenon. An elderly household head is more likely to have a better experience of climate variability and change over the years and is also likely to be more knowledgeable about indigenous coping and adaptation practices for climate change hazards. This experience and knowledge will enhance the coping capabilities of the household and predispose the household to less vulnerability.

The income of the household is expected to be negatively related to vulnerability, i.e. the higher the household income, the lower the vulnerability. A higher income gives the household better access to coping strategies and adaptation practices which reduce the vulnerability of the household.

The level of education of household head is also expected to be negatively related to vulnerability, i.e. the higher the level of education of the household head, the lower the household vulnerability. The higher the level of education of the household head, the less conservative the household head. Consequently, the greater the awareness of climate change and climate change hazards. The household is thus in a better position to accept and adopt new coping and adaptation practices which reduces the vulnerability of the household.

Household dependency ratio and vulnerability are expected to be positively related, i.e. the higher the dependency ratio, the higher the vulnerability of the household. A higher dependency ratio implies lower income for the household which reduces the capacity of the household to cope with and adapt to climate change hazards.

The household access to credit indicated by the amount of credit received is expected to be negatively related to household vulnerability. Access to credit improves the income earning capacity of the household and puts the household in a better position to cope with and adapt to climate change impacts.

The household's landholding and value of farm outputs are expected to be negatively related to vulnerability for similar reasons as for access to credit. Permanent land ownership is expected to influence vulnerability positively, i.e. reduce vulnerability while user rights are expected to increase vulnerability. Permanent ownership status enables the household to make long term investments on the land which conserve the land resources and yield higher income in the long-term. For instance, adaptation to flooding and erosion require long term investments and this is only possible where there is permanent ownership of land.

The distance from household residence to a potable water source is expected to be directly related to vulnerability, i.e. the longer the distance, the higher the household vulnerability. This is due to the fact that the longer the distance to water source, the higher the cost of access and this will reduce the coping capacity of the household making the household more vulnerable.

Medical expenses are similarly expected to be directly related to vulnerability. The higher the cost of health care, there is less access and consequently greater vulnerability for the household. Alternatively, if a household spends a large proportion of its income on health care, its ability to address other household needs will be severely constrained. This will increase its vulnerability.

The model above was used to run two regressions, one for male-headed and one for female-headed households. The data for both households were pooled together and used to run a third regression. The residual sums of squares were used to compute Chow's f-statistic which was used to compare with the tabulated f-statistic. If the f-computed is greater than the tabulated f-values, the coefficients from the two households are different suggesting differences in vulnerability due to the gender of the household head. A fourth regression was run with a dummy variable sex (1 = male headed household, 0 = female headed household) introduced into the model. The fourth regression was run using the pooled data. The residual sums of squares from the third and fourth regressions were used to compute Chow's f-statistics which was compared to the tabulated f-value. If the computed f-value is greater than the tabulated f-value then the difference in the vulnerability functions of the two households is due to the gender of the household head.

4. RESULTS AND DISCUSSION

Trend Analysis of Climatic Variables

Rainfall Trend

The regression results of the trend analysis of temperature and rainfall in the south east are shown in Table 5. The trend coefficient for time was not significant for rainfall in the regression model which showed that mean annual rainfall did not vary significantly during the period analyzed. Generally, there is more rainfall at Umudike than at Enugu (Figure 2). The annual trends of rainfall at Enugu and Umudike appear to be non-declining and the trends in the first and fourth quarters of the years were different.

Table 5. Regression result of the trend of temperature and rainfall in the south east

Variable	Temperature	Rainfall
Constant	3.466 (930.343)^{xxx}	7.433 (141.201)^{xxx}
Time	3.627E-04 (2.066)^{xx}	9.590E-04 (.492)
R^2	.112	.005
f-Ratio	4.268^{xx}	.242

^{xxx} significant at 1%, ^{xx} significant at 5%, figures in parentheses are t-ratios.

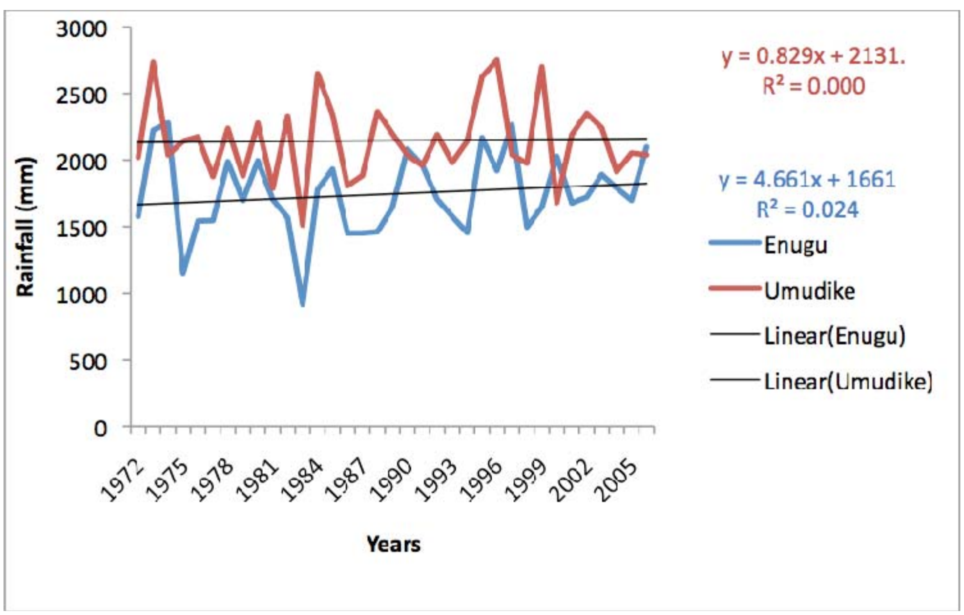

Figure 2. Rainfall amounts in Enugu and Umudike

The trends in quarterly rainfall distribution in the south east of Nigeria are shown for Umudike (Figure 3) and for Enugu (Figure 4). Based on 36 years of data (1972-2008), quarterly rainfall trends at Umudike showed low rainfall values in the first and fourth quarters of the years. On average, 78% of the rains at Umudike fell in the second (243 mm) and third (314 mm) quarters. Rainfall in the first quarter showed a declining trend with only about 50 mm of rain. The quarterly rainfall trends at Enugu over 46 years, showed very prominent decline in rainfall in the first and fourth quarters from 1961-2006. As shown for rainfall at Umudike, there is an increasing trend in the second and third quarters which received 79% of the total rains but a declining trend in the first and fourth quarters that received just 21% of the rains. Rainfall in the first quarter is crucial for crop production in south eastern Nigeria for two major reasons. First, agriculture in the region is totally weather dependent. Second, arable crops that are adapted to the region require 7-8 months of rainfall. These crops include yam, cassava and cocoyam which are the food staples of the region. With 78-79 % of the rains concentrated in 6 months of the year (May-October), farmers will be compelled to adopt late planting with many adverse effects to the farmer.

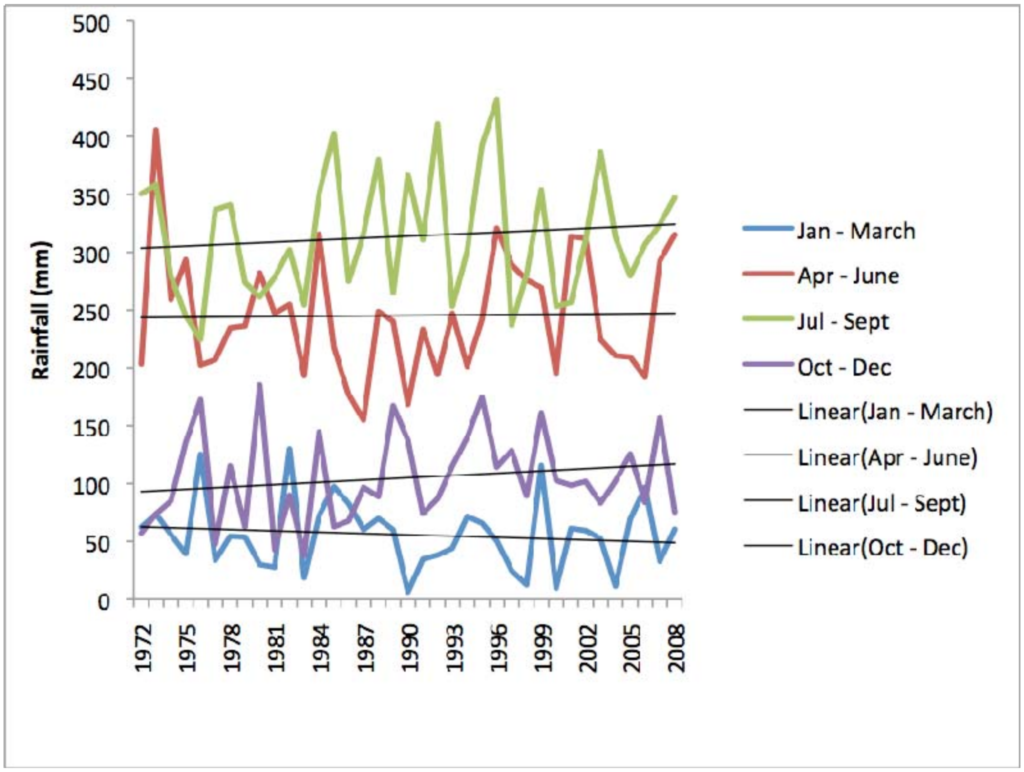

Figure 3. Trends in quarterly rainfall at Umudike 1972-2008

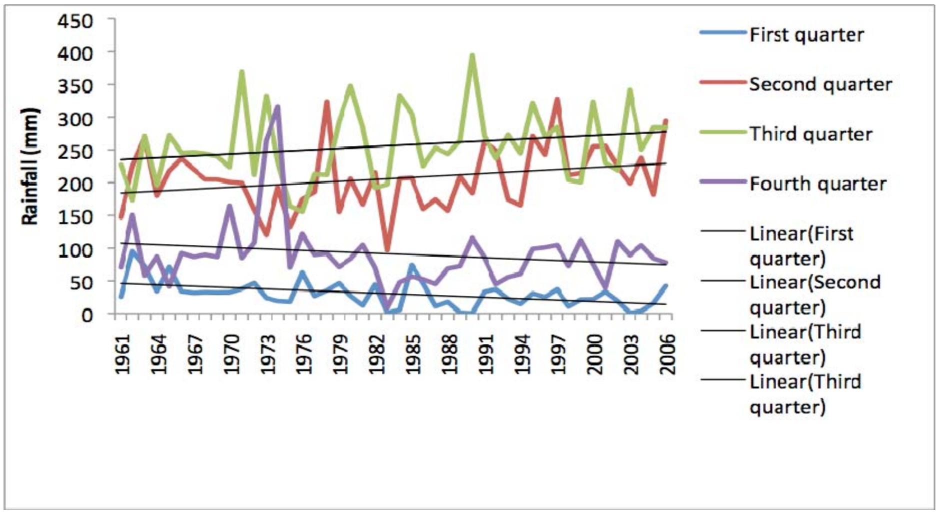

Figure 4 Rainfall trends in the first to fourth quarters at Enugu, 1961 - 2006

When looking at the number of rainy days, Figure 5 below shows one rainfall event in 30 days in January, a rainfall event in 15 days in February, one rainfall event every four days in March and one rainfall event every three days in the month of April. A closer look at the data showed a steady decline in number of rainy days from 1970s. For example, there was a decrease from four to two rainy days in the month of February, a decline from eight to six rainy days in the month of March and from seven to four rainy days in the month of November. The decrease in the number of rainy days is stronger in the first and fourth quarters of the year. A decrease in number of rainy days will delay the recharge of soil moisture and early planting by farmers.

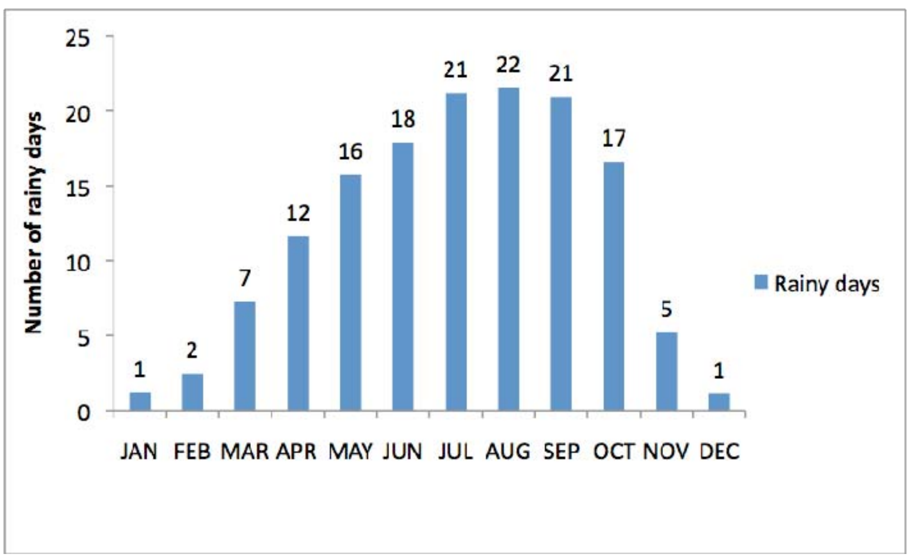

Figure 5 Mean number of rainy days at Umudike (1972 - 2008)

Temperature Trend

The results in Table 5 (above) indicate that the trend coefficient was statistically significant for temperature. This implies that there was a significant change in temperature over time. The trend coefficient was positively signed, indicating an increase in the temperature in the south east over time. Increasing temperature trends is shown in Figure 6. A closer look at the temperature data from 1971-2007 shows a sharper increase in the first quarter of the year than in the other quarters. Increasing temperatures and decreasing rainfall in the first quarter has detrimental effects on arable crop production in south eastern Nigeria. Mean maximum temperature ranges from 29-34 ^{O}C at Umudike and from 30-35 ^{O}C at Enugu (Table 6).

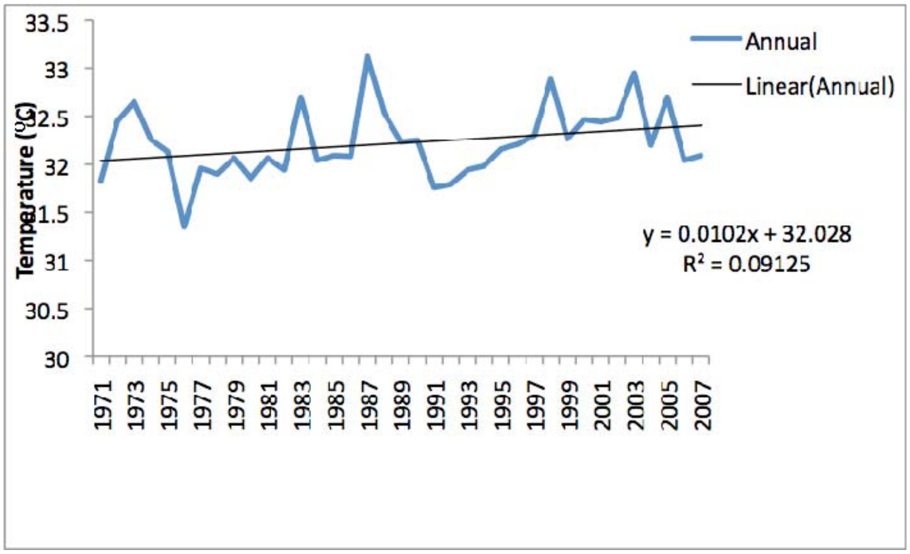

Figure 6 Annual temperature variability in Enugu (1971 - 2007)

Table 6 Mean maximum temperatures at Umudike (1972 – 2008) and Enugu (1971 – 2007)

Months	Umudike	Enugu
January	32	34
February	34	35
March	33	35
April	32	34
May	31	32
June	30	31
July	29	30
August	29	30
September	29	30
October	30	31
November	31	33
December	32	33

Major Climate Change hazards and impact on human livelihoods in the study area

The major climate change hazards in the communities include sheet and gully erosion, especially on roads and residential areas, landslide, flooding of roads, farms and residential areas, wind damage to economic trees, houses, electric poles, etc., and heat stress. Some of the observed climate induced hazards are shown in Figure 7 to Figure 19. The major agent of erosion in the study area is water. As mentioned previously, nearly 80% of the rains in the year fall within six months, much less than the past when the rainy season extended to 8 to 10 months. High intensity rainfall on poorly vegetated land causes soil erosion especially on fragile soils. The deep and extensive gully erosion and landslides in the study area are the result of a combination of pedological and climatic components. A close observation of the soils inside the gully erosion sites showed that the soils are developed from unconsolidated parent materials. They are generally sandy in nature and loose to depths of 50 meters. Soils with these characteristics are highly erodible especially when exposed to high rainfall. Gullies are usually quite deep because of the large volume of soil removed from the land through erosion. Gully eroded lands are completely wasted and cannot be used for arable farming purposes since the fertile top soil is lost. Thus gully erosion is severely compromising arable lands in south eastern Nigeria in areas characterized by high population density and limited land area.

Figure 7 Gully Erosion at Elu Ohafia, Abi State

Figure 8 Gully Erosion at Ebem Ohafia, Abia State

Figure 9 Wind damage to plantain at Owerinta in Abia State

Figure 10 Wind damage to electric poles at Umudike, Abia State

Figure 11 Developing gully along the road to Akanu-Ukwu Ohafia, in Abia State

Figure 12 Gully erosion at Oko in Anambra State

Figure 13 Gully erosion at Ekwulobia in Anambra State

Figure 14 Sheet erosion at Ngwo-uno in Enugu State

Figure 15 Eroded road at Ngwo-uno in Enugu State

Figure 16 Sheet wash exposing plant roots at Ngwo-uno in Enugu State

Figure 17 Gully and landslide at Amucha, Imo State

Figure 18 Gully and landslide at Umuoma Nekede, Imo State

Figure 19 Flooded cocoyam field at Okwudor, Imo State

Processes by which hazards impact livelihoods

Both erosion and floods contribute to poor access roads and the consequent high cost of transportation. Wind storms damage crops like plantain, banana, kola and electric poles while excessive heat causes rashes, chicken pox, and frequent visits to the hospitals. Flooding causes crop failure and is thus a threat to food security. During the field study, we were informed by respondents at Okwudor that in the peak of the rainy season, people from one of the villages abandon their homes to floods and seek refuge with family members and friends living in other villages or towns. Besides the loss of agricultural lands, soils eroded from gullies have been implicated in the silting up of streams on which rural populations depend for domestic, social and economic uses. When roads are cut by gully erosion, interaction between neighbours and friends are hindered and access to socio-economic amenities like markets, hospitals, schools, churches etc. are denied.

Characteristics of the Respondents

Age Distribution of Household heads in Enugu State

Most of the men sampled in Enugu state (62%) were at least 60 years old, compared to about 16% of the women. Most (62%) of the women were at most 49 years old compared to about 14% of the men. In general, most of the respondents in Enugu state (about 65%) were at least 50 years old. The mean age for men was 61 years while the mean age of the women was 46 years. This result indicates a paucity of male youth in the state, which is most likely due to out-migration to urban centres in search of livelihoods leaving behind aged men and younger women to contend with the adaptation challenge of climate change hazards. The absence of younger men in the local areas will to a large extent limit the capacity of the rural people to adapt to climate change hazards especially in terms of the application of indigenous practices that are often times labour intensive.

Table 7 Age distribution of household heads in Enugu State

	Men		Women		Total	
Age	F	RF	F	RF	F	RF
20 – 29	0	0	7	9.1	7	4.0
30 – 39	1	1.0	18	23.4	19	11.0
40 – 49	12	12.5	23	29.9	35	20.2
50 – 59	21	21.9	17	22.1	38	22.0
60 – 69	38	39.6	8	10.4	46	26.6
≥70	24	25.0	4	5.2	28	16.2
Total	96	100.0	77	100.1	173	100

Mean age for men = 61 years; Mean age for women = 46 years
F = frequency; RF = Relative frequency

Level of education of household heads

About 85% of men and about 90% of women in Enugu state spent at least six years in formal education. The women had more access to education than the men. About 54% of the women spent between 12-29 years in school compared to about 45% of the men. The mean number of years spent in school by men was about 10 years compared to about 11 years for women. These results are an indication of a high level of literacy in Enugu state. This high level of literacy is a positive factor that should be exploited in formulating policies and programmes for adaptation to climate change hazards and for harnessing indigenous knowledge practices for climate change adaptation, especially in terms of environmental education campaigns and awareness.

Table 8 Level of education of household heads in Enugu State

	Men		Women		Total	
Years in Sch.	F	RF	F	RF	F	RF
0 – 5	14	15.2	6	10.2	20	13.2
6 – 11	37	40.2	21	35.6	58	38.4
12 – 17	36	39.1	31	52.6	67	44.4
18 – 23	4	4.3	1	1.7	5	3.3
24 – 29	1	1.1	0	0.0	1	0.7
total	92	99.9	59	100.0	151	100.0

Mean number of years spent in school for men = 10 years
Mean number of years spent in school for women = 11 years
F = frequency; RF = relative frequency

Age Distribution of Household heads in Anambra State

In Anambra state, about 66% of the men were at least 50 years old while about 40% of the women were at least 50 years. More women (61%) were at most 49 years compared to about 34% of men. This suggests that women were in general much younger than the men. The mean age for men was about 55 years and about 45 years for women. This trend again suggests the absence of male youth in the local communities due to out-migration to urban and industrial centres in search of means of livelihood. Male youth are important in terms of the implementation of indigenous adaptation practices such as drainage construction, laying of sandbags etc., which are usually labour intensive. They are also important in mobilizing the people for communal projects.

Table 9 Age distribution of household heads in Anambra State

	Men		Women		Total	
Age of H H Head	F	RF	F	RF	F	RF
20 – 29	1	0.94%	4	6.56%	5	2.99
30 – 39	8	7.55%	10	16.39%	18	10.78
40 – 49	27	25.47%	23	37.70%	50	29.94
50 – 59	34	32.08%	18	29.51%	52	31.14
60 -69	20	18.87%	6	9.84%	26	15.57
70 – 79	14	13.21%	0	0	14	8.38
80 – 89	2	1.89%	0	0	2	1.20
Total	106	100	61	100	167	100

Mean age for men= 55 years
Mean age for women= 45 years for women
F = frequency; RF = relative frequency

Level of Education of Household heads in Anambra State

About 60% of the men and 76% of the women in Anambra state had spent at least 12 years in school. This is an indication that the women had more access to education than the men. The mean number of years spent in school was about 13 years for men and about 14 years for women. In general, about 66% of the respondents in the state spent at least 12 years in school. A minimum of 12 years in school suggests that most of the respondents had at least complete secondary education, which is indicative of a high literacy level in the state. This is an advantage for climate change adaptation since a higher literacy level will lead to better awareness of climate change and climate change hazards. Impacts and this awareness will enhance coping and adaptation capacity and capability, both locally and externally.

Table 10 Level of education of household heads in Anambra State

	Men		Women		Total	
Years spent in school	F	RF	F	RF	F	RF
0 – 5	3	3.03%	1	1.69%	4	2.53%
6 – 11	37	37.37%	13	22.03%	50	31.65%
12 – 17	36	36.36%	36	61.02%	72	45.57%
18 – 23	23	23.23%	7	11.86%	30	18.98%
24 – 29	0	0	2	3.39%	2	1.27%
total	99	100%	59	100%	158	100%

Mean number of years spent in school for men= 13 years
Mean number of years spent in school for women =14 years
F = frequency; RF = relative frequency

Age distribution of household heads in Abia State

About 66% of the male respondents in the state were at least 50 years old while about 64% of the female respondents were at least 50 years. The result showed that male and female youth have left the communities for urban and market centres. This indicates that out-migration from the rural communities is age selective. Out migration to urban and market centres have important implications for climate change adaptation. In the local communities coping and adaptation strategies such as drainage construction , laying of sandbags and construction of catchment pits are invariably labour intensive and in the absence of able bodied youths due to outmigration, the challenge of adaptation becomes more difficult for the aged at home.

Table 11 Age distribution of household heads in Abia State

	Men		Women		Total	
Age	F	RF	F	RF	F	RF
20 – 29	2	5.3	5	5.2	7	5.2
30 – 39	3	7.9	14	14.4	17	12.6
40 – 49	8	21.1	17	17.5	25	18.5
50 – 59	10	26.3	31	32.0	41	30.4
60 – 69	5	13.2	20	20.6	25	18.5
≥ 70	10	26.3	10	10.3	20	14.8
total	38	100.1	97	100.0	135	100.0

F = frequency; RF = relative frequency

Level of education of household heads in Abia State

Most male and female respondents in Abia State spent at most 17 years in school. Access to education in the state was almost equal between genders. The mean number of years spent in school for women was eight years and for men, nine years. In general, the level of literacy in the state is high. About 69% of the respondents in the state spent between six and 23 years in school. A high literacy level will lead to better awareness and predispose the people to accept and adopt climate change coping and adaptation practices more readily, thereby reducing vulnerability.

Table 12 Level of education of household heads in Abia State

	Men		Women		Total	
Years spent in school	F	RF	F	RF	F	RF
0 – 5	10	27.8	29	29.9	39	29.3
6 – 11	7	19.4	34	35.1	41	30.8
12 – 17	19	52.8	30	31.0	49	36.8
18 – 23	0	0.0	4	4.1	4	3.0
24 – 29	0	0.0	0	0.0	0	0.0
total	36	100.00	97	100.1	133	99.9

Mean number of years spent in school for women = 8 years
Mean number of years spent in school for men = 9 years
F = frequency; RF = relative frequency

Age distribution of household heads in Imo State

About 74% of the men in Imo state were at least 50 years old (Table 12). The mean age of the men was 57 years. About 65% of the women were at least 50 years old. The women had an average age of 52 years. About 13% of the men were less than 40 years compared to about 35% of the women. This indicates that there were more female youth in the communities than male youth. In general, less than 20% of the respondents in the state were less than 40 years old. This also indicates the prevalence of the elderly in the communities, which may be a disadvantage in terms of the implementation of coping adaptation projects which are of often labour intensive involving self-help efforts such as drainage construction.

Table 13 Age distribution of household heads in Imo State

	Men		Women		Total	
Age of household head	F	RF	F	RF	F	RF
20 – 29	4	4.7	0	0	4	2.8
30 – 39	7	8.2	4	6.7%	11	7.6
40 – 49	11	12.9	17	28.3%	28	19.3
50 – 59	22	25.9	22	36.7%	44	30.3
60 - 69	21	24.7	14	23.3%	35	24.1
≥ 70	20	23.5	3	5.0%	23	15.9
total	85	99.9	60	100%	145	100.0

Mean age of men = 57 years
Mean age of Women = 52 years
F = frequency; RF = relative frequency

Level of education of household heads in Imo State

The mean number of years spent in school for men was 11 years and for women 15 years (Table 13). This is an indication that, on average, women have more access to education than men. About 39% of the men spent at least 12 years in school compared to about 51% of the women.

Table 14 Level of education of household heads in Imo State

	Men		**Women**		**Total**	
No. of years spent in school	F	RF	F	RF	F	RF
0 – 5	3	3.6	2	3.8	5	3.7
6 – 11	48	57.8	24	45.3	72	52.9
12 – 17	28	33.7	18	34.0	46	33.8
18 – 23	4	4.8	9	17.0	13	9.6
24 – 29	0	0	0	0	0	0
total	83	99.9	53	100.1	136	100.0

Mean number of years spent in school for women = 15 years
Mean number of years spent in school for men = 11 years
F = frequency; RF = relative frequency

Gender differences in awareness and perception of climate variability and climate change

In Anambra State, about 92% of men were aware of climate change and climate hazards compared to about 100% of the women. The results were similar in Imo, Enugu and Abia States. The results indicate that the level of awareness of climate change and climate hazards was higher among women than men in the southeast. The explanation is that since the impact of climate change is worse on natural resource-based livelihoods, which women engage in more than men, they are therefore in a better position to want to understand climate change and its impacts. In the study area in general, there is a high level of awareness of climate change, climate change hazards and impacts. This is an important factor that will lead to reduced vulnerability by enhancing coping and adaptation capacities. From a gender point of view, there is no significant difference in the level of awareness of climate change between men and women.

The people of Igboukwu in Anambra State contend that the present weather conditions are bad as indicated by hot sun, unstable rainfall, lack of harmattan season, etc. According to them, compared to 30 years ago, there is an increase in amount of rain, rainfall intensity, rain fall frequency, sunshine intensity, wind speed and decrease in harmattan period, August break, rainy season and dry season periods. They lamented that their forests, land and soils are degraded; fallow periods have shortened from about four years to about two years and in some cases fallows have been completely eliminated. A female community leader described the situation as: “it is as if the sun has come down close to human beings”. According to her, the weather condition presently is different compared with that of 30 years ago.

According to the people of Oko, the present weather condition is harsh and has led to sickness, erosion and flooding which threatens livelihood activities and the welfare of the people. The people claimed they are aware of climate change which, according to them, is indicated by poor harvests, long dry spells, excessive heat, change in rainfall pattern and shorter periods of harmattan. The communities claimed that their farm lands and forest are degraded and streams, where available, were significantly reduced in size, fallow periods have shortened and the soil is less productive.

The present weather conditions in Nekede are worse than 30 years ago due to the "hotness of the sun". Rainfall amount and intensity are increasing while harmattan, August break and the duration of the rainy season and dry seasons are decreasing. Presently, farmers are unable to detect when to commence the farming season. The people of Okponakuma have observed the variation in climate, as indicated by the absence of harmattan and consequent lack of fruits, irregular rains and as a result people cannot accurately predict when to start farm work. Excessive heat and the absence of the August break are recent phenomena which people have observed. Due to the small size of their land area, the people practice intensive cultivation and as a result fallow periods have significantly decreased. In both Okwudor and Amucha communities, people are aware of the change in weather conditions. According to the respondents, the present weather conditions are totally different from the situation 30 years ago. Soils and forests are degraded while streams have been polluted and in some cases dried up. The people of Enugu State agreed that there is climate change because the weather is no longer what it was in the past. As shown in the trend analysis, there has been an increase in air temperature in the study area and this confirms the increased heat which the respondents referred to. Although mean annual rainfall has neither been increasing nor decreasing, there were clear indications of declining rainfall as well as number of rainy days in the study area which confirms the late onset of rains reported by respondents. The high maximum temperatures in December and January confirm the disappearance of harmattan, which was also indicated by the respondents.

Table 15 Gender distribution of awareness of climate change and its hazards

	Awareness of climate Change			Perception of Climate Change impacts	
	Frequency	Relative frequency		Frequency	Relative frequency
Anambra State Men Aware	103	92.0	Agree	103	98.1
Not aware	9	8.0	Disagree	2	1.9
Total	112	100.0		105	100.0
Anambra State women			Total		
Aware	65	100.0	Agree	66	100.0
Not aware	0	0.0	Disagree	0	0.0
Total	65	100.0	Total	66	100.0
Imo State women					
Aware	62	98.4	Agree	62	98.4
Not aware	1	1.6	Disagree	1	1.6
Total	63	100.0	Total	63	100.0
Imo State men					
Aware	90	100.0	Agree	89	100.0
Not aware	0	0.0	Disagree	0	0.0
Total	90	100.0	Total	89	100.0
Enugu State women					
Aware	71	88.8	Agree	63	87.5
Not aware	9	11.2	Disagree	9	12.5
Total	80	100.0	Total	72	100.0
Enugu State men					
Aware	83	91.2	Agree	74	86.0
Not aware	8	8.8	Disagree	12	14.0
Total	91	100.0	Total	86	100.0
Abia State women					
Aware	96	99.0	Agree	96	99.0
Not aware	1	1.0	Disagree	1	1.0
Total	97	100.0	Total	97	100.0
Abia State men					
Aware	76	91.6	Agree	75	91.5
Not aware	7	8.4	Disagree	7	8.5
Total	83	100.0	Total	82	100.0

Determinants of vulnerability in male-headed households in Abia State

The regression results of the determinants of vulnerability in male and female-headed households in Abia State are shown in Table 16. The exponential model was chosen as the lead equation. The regressors explained about 90% of the variation in the vulnerability level of the household. However, access to credit was the only significant determinant of the level of vulnerability of the household. The positive relation between access to credit and vulnerability suggests that total household expenditure was positively influenced by access to credit i.e. vulnerability was reduced by access to credit. Access to credit improves income-earning ability which reduces vulnerability.

Table 16 Regression results of the determinants of vulnerability of men in Abia State

Variables	Linear	Exponential	D. Log	S. Log
constant	-420286.5	9.895***	-1.068E-02	-4475498
	(-0.995)	(8.069)	(-0.002)	(-2.654)
Age	6065.910	-2.196E-03	0.224	340443.76
	(0.839)	(-0.105)	(0.271)	(1.098)
Income	0.506	1.424E-06	0.354	203651.67
	(1.114)	(1.078)	(1.021)	(1.566)
Education	-5595.660	-0.140	-0.118	4591.019
	(-0.149)	(-1.287)	(-0.200)	(0.021)
Dependency ratio	-123251.4	0.733	0.508	33286.098
	(-0.305)	(0.625)	(1.375)	(0.240)
Access to credit	117087.45	1.289	1.208	105301.38
	(0.632)	(2.389)**	(2.070)	(0.482)
Farm output	0.676	3.803E-06	8.228E-02	-68863.21
	(0.289)	(0.559)	(0.238)	(-0.531)
Land ownership	-136868.0	0.128	0.580	100001.11
	(-0.492)	(0.158)	(1.653)	(0.760)
Water source	181225.41	3.101E-02	0.191	279376.01
	(0.869)	(0.051)	(0.329)	(1.285)
Medical expenses	6.270	1.313E-05	0.514	144666.10
	(0.845)	(0.609)	(0.760)	(1.321)
F – ratio	1.641	6.195^{xx}	12.911^{xx}	3.220
R – square	0.711	0.903	0.959	0.853
R^2 - Adj.	0.278	0.757	0.884	0.588

*** = Significant at 1%. Figures in parenthesis are t – ratios.

Determinants of vulnerability in female-headed households in Abia State

For the female-headed households, the semi-log model was chosen as the lead equation (Table 17). The regressors included in the model explained about 55% of the variation in the level of vulnerability of the household. Age of household heads, income of the household and access to credit were positive, while value of farm output and expenditure on health were negative and significant determinants of household vulnerability. The results indicate that household expenditure increased (indicating decreased vulnerability) as age of the household head, access to credit and income of the household all increased. As the age of the household head increased, household income may increase as more members of the household become independent, economically. Consequently expenditures will increase indicating reduced vulnerability. Alternatively, an elderly household head is more likely to have a better experience of climatic variation and change over time and is also likely to be more knowledgeable about indigenous coping and adaptation practices for climate change hazards. This experience and knowledge will enhance the coping ability of the household.

Access to credit improves income-earning capacity and higher incomes will reduce vulnerability because the household has more resources at its disposal with which to cope and adapt to climate change hazards.

The higher the cost of healthcare the less access there is and consequently the more vulnerable the household is. Also, if a household spends a large proportion of its income on health care its ability to address other household needs will be constrained and vulnerability will increase.

Table 17 Regression results of the determinants of vulnerability of women in Abia State

Variables	Linear	Exponential	D. Log	S. Log
Constant	-240274.4	10.714	3.847	-1250527
	(-1.259)	(10.677)**	(1.262)	(-2.050)**
Age	5470.823	1.625E-03	0.512	283676.33
	(1.972)	(0.111)	(0.816)	(2.261)**
Income	0.514	2.695E-06	0.581	106146.05
	(3.631)	(3.624)***	(4.609)***	(4.205)***
Education	12431.412	0.105	0.169	41768.262
	(0.819)	(1.310)	(0.775)	(0.957)
Dependency ratio	79560.161	4.574E-02	0.269	133862.77
	(1.168)	(0.128)	(0.567)	(1.408)
Access to credit	168106.42	1.152	0.970	151435.57
	(2.575)	(3.357)**	(3.228)***	(2.518)**
Farm output	-0.907	-3.052E-06	-0.164	-50850.98
	(-2.629)	(-1.684)*	(-1.155)	(-1.790)*
Land ownership	-4819.512	0.253	0.209	-13228.26
	(-0.072)	(0.719)	(0.638)	(-0.202)
Water source	-32710.777	-0.494	-0.322	-10174.52
	(0-496)	(-1.427)	(-1.022)	(-0.161)
Medical expenses	-0.770	-3.976E-06	4.975E-02	-41826.40
	(-0.855)	(-0.839)	(0.413)	(-1.736)*
F – ratio	4.138**	4.373***	6.086***	4.856
R – square	0.509	0.522	0.603	0.548
R^2 - Adj.	0.386	0.403	0.504	0.435

*** = Significant at 1%; ** = Significant at 5%; * = Significant at 10%. Figures in parenthesis are t - ratios

Effect of gender of household head on vulnerability in Abia State

For all households (male and female-headed) the significant determinants of the level of household vulnerability include: age of household head, income of household, dependency ratio, access to credit, value of farm output and sex of household head as indicated in the lead linear equation (Table 18). Age of household head, household income, dependency and access to credit were positive while the value of farm output and sex of household head were negative determinants of vulnerability. A higher dependency ratio implies higher household expenditures and this could predispose the household to greater vulnerability if the household has a low income earning capacity.

The negative sign of the sex of the household head indicates that vulnerability of households in Abia State was higher in female-headed households (Table 19). The calculated F* statistic (F*.03) was less than F_{tab} (f_2 .63) (V_1 = 10, V_2 = 42) indicating that there was no difference in the vulnerability function of male and female-headed households in the State.

Table 18 Regression results of the determinants of vulnerability in Abia State

Variables	Linear	Exponential	D. Log	S. Log
Constant	-274019.5	10.369	3.393	-1297549
	(-1.492)	(10.508)***	(1.120)	(-2.200)**
Age	4869.907	1.268E-05	0.575	286377.94
	(1.844)*	(0.001)	(0.926)	(2.367)**
Income	0.502	2.589E-06	0.528	98761.150
	(3.605)***	(3.461)***	(4.233)***	(4.069)***
Education	12549.671	9.301E-02	0.130	37923.077
	(0.846)	(1.166)	(0.596)	(0.894)
Dependency ratio	112154.05	0.276	0.682	192848.13
	(1.758)*	(0.805)	(1.789)*	(2.599)**
Access to credit	169318.32	1.198	1.019	154596.33xxx
	(2.781)**	(3.660)***	(3.537)***	(2.755)
Farm output	-0.823	-2.469E-06	-0.131	-46584.777
	(-2.446)**	(-1.366)	(-0.934)	(-1.701)*
Land ownership	-22744.281	0.240	0.288	-8458.113
	(-0.361)	(0.708)	(0.912)	(-0.138)
Water source	-3096.287	-0.323	-0.154	20223.453
	(-0.051)	(-0.983)	(-0.522)	(0.352)
Medical expenses	-0.599	-2.710E-06	8.910E-02	-35591.679
	(-0.682)	(-0.574)	(0.745)	(-1.528)
F – ratio	4.464***	4.598***	6.483***	5.392xxx
R – square	0.501	0.508	0.593	0.548
R^2 - Adj.	0.389	0.398	0.502	0.447

*** = Significant at 1%; ** = Significant at 5%; * = Significant at 10%. Figures in parenthesis are t-ratios

Table 19 Regression results of the effects of gender on vulnerability in Abia State

Variables	Linear	Exponential	D. Log	S. Log
Constant	-338650.9	10.118	5.056	-1444089
	(-2.044)**	(11.897)***	(1.992)**	(-2.565)**
Age	5651.295	5.010E-03	0.121	203468.66
	(2.362)**	(0.408)	(0.233)	(1.771)*
Income	0.373	1.832E-06	0.480	87171.871
	(3.396)***	(3.250)***	(4.494)***	(3.683)***
Education	14117.649	8.276E-02	0.313x	64713.535
	(1.065)	(1.217)	(1.668)	(1.555)

Variables	Linear	Exponential	D. Log	S. Log
Dependency ratio	140652.01	0.470	-0.155	-748.640
	(2.388)**	(1.554)	(-0.415)	(-0.009)
Access to credit	139145.10	1.039	1.033	142829.66
	(2.468)**	(3.591)***	(3.911)***	(2.438)**
Farm output	-0.623	-1.588E-06	0.121	31575.103
	(-2.014)**	(0.999)	(0.473)	(0.557)
Land ownership	-7987.380	0.214	0.216	-21439.660
	(-0.137)	(0.715)	(0.782)	(-0.350)
Water source	42753.814	-0.157	-9.725E-02	52438.733
	(0.759)	(-0.543)	(-0.359)	(0.873)
Medical expenses	-0.307	-1.562E-06	2.815E-02	-23442.734
	(-0.371)	(-0.367)	(0.253)	(-0.951)
Sex	-165927.7**	-0.715	-2.374	-525881.6
	(-2.599)	(-2.182)**	(-0.787)	(-0.786)
F – ratio	4.381***	4.923***	6.889***	4.454**
R – square	0.462	0.491	0.561	0.452
R^2 - Adj.	0.357	0.391	0.479	0.350

*** = Significant at 1%; ** = Significant at 5%; * = Significant at 10%. Figures in parenthesis are t-ratios

Determinants of the level of vulnerability of male-headed households in Enugu state

The exponential model was chosen as the lead equation in Table 20. The model's coefficient of multiple determinations was 0.32. There were three significant explanatory variables: household income, land ownership status and medical expenses. Household income and medical expenses were positively related to vulnerability while land ownership status was negative. The negative sign of land ownership status indicates that temporary ownership of land negatively influenced vulnerability, i.e. temporary ownership of land increased vulnerability.

Table 20 Regression results of the determinants of vulnerability of men in Enugu State

Variables	**Linear**	**Exponential**	**D. Log**	**S. Log**
Constant	-127003.0	11.871	2.940	-2281550
	(-0.340)	(12.036)***	(0.971)	(-1.817)*
Age of household	4043.205	4.363E-03	0.454	203862.44
	(0.865)	(0.354)*	(0.738)	(0.798)
Income of household	0.155	4.108E-07	0.342	106047.09
	(1.727)*	(1.729)	(3.303)***	(2.467)**
Level of education	12043.515	-1.719E-02	-4.574E-02	10692.690
	(0.544)	(-0.294)	(-0.260)	90.147)
Dependency ratio	129348.10	2.808E-02	4.261E-02	55469.552
	(1.118)	(0.092)	(0.249)	(0.780)
Access to credit	84009.143	7.725E-02	-0.149	13854.099
	(0.852)	(0.297)	(-0.648)	(0.145)
Total farm output	-0.169	-1.872E-07	-1.228E-02	-16669.10
	(-1.421)	(-0.597)	(-0.158)	(-0.518)
Land ownership status	-81097.18	-0.506	-0.276	-48230.88
	(-0.761)	(-1.799)*	(-1.071)	(-0.452)

Variables	Linear	Exponential	D. Log	S. Log
Distance from water source	-66853.32	0.262	0.156	-100537.8
	(-0.424)	(0.629)	(0.418)	(-0.648)
Medical expenses	2.339	1.016E-05	0.370	71845.327
	(1.977)*	(3.255)***	(3.500)***	(1.638)
F – ratio	1.725*	3.140***	5.663***	2.174**
	(0.103)	(0.004)	(0.000)	(0.037)
R – square	0.206	0.320	0.463	0.249
R^2 - Adj.	0.086	0.218	0.382	0.134

*** = Significant at 1%; ** = Significant at 5%; * = Significant at 10%. Figures in parenthesis are t-ratios

Determinants of the level of vulnerability of female-headed households in Enugu state

The exponential model was chosen as the lead equation in Table 21. The regressors explained about 70% of the variability in the vulnerability function. Age of household head, household income, and dependency ratio, access to credit and distance of household dwelling from water source were significant determinants of household vulnerability. Vulnerability increased as age of household head increased. Vulnerability was lower as the income of the household head and dependency ratio increased. Access to credit also reduced vulnerability. The positive sign for the distance from water source indicates that the shorter the distance the lower the household vulnerability.

Table 21 Regression results of the determinants of vulnerability of women in Enugu State

Variables	Linear	Exponential	D. Log	S. Log
Constant	32344.884	12.026	12.623	51663.614
	(0.315)	(26.240)***	(5.603)***	(0.071)
Age of household	-938.567	-1.254E-02	-0.986	-234270.4
	(-0.711)	(-2.128)**	(-3.091)***	(-2.266)**
Income of household	0.545	1.544E-06	0.215	71384.609
	(5.688)***	(3.611)**	(2.214)**	(2.269)**
Level of education	16664.080	-3.336E-03	0.275	91762.812
	(2.025)**	(-0.091)	(2.069)*	(2.130)**
Dependency ratio	40657.955	0.400	0.255	91633.551
	(0.962)	(2.123)**	(1.599)	(1.771)*
Access to credit	8933.109	0.272	8.964E-02	14686.878
	(0.289)	(1.972)*	(0.512)	(0.259)
Total farm output	6.781E-02	-4.234E-07	4.227E-02	22651.029
	(0.749)	(-1.048)	(0.725)	(1.199)
Land ownership status	-17179.24	-0.246	-0.253	-48040.52
	(-0.378)	(-1.212)	(-1.132)	(-0.664)
Distance from water source	-10034.43	0.331	0.364	59176.946
	(-0.235)	(1.741)*	(2.001)*	(1.004)
Medical expenses	-0.510	-3.370E-07	1.500E-02	-7142.555
	(-0.789)	(-0.120)	(0.112)	(-0.164)

Variables	Linear	Exponential	D. Log	S. Log
F – ratio	12.369***	9.400***	4.252***	3.584***
R – square	0.799	0.751	0.646	0.606
R^2 - Adj.	0.734	0.671	0.494	0.437

*** = Significant at 1%; ** = Significant at 5%; * = Significant at 10%. Figures in parenthesis are t - ratios

Effect of gender of household head on vulnerability in Enugu State

As shown in Table 22, the lead equation was the exponential model with an R^2 of 38% and three significant variables – household income (positive), land ownership status (negative) and medical expenses (positive). The signs indicate that vulnerability was lowered with an increase in income and medical expenses. The negative sign of land ownership status implies that temporary ownership increased the level of household vulnerability.

Chows test indicated that in Enugu State, the vulnerability functions of male and female headed households were not significantly different. Chows f – statistic (f* = 0.88) was less than f_{tab} (f= 1.89) at 5% with V_1 = 10, and V_2 = 88 degrees of freedom.

Table 22 Regression results of the effect of gender on vulnerability in Enugu State

Variables	Linear	Exponential	D. Log	S. Log
Constant	-24734.61	11.956	5.148	-1660931
	(-0.123)	(21.931)***	(2.524)***	(-2.064)**
Age of household	661.104	-4.185E-03	5.541E-02	53785.869
	(0.257)	(-0.597)	(0.148)	(0.364)
Income of household	0.194	5.019E-07	0.272	89910.834
	(2.804)***	(2.661)***	(3.373)***	(2.821)***
Level of education	7627.404	-1.573E-02	5.839E-02	22713.177
	(0.527)	(-0.399)	(0.472)	(0.465)
Dependency ratio	108537.58	0.101	7.126E-02	66460.320
	(1.513)	(0.515)	(0.592)	(1.399)
Access to credit	48855.544	0.106	-0.101	1967.414
	(0.802)	(0.639)	(-0.615)	(0.030)
Total farm output	0.110	-1.554E-07	3.399E-02	4950.560
	(-1.223)	(-0.634)	(0.618)	(0.228)
Land ownership status	-45286.17	-0.363	-0.218	-20969.89
	(-0.637)	(-1.877)*	(-1.171)	(-0.286)
Distance from water source	-4519.727	0.295	0.229	-20881.90
	(-0.053)	(1.261)	(1.018)	(-0.235)
Medical expenses	1.832	8.964E-06	0.313	53012.399
	(2.105)**	(3.784)***	(3.615)***	(1.550)
Sex	104497.77	0.253	0.153	108373.39
	(1.662)*	(1.478)	(0.835)	(1.504)
F – ratio	3.526***	5.964***	6.403***	3.203 ***
R – square	0.267	0.381	0.418	0.265
R^2 - Adj.	0.191	0.317	0.353	0.182

*** = Significant at 1%; ** = Significant at 5%; * = Significant at 10%. Figures in parenthesis are t - ratios

Determinants of vulnerability in male-headed households in Anambra State

The exponential model was chosen as the lead equation in table 23. The model indicates that the explanatory variables included in the model explained about 52% of the variation in the endogenous variable. Access to credit and value of total farm output were the significant determinants of vulnerability used as a proxy by total household expenditure. Access to credit was positively related to vulnerability while the value of total farm output was negatively related to vulnerability. The positive relationship between access to credit and the level of vulnerability suggests that total household expenditure increases as access to credit increases. This implies that as access to credit increases, the level of vulnerability of the household decreases since lower household expenditures implies higher levels of vulnerability. Access to credit probably empowers the household economically by increasing the income earning capacity of the household and consequently reduces the level of vulnerability of the household.

The negative relationship between total farm income and vulnerability indicates that Vulnerability decreased. An increase in income enhances the ability of the household to cope with and adapt to adverse conditions. Consequently the household is less vulnerable.

Table 23 Regression results of the determinants of vulnerability of men in Anambra State

Variables	D. Log	S. Log	Linear	Exponential
Constant	14.683	517200.85	202678.04	11.926
	(5.018)***	(.514)	(.615)	(12.677)***
Age of household	-.682	-63867.54	-1165.027	-1.209E-02
	(-1.140)	(-311)	(-.315)	(-1.147)
Income of household	6.128E-02	18692.332	8.018E-02	4.337E-07
	(.706)	(.627)	(.347)	(.658)
Level of education	.247	31889.337	16985.298	8.030E-02
	(.999)	(.375)	(.724)	(1.200)
Dependency ratio	3.916E-03	-66870.68	-48468.45	9.967E-02
	(.009)	(-.446)	(-296)	(.213)
Access to credit	1.228	366130.51	321156.09	1.095
	(4.471)***	(3.814)***	(3.648)***	(4.362)***
Total farm output	-.203	-50929.44	-384	-1.838E-06
	(-1.443)	(-1.051)	(-1.055)	(-1.772)*
Land ownership status	-8.668E-03	37109.196	37885.285	3.042E-02
	(-.031)	(.386)	(.396)	(.112)
Distance from water source	.483	30304.498	12286.631	.417
	(1.208)	(.221)	(.090)	(1.073)
Medical expenses	9.320E-02	17178.252	6.315E-02	2.260E-06
	(.900)	(.483)	(.046)	(.581)
F – ratio	4.424 ***	2.577 **	2.605**	4.822 ***
R – square	0.499	0.367	0.370	0.520
R^2 - Adj.	0.386	0.225	0.228	0.412

*** = Significant at 1%; ** = Significant at 5%; * = Significant at 10%. Figures in parenthesis are t-ratios

Determinants of vulnerability in female-headed households in Anambra State

For female-headed households (Table 24), the linear model was chosen as the lead equation. About 87% of the variation in the level of vulnerability of the household was accounted for by the explanatory variables. Household income, dependency ratio and the distance between the household dwelling and water source and medical expenses were positive and significant determinants of the level of vulnerability of the household while the value of total farm output was a significant and a negative determinant.

The higher the household income, the less vulnerable the household will be. Whereas vulnerability will increase as dependency ratio increases. The further away the water source, the higher the cost of access and the more vulnerable the household. Similarly, the high cost of medical health care, reduces access and this predisposes the household to higher vulnerability.

Table 24 Regression results of the determinants of vulnerability of women in Anambra State

Variables	S. Log	Linear	Exponential	D. Log
Constant	-1515897	401613.64	12.228	11.952
	(-460)	(.709)	(14.757)***	(3.257)***
Age of household	-542378	-8756.685	-6.840E-03	-.623
	(-.984)	(-1.077)	(-.575)	(-1.015)
Income of household	530625.61	1.639	1.094E-06	.615
	(4.130)***	(8.638)***	(6.210)***	(4.293)***
Level of education	220102.30	-23413.76	4.449E-02	.353
	(.909)	(-.552)	(.717)	(1.307)
Dependency ratio	34931.63	287379.90	.345	7.518E-02
	(.091)	(1.880)**	(1.544)	(.177)
Access to credit	68892.395	-208718.4	-.308	-.179
	(.244)	(-1.228)	(-1.236)	(-.571)
Total farm output	-393443.9	-2.482	-3.038E-06	-.477
	(-2.110)**	(-2.253)**	(-1.885)*	(-2.295)**
Land ownership status	37441.195	-40336.77	-9.603E-02	8.037E-02
	(.157)	(-.264)	(-.429)	(.303)
Distance from water source	1487006.6	789595.60	.977	1.450
	(4.139)**	(3.358)***	(2.839)***	(3.621)***
Medical expenses	128898.99	1.795	2.779E-07	6.271E-03
	(1.531)	(3.950)***	(.419)	(.067)
F – ratio	6.668 ***	21.279 ***	8.837 ***	5.189 ***
R – square	0.667	0.865	0.726	0.609
R^2 - Adj.	0.567	0.824	0.644	0.472

*** = Significant at 1%; ** = Significant at 5%; * = Significant at 10%. Figures in parenthesis are t - ratios

Effect of gender of household on vulnerability in Anambra State

As shown in Table 25, the exponential model was selected as the lead equation. The regressors explained about 51% of the variation in the level of household vulnerability. Age of household head and value of total farm output were negative and significant determinants of household vulnerability while household income, level of education of household head, access to credit and distance between household dwelling and water source were positively and significantly related to the level of household vulnerability. The older the household head, the lower the vulnerability of the household. Old age probably indicates greater experience of climate variability and change and better knowledge of indigenous coping and adaptation practices. This strengthens the capacity of the household to adapt to climate change impacts and consequently the less vulnerable the household.

A high household income increases the capacity of the household to cope with adverse climate change impacts. The higher the level of education of the household head, the higher the income earning capacity. A higher level of education of the household head also increases the awareness level of the household of climate change and its impact and puts the household in a better position to cope and adapt to climate change. Consequently, the level of vulnerability of the household decreases as the level of education of the household head increases. The relationship between access to credit, value of farm output and distance between household dwelling and water source and the level of vulnerability of the household has been discussed previously.

Chows test indicated that the vulnerability function for male-headed households was different from that of the female-headed households. The calculated chows f statistic ($f^* = 7$) was greater than the f tabulated ($f_{01} = 2.47$) of $V_1 = 10$ and $V_2 = 70$ degrees of freedom. Chows test for the stability of the intercepts indicated that the difference in the vulnerability function was not due to the sex of the household head. ($f^* = .012 < f_{01}$, $V_1 = 1$, $v_2 = 79$).

Table 25 Regression results of the effects of gender on vulnerability in Anambra State

Variables	S. Log	Linear	Exponential	D. Log
Constant	206006.30	-20052.46	12.183	15.146
	(.123)	(-.061)	(20.061)***	(6.508)***
Age of household	-260238.2	-5323.913	-1.427E-02	-.722
	(-.791)	(-1.207)	(-1.749)*	(-1.582)
Income of household	147531.89	.893	8.643E-07	.159
	(2.707)***	(8.656)***	(4.531)***	(2.109)**
Level of education	-713.216	1568.298	8.776E-02	.286
	(-.005)	(.062)	(1.867)*	(1.509)
Dependency ratio	-57977.082	193473.51	.224	.131
	(.258)	(1.678)*	(1.651)	(.419)
Access to credit	437099.76	89141.660	.516	.803
	(2.932)***	(.925)	(2.895)***	(3.881)***
Total farm output	-177139.5	-.735	-2.233E-06	-.296
	(-2.082)**	(-1.561)	(-2.665)**	(-2.510)**
Land ownership status	891.358	37458.207	-4.770E-03	-1.222E-02
	(.006)	(.388)	(-.027)	(-.061)
Distance from water source	844300.82	481254.44	.678	0.901
	(4.134)***	(3.373)***	(2.569)***	(3.180)***

Variables	S. Log	Linear	Exponential	D. Log
Medical expenses	124893.97	1.951	2.805E-07	8.208E-02
	(2.420)**	(4.821)***	(.375)	(1.146)
Sex	-88093.52	111249.25	-2.317E-02	-.191
	(-.544)	(1.013)	(-114)	(-.849)
F – ratio	5.922 ***	22.354 ***	10.278 ***	6.906 ***
R – square	0.425	0.736	0.562	0.463
R^2 - Adj.	0.354	0.704	0.508	0.396

*** = Significant at 1%; ** = Significant at 5%; * = Significant at 10%. Figures in parenthesis are t-ratios

Determinants of vulnerability in male-headed households in Imo State

The double log model was chosen as the lead equation (Table 26). The explanatory variables included in the model explained about 50% of the variation in household vulnerability. The level of education of the household head, dependency ratio, access to credit and expenditure on health were significant determinants of the levels of vulnerability of the household. While the level of education, dependency ratio and medical expenses were positively related to vulnerability, access to credit was negative. An increase in the level of education of the household head, and access to credit reduced vulnerability, while an increase in the dependency ratio and the cost of health care increased vulnerability.

Table 26 Regression results of the determinants of vulnerability of men in Imo State

Variables	Linear	Exponential	D. Log	S. Log
Constant	213556.80	12.006	4.376	-2369434
	(0.728)	(9.650)***	(1.100)	(-1.957)*
Age of household	-2032.333	-9.875E-03	0.413	90600.409
	(-0.683)	(-0.783)	(0.585)	(0.422)
Income of household	0.271	6.617E-07	0.137	88186.129
	(4.102)***	(2.364)**	(1.045)	(2.202)**
Level of education	15067.527	-1.172E-02	0.562	225912.46
	(0.652)	(-0.120)	(2.102)**	(2.776)***
Dependency ratio	52679.144	0.606	1.015	122802.52
	(0.480)	(1.301)	(3.401)***	(1.352)
Access to credit	-33901.06	-1.156E-02	-0.604	-225051.1
	(-0.433)	(-0.035)	(-1.965)*	(-2.404)**
Total farm output	0.790	2.437E-06	2.389E-02	62825.63
	(3.695)***	(2.687)***	(0.152)	(1.312)
Land ownership status	-99082.87	-0.415	3.971E-02	-111201.0
	(-0.787)	(-0.777)	(0.045)	(-0.418)
Distance from water source	-7061.274	-0.320	-6.739E-02	45835.092
	(-0.069)	(-0.734)	(-0.169)	(0.377)
Medical expenses	0.675	3.267E-06	0.422	57844.83
	(1.368)	(1.561)	(2.430)**	(1.095)
F – ratio	4.374 ***	2.802 **	4.920 ***	2.818 **
R – square	0.522	0.412	0.588	0.450
R^2 - Adj.	0.403	0.265	0.469	0.290

*** = Significant at 1%; ** = Significant at 5%; * = Significant at 10%. Figures in parenthesis are t-ratios

Determinants of vulnerability in female-headed households in Imo State

For the female-headed households in Imo State (Table 27), the exponential model was selected as the lead equation, with an R^2 of 65% and only one significant variable – access to credit - was negatively related to the level of household vulnerability. The negative sign indicates that for female-headed households the level of vulnerability was reduced by access to credit.

Table 27 Regression results of the determinants of vulnerability of women in Imo State

Variables	Linear	Exponential	D. Log	S. Log
Constant	642080.29	12.908	10.172	882614.34
	(0.461)	(11.840)***	(3.037)***	(0.212)
Age of household	-10323.31	8.210E-03	0.585	-343440.2
	(-0.584)	(0.593)	(0.848)	(-0.401)
Income of household	-0.562	1.595E-07	1.767E-02	-208689.2
	(-0.861)	(0.312)	(0.150)	(-1.430)
Level of education	33191.386	-6.408E-03	9.460E-02	67726.332
	(0.275)	(-0.068)	(0.268)	(0.154)
Dependency ratio	187326.34	-0.122	-3.722E-02	179013.74
	(0.315)	(-0.263)	(-0.107)	(0.414)
Access to credit	-595317.9	-1.617	-1.687	-700381.1
	(-1.140)	(-3.953)***	(-3.981)***	(-1.330)
Total farm output	2.325	1.288E-06	3.923E-02	158743.18
	(0.857)	(0.606)	(0.307)	(0.999)
Land ownership status	101788.21	-0.229	-0.210	61560.091
	(0.206)	(-0.591)	(-0.536)	(0.126)
Distance from water source	875031.61	0.432	0.414	868129.20
	(1.544)	(0.973)	(1.005)	(1.693)
Medical expenses	9.256	2.660E-06	2.122E-02	202973.78
	(1.197)	(0.439)	(0.119)	(0.919)
F – ratio	1.723	5.981 ***	5.764 ***	1.872 *
R – square	0.348	0.650	0.641	0.367
R^2 - Adj.	0.146	0.541	0.530	0.171

*** = Significant at 1%; ** = Significant at 5%; * = Significant at 10%. Figures in parenthesis are t-ratios

Effect of gender of household on vulnerability in Imo State

For both male and female-headed households, the exponential model was selected as the lead model (Table 28). The exogenous variables explained about 40% of the variation in the level of household vulnerability. Household income, access to credit, value of farm output, medical expenses and sex of household head were significant determinants of vulnerability. Household income, value of farm output and medical expenses had a positive relationship, while access to credit and sex of household head had a negative relationship to vulnerability. Household income, value of farm output and access to credit increased household expenditures (reduced vulnerability) while higher health care costs increased vulnerability. Vulnerability was higher in households headed by women.

Chows test indicated that there was a different between the vulnerability function of male and female headed households. Chows F statistic (f* = 4.88) was greater than the f_{tab}. (f = 1.99) at 5% with $V_1 = 10$, and $V_2 = 60$ degrees of freedom. The test for the stability of the intercepts derived from the male and female-headed household vulnerability functions showed that the intercepts were heterogeneous. At 5% level of significance, chows f = statistic (f* = 6.58) was greater than f_{tab} (f = 3.92) with $V_1 = 1$ and $V_2 = 69$ degrees of freedom. The heterogeneity of the intercepts indicates that the difference between the vulnerability functions of male and female headed households in Imo state was due to the sex of the household head.

Table 28 Regression results of the effects of gender on vulnerability in Imo State

Variables	Linear	Exponential	D. Log	S. Log
Constant	268455.36	12.146^{xxx}	5.269^{x}	-244101.5
	(0.381)	(13.534)	(1.798)	(-0.102)
Age of household	-1309.475	5.804E-03	0.819	-134775.1
	(-0.156)	(0.543)	(1.417)	(-0.285)
Income of household	9.198E-02	5.705E-07^{xx}	0.122	-47206.61
	(0.482)	(2.347)	(1.508)	(-0.715)
Level of education	75224.384	4.336E-02	0.329	242813.52
	(1.460)	(0.660)	(1.524)	(1.375)
Dependency ratio	63701.954	0.200	0.507^{xx}	55448.444
	(0.251)	(0.618)	(2.358)	(0.515)
Access to credit	-441857.5^{xx}	-0.929^{xxx}	-1.237^{xxx}	-434904.7^{xx}
	(-2.452)	(-4.046)	(-5.065)	(-2.176)
Total farm output	0.332	1.352E-06^{x}	-6508E-03	4505.335
	(0.542)	(1.730)	(-0.075)	(0.063)
Land ownership status	85095.547	-0.304	-0.269	169531.54
	(0.328)	(-0.919)	(-0.745)	(0.574)
Distance from water source	479186.93^{xx}	0.188	0.198	536583.89^{xx}
	(1.984)	(0.611)	(0.664)	(2.197)
Medical expenses	1.766	4.505E-06^{xx}	0.316^{xx}	159040.84
	(1.150)	(2.302)	(2.485)	(1.529)
Sex	-291208.5^{x}	-0.500^{xx}	-0.327	-250423.3
	(-1.687)	(-2.272)	(-1.463)	(-1.370)
F – ratio	2.191^{xx}	4.838^{xxx}	5.776^{xxx}	2.385^{xx}
R – square	0.231	0.399	0.459	0.260
R^2 - Adj.	0.125	0.316	0.380	0.151

*** = Significant at 1%; ** = Significant at 5%; * = Significant at 10%. Figures in parenthesis are t - ratios

Frequency of Food Consumption

Frequency of food consumption in the study area is shown in Table 29. In Abia State, mean daily food consumption frequency for both men and women was highest for fruits and lowest for pastas. In the state, the mean daily food consumption frequency was highest for fruits and lowest for confectioneries.

In Anambra state, both men and women consumed meat and fish most frequently and confectioneries least frequently.

Men in Enugu state on the average consumed legumes most frequently while the women consumed meat and fish most frequently. Leafy vegetables were the most frequently consumed food by men in Imo State while fats and oils were consumed most by women.

In the south east, men consumed leafy vegetables most frequently while women consumed meat and fish most frequently. For all foods listed in table and for all states, there was a significant difference in the mean daily food consumption frequency between men and women.
The average expenditure on food (Table 30) was highest (₦1,754.2) for meat and fish in Anambra State, roots and tubers (₦ 1,757.95) in Abia and Enugu States (₦ 636.09) meat and fish (₦ 759.22) in Imo State. In the south east in general, average expenditure on food was highest for meat and fish (₦ 931.55).

Incidence of illness and expenditure on health

Over a five week period, many men (38.8%) and women (61.2%) in Anambra State suffered from malaria. In Abia State, just over 40% of men and women reported contracting malaria and many also reported typhoid fever (women at 64.9% had typhoid compared to 35.1% of men).
In Enugu State more women (65.9%) had malaria relative to 34.1% of men. Similarly in Imo, malaria was the most prevalent ailment and women reported less (21.3%) than men (78.8%).

During the rainy season, the most common ailment among men was malaria in Anambra, Abia, Enugu and Imo States. Among women, malaria was common in Anambra State, Enugu State and Imo state while pneumonia was most common in Abia State during the rainy season.
In the dry season, cough was prevalent among men in Anambra State, small pox in Abia and Enugu States and measles in Imo State. Most women in Anambra State had to contend with measles and cough, small pox and measles in Imo state during the dry season.

For a five week period, the average expenditure on medication (Table 29) for women was highest in Abia State (₦ 27,003.25) and lowest for Imo State (₦ 1,691.25). For men, the average expenditure on health for the period was highest in Anambra State (₦ 6,629.17) and lowest in Enugu State (₦ 1,823.50). Total expenditure on medication for the period was highest in Abia State (₦ 16,549.31) and lowest in Enugu State (₦ 2,491.25). In general, the mean expenditure on medication was significantly higher for women than for men in the south east. It was however significantly higher for men in Anambra and Imo states. The expenditure on health indicates that women in Abia were the most vulnerable while the women in Imo state were the least vulnerable. Vulnerability was highest for men in Anambara State and lowest for men in Enugu State. In terms of gender differences, the mean expenditure on health was significantly higher for women than for men indicating that in the south east, women were more vulnerable than men.

Table 29 Mean daily consumption frequency of foods

State	Sex	Roots/ Tubers	Legumes	Plantain/ Banana	Cereals	Leafy vegetables	Non-leafy vegetables	Fruits	Meat & Fish	Dairy products	Baked products	Fats & Oil	Pastas	Beverage/ soft drinks	Confectionaries
Anambra	M	1.33 ± 0.58	1.00 ± 0.00	1.00 ± 0.00	1.67 ± 0.58	1.67 ± 1.15	1.33 ± 0.58	1.67 ± 1.15	2.33 ± 0.58	1.00 ± 0.00	1.33 ± 0.58	2.00 ± 1.00	1.33 ± 0.58	1.00 ± 0.00	1.00 ± 0.00
	F	2.35 ± 1.54	2.21 ± 1.62	1.46 ± 0.65	2.42 ± 1.23	3.35 ± 2.60	2.90 ± 1.53	3.17 ± 1.98	3.56 ± 2.01	1.23 ± 0.59	1.42 ± 0.79	2.71 ± 1.18	1.52 ± 0.74	1.56 ± 0.80	1.06 ± 0.24
	Total	2.29^{b} ± 1.51	2.14^{a} ± 1.60	1.43^{b} ± 0.64	2.37^{a} ± 1.22	3.25^{a} ± 2.56	2.80^{a} ± 1.54	3.08^{a} ± 1.97	3.49^{a} ± 1.97	1.22^{b} ± 0.58	1.41^{bc} ± 0.78	2.67^{a} ± 1.18	1.51^{a} ± 0.73	1.53^{b} ± 0.78	1.06^{b} ± 0.24
Abia	M	2.14 ± 0.77	2.00 ± 0.76	1.68 ± 0.78	2.18 ± 1.05	2.45 ± 1.26	1.86 ± 1.08	2.64 ± 1.47	2.55 ± 1.26	1.77 ± 0.97	1.91 ± 1.06	2.23 ± 1.15	1.59 ± 0.96	2.09 ± 1.34	1.68 ± 0.78
	F	2.14 ± 0.89	2.00 ± 1.07	1.68 ± 0.95	1.95 ± 1.09	2.18 ± 0.85	1.50 ± 0.60	2.32 ± 0.99	2.18 ± 0.73	1.27 ± 0.55	1.50 ± 0.67	1.68 ± 0.84	1.45 ± 0.74	1.50 ± 0.60	1.23 ± 0.43
	Total	2.14^{b} ± 0.82	2.00^{a} ± 0.91	1.68^{a} ± 0.86	2.07^{ab} ± 1.07	2.32^{b} ± 1.07	1.68^{b} ± 0.88	2.48^{b} ± 1.25	2.36^{b} ± 1.04	1.52^{a} ± 0.82	1.70^{a} ± 0.90	1.95^{bc} ± 1.03	1.52^{a} ± 0.85	1.80^{a} ± 1.07	1.45^{a} ± 0.66
Enugu	M	2.40 ± 0.51	2.93 ± 0.80	1.13 ± 0.52	2.53 ± 0.52	2.80 ± 0.68	2.53 ± 0.64	2.73 ± 0.59	2.20 ± 0.86	1.27 ± 0.46	1.87 ± 0.64	2.27 ± 0.70	1.47 ± 0.52	1.60 ± 0.83	1.00 ± 0.00
	F	1.26 ± 0.56	1.53 ± 1.17	1.16 ± 0.37	1.26 ± 0.45	1.26 ± 0.56	1.16 ± 0.37	1.21 ± 0.54	1.58 ± 1.26	1.05 ± 0.23	1.11 ± 0.46	1.37 ± 0.60	1.26 ± 0.45	1.11 ± 0.32	1.05 ± 0.23
	Total	1.76^{a} ± 0.78	2.15^{a} ± 1.23	1.15^{c} ± 0.44	1.82^{b} ± 0.80	1.94^{b} ± 0.98	1.76^{b} ± 0.85	1.88^{c} ± 0.95	1.85^{b} ± 1.13	1.15^{b} ± 0.36	1.44^{b} ± 0.66	1.76^{c} ± 0.78	1.35^{a} ± 0.49	1.32^{bc} ± 0.64	1.03^{b} ± 0.17
Imo	M	1.53 ± 0.50	1.23 ± 0.43	1.00 ± 0.00	1.09 ± 0.29	2.45 ± 0.80	2.08 ± 0.84	1.36 ± 0.63	2.20 ± 0.76	1.00 ± 0.00	1.02 ± 0.13	2.30 ± 0.71	1.02 ± 0.13	1.05 ± 0.21	1.02 ± 0.13
	F	1.61 ± 0.50	1.37 ± 0.49	1.08 ± 0.27	1.11 ± 0.31	1.68 ± 0.53	1.47 ± 0.76	1.68 ± 0.66	2.13 ± 0.93	1.39 ± 0.72	1.42 ± 0.72	2.21 ± 0.87	1.79 ± 1.17	1.29 ± 0.46	1.45 ± 0.95
	Total	1.56^{a} ± 0.50	1.28^{b} ± 0.45	1.03^{c} ± 0.17	1.10^{c} ± 0.30	2.17^{b} ± 0.80	1.85^{b} ± 0.86	1.48^{c} ± 0.66	2.18^{b} ± 0.83	1.15^{b} ± 0.48	1.17^{c} ± 0.49	2.26^{b} ± 0.77	1.30^{a} ± 0.81	1.14^{c} ± 0.35	1.18^{b} ± 0.62
Total	M	1.78 ± 0.67	1.63 ± 0.84	1.16 ± 0.48	1.55 ± 0.82	2.48 ± 0.91	2.08 ± 0.89	1.84 ± 1.07	2.28 ± 0.90	1.20 ± 0.56	1.34 ± 0.69	2.27 ± 0.82	1.21 ± 0.55	1.35 ± 0.82	1.15 ± 0.46
	F	1.93 ± 1.14	1.82 ± 1.26	1.34 ± 0.63	1.77 ± 1.08	2.34 ± 1.86	1.97 ± 1.29	2.28 ± 1.54	2.60 ± 1.64	1.26 ± 0.59	1.39 ± 0.71	2.18 ± 1.08	1.55 ± 0.87	1.40 ± 0.63	1.20 ± 0.60
	Total	1.86 ± 0.96	1.74 ± 1.09	1.26 ± 0.58	1.67 ± 0.98	2.40 ± 1.51	2.02 ± 1.13	2.08 ± 1.37	2.45 ± 1.36	1.23 ± 0.58	1.36 ± 0.70	2.22 ± 0.97	1.40 ± 0.76	1.38 ± 0.72	1.18 ± 0.54

Values are mean ± standard deviation

Means with similar superscripts in a column are not significantly different (P>0.05)

Table 30 Average amount (₦) spent on food

State	Sex	Roots/ Tubers	Legumes	Plantain/ Banana	Cereals	Leafy vegetables	Non-leafy vegetables	Fruits	Meat & Fish	Dairy products	Baked products	Fats & Oil	Pastas	Beverage/ soft drinks	Confec- tionaries
Anambra	Male	166.67±121.11	136.67±95.22	291.67±135.71	198.33±252.78	145.00±175.70	121.67±56.36	190.00±232.89	416.67±304.41	150.00±54.77	111.67±126.40	155.00±153.59	286.67±142.36	243.33±183.48	41.67±67.95
	Female	458.75±337.22	666.02±1219.74	426.59±245.22	361.93±329.20	279.32±236.57	252.27±143.27	350.91±351.94	803.64±616.85	218.64±267.87	218.64±201.50	514.77±2022.11	344.32±200.19	287.27±224.36	24.57±14.96
	Total	423.70^{b}±332.39	602.50^{a}±1156.17	410.40^{b}±237.93	342.30^{a}±323.28	263.20^{b}±232.82	236.60^{b}±142.03	331.60^{b}±342.08	757.20^{b}±599.58	210.40^{a}±252.55	205.80^{c}±196.20	471.60^{a}±1898.57	337.40^{a}±193.89	282.00^{bc}±218.67	26.62^{b}±26.44
Abia	Male	2990.91±4415.49	630.91±945.04	984.09±836.57	2651.82±6329.62	1276.82±1559.33	498.64±42.61	1484.55±1998.51	1772.73±1783.37	288.86±278.59	349.55±284.19	334.09±286.67	190.91±174.71	868.41±1181.18	123.41±143.53
	Female	525.00±614.46	231.36±134.07	715.91±692.54	534.09±751.09	400.00±508.73	215.45±215.75	668.18±712.57	1654.55±1120.26	171.82±82.50	205.45±110.36	398.18±276.26	156.82±68.27	325.00±400.82	61.59±60.58
	Total	1757.95^{a}±3355.82	431.14^{a}±696.98	850.00^{a}±770.99	1592.95^{a}±4581.37	838.41^{a}±1229.04	357.05^{a}±494.89	1076.36^{a}±1539.17	1713.64^{a}±1472.99	230.34^{a}±211.50	277.50^{b}±225.17	366.14^{a}±280.10	173.86^{c}±132.22	596.70^{a}±913.98	92.50^{a}±113.27
Enugu	Male	775.00±329.35	689.00±271.11	370.00±141.81	292.40±120.28	254.00±103.62	292.00±111.83	258.00±83.90	485.00±355.16	227.00±202.32	679.00±335.71	199.00±109.79	270.00±118.32	345.00±292.66	21.50±29.63
	Female	529.23±612.58	413.85±153.00	743.85±1644.41	336.92±150.41	255.38±122.04	244.62±80.17	326.92±281.82	650.77±509.01	231.54±169.99	248.46±141.94	260.77±96.04	222.31±121.67	400.00±165.93	76.15±130.02
	Total	636.09^{b}±514.37	533.48^{a}±249.57	581.30^{b}±1232.51	317.57^{b}±136.99	254.78^{b}±111.88	265.22^{ab}±95.91	296.96^{b}±217.77	578.70^{b}±447.20	229.57^{a}±180.31	435.65^{a}±323.60	233.91^{a}±104.61	243.04^{b}±119.94	376.09^{b}±225.46	52.39^{b}±101.72
Imo	Male	280.47±139.33	314.69±214.08	305.78±147.08	325.31±424.83	241.25±95.81	178.91±63.10	212.34±125.24	756.88±493.53	115.31±50.86	186.25±71.06	204.84±114.86	227.81±145.47	139.84±113.27	31.72±33.17
	Female	607.63±746.31	342.11±214.65	453.95±353.63	258.16±92.56	235.53±99.96	172.37±95.17	194.21±134.70	763.16±540.36	148.42±93.77	176.32±78.27	328.16±186.28	229.21±121.89	119.74±59.84	30.00±36.61
	Total	402.35^{b}±491.34	324.90^{a}±213.64	360.98^{b}±253.94	300.29^{b}±341.73	239.12^{b}±96.92	176.47^{b}±76.23	205.59^{b}±128.48	759.22^{b}±508.83	127.65^{b}±71.37	182.55^{c}±73.60	250.78^{a}±156.63	228.33^{bc}±136.53	132.35^{c}±97.01	31.08^{b}±34.32
Total	Male	906.86±2303.30	409.12±499.81	457.55±488.97	816.41±3063.28	460.20±836.37	255.59±327.73	489.90±1057.60	929.31±1018.81	165.74±163.85	265.39±233.73	229.22±175.35	227.45±149.92	323.19±627.59	51.08±82.13
	Female	527.39±575.22	451.07±776.27	525.13±668.09	357.82±395.70	285.13±275.22	218.55±144.21	357.01±423.08	933.50±782.07	188.46±186.43	205.73±147.80	404.02±1245.15	258.12±164.78	252.48±247.79	39.03±57.28
	Total	704.13±1634.00	431.53±660.93	493.65591.11	571.41±2117.40	366.67±609.96	235.80±247.33	418.90±786.05	931.55±897.98	177.88±176.24	233.52±194.48	322.60±920.25	243.84±158.42	285.41±465.19	44.64±70.05

Values are mean ± standard deviation
Means with similar superscripts in a column are not significantly different (P>0.05)

Measures taken by communities to adapt to impacts of climate change hazards and assess

To check erosion in Anambra State, people plant trees especially Indian bamboos. They also dig catchment pits to collect flood water. Flood catchment pits are constructed both within the compounds and by road sides to harvest flood water. There is a regulation in the community which stipulates a penalty of ₦50,000.00 for anyone who does not have a catchment pit in their compound, which allows flood water from the compound to flow into the road or into someone else's compound. These measures are shown in Figure 20 to Figure 33.

Figure 20 Flood reception pit in Oko, Anambra State

Figure 21 In Oko, Anambra State, water from the roof is not allowed to run off the compound

Figure 22 Flood reception pit at Isuofia, Anambra State prevents flooding of roads

Figure 23 Harvested floods are used for some purposes

Figure 24 Mulching prevents crop desiccation

Adaptation measures adopted by communities in Abia State include planting of trees inside gullies, dumping of household refuse inside gullies, construction of drains, use of sandbags, planting of tress, legislation on harvesting of sand, falling of tress, and proper sighting of buildings.

Figure 25 Bamboo trees are planted to stabilize gullies

Figure 26 Planting plantain, papaya and dumping household refuse into gullies

Figure 27 Sand bags are used to fill up eroding areas around homes

Figure 28 Household refuse dumped inside gullies to stop expansion

Adaptation measures at the community level in Enugu State include construction of drains, use of sand bags, planting of Indian bamboo trees and local legislation against sand mining.

Figure 29 Flood reception pit to check flooding around residential areas in Ngwo-uno, Enugu State

Figure 30 Refuse deposited along water way to reduce the speed of flood waters

The common adaptation practices to control erosion in Imo State include construction of drains, use of sandbags, planting of tress particularly Indian bamboo, plantain and planting of grasses. The women use powder or native chalk, called "*Nzu*" on their bodies when there is excessive heat.

Figure 31 Planting of bamboo trees to control erosion

Figure 32 Erosion-prone area planted to cashew trees at Okwudor, Imo State

Figure 33 Planting of bamboo and cashew trees to control erosion

Economic, social, cultural, technological and institutional constraints

The economic, social, cultural, technological and institutional constraints to and opportunities for enhancing adaptive capacities of males and females to climate change impacts is discussed in this section. In the community of Igboukwu in Anambra State, the town union and the age grade associations are the most important social groups that positively contributed to the development of the community. Other social groups such as cooperatives, savings and credit associations and professional groups concern themselves primarily with the welfare of their members. The situation is the same in the other communities. Ultimately, all social groups contribute to the development of their communities. Most of the infrastructure, including access roads, schools, hospitals, and health centres, need improvement in terms of buildings, and personnel. The people asserted that their most important income-generating activity is crop farming followed by trading. Isuofia people asserted that they are a peaceful people who are talented blacksmiths ("*Ikpuzu*"), and who engage in trading. They have various functional social, cultural, and religious groups that assist in community work and also assist their members with credit. Infrastructural facilities in the community, such as the civic centre where the FDGs and IDIs were held, were provided through community effort. Oko people state that they are peaceful and are predominantly farmers and traders. The town union was influential in assisting in self-help projects. In collaboration with the Igwe council, the community is well governed. On the instruction from the traditional ruler, the town union facilitated the research team's movement into the villages for the research.

The selected communities in Abia State are located within the same Local Government Area (LGA) and as a result the climate change situations of the communities are similar. In the communities of Abia State, Age Grades are sustainable platforms for development in their respective communities. The town hall, roads, structural facilities in primary and secondary schools in the communities are built by the Age Grade associations.

The selected communities in Imo State include Umuoma Nekede, Okwudor, Amucha Ebeise, Okponakuma and Mbieri. In Umuoma Nekede, there are various social, cultural and religious groups contributing to the development of the members. The religious and professional groups also render humanitarian services and evangelism. Existing infrastructure such as roads, public transport, local market, clinics, health centres etc. are in poor condition. The Otamiri River, once the pride of the people and a source of clear and clean drinking water has been polluted due to erosion and sand harvesting activities. Farming and trading are the most important income generating activities. The people of Oponakuma are mostly farmers and traders. They have town union, Age Grade associations and other socio-cultural groups. These groups of people maintain peace and contribute to community development. Public infrastructure such as roads, markets, schools, clinics are in poor condition, structurally and without equipment. Okwudor and Amucha communities also have various social and cultural groups and town unions. Public infrastructure in the two communities is very poor. The two communities have been associated with erosion and flood for some time now and town unions and cultural groups have been organizing their members to implement minor coping strategies from time to time.

The communities in Enugu State have various social and cultural groups that assist their members and also contribute to community development. The most important income- generating activities include crop framing in Eke, Ebe, Udi and oil palm processing in Ngwouno. Infrastructural facilities are generally in very poor condition. The soils and forests are degraded.

Costs associated with climate change impacts

The results shown in Table 30 indicate that for male-headed households, the average cost of erosion was highest in Enugu State (about ₦ 454, 000) and lowest in Abia State (about ₦43, 000) while the average cost of adaptation was highest in Anambra state (about ₦125,000). The estimated average cost of erosion, for female-headed household was highest in Anambra state (about ₦161, 000) while the mean cost of adaptation was highest for Imo State (about ₦191, 000). Costs of impact and adaptation for erosion were higher for men in Anambra and Enugu states and higher for women in Abia and Imo states.

The average cost of floods on the male headed-households was highest in Enugu state, (N441,000) while the cost of impact for heat and cold was highest in Imo (₦26,000) and Enugu state (₦43,000) respectively. For floods and cold, the average household cost of adaptation was highest for Anambra (about ₦147, 000) and (about ₦98, 000) respectively while the cost of adaptation to heat was highest in Imo State (about ₦26, 000).

The mean cost for floods was higher for men than women in Anambra State but higher for women in Abia, Enugu and Imo States. The cost of adaptation to heat was higher for women than men in all states. The cost of adaptation to cold was higher for men than women in Anambra State but higher for women than men in other states.

In general, the cost of climate change hazards was higher for women (₦495757) than for men (₦490455) and the cost of adaptation was also higher for women (₦1,291,999) than for men (₦185,359).

Box 1: Flood Disaster – The experience of a farmer

Floods have become a serious threat in the Niger delta region since the construction of Enugu – Onitsha expressway. When it rains, very serious and uncontrollable floods can occur in villages such as Uboji, Amadikwu, Akama and Ameti.

As spoken by a local farmer in the area: "Since my area is level land, the flood will run down and remain on my land. The flood remains within this vicinity for days, leaving the entire place muddy and impassable for over two weeks. The worst and most painful aspect happened a few months ago when the flood weakened the entire wall foundation and flooded my compound. The entire compound looked like a lake and we could not move out. Properties in the dwelling houses, both mine and those of my tenants were badly damaged. Valuable possessions such as rugs, food stuffs (rice, beans, garri etc.) were all destroyed. Besides breaking into my compound, the farm behind my house where I planted yams and cassava were also flooded. Over 1500 stands of yam in my farm were waterlogged and all got rotten. All the plantain and banana trees were brought down. The yams, which were worth over ₦1.5m were destroyed. The flood also touched my poultry farm, penetrated through the wall foundation and killed over 550 birds worth over ₦ 5,000. The damage to my house and farms was so enormous that friends and in-laws came to sympathize with me and my family.

I made a passionate report to both Enugu North and Udi Local Government Authorities for immediate assistance. The former Local Government Chairman of Udi, his Secretary and the community sympathizers paid condolence visits to me each time there was a heavy down pour last year (2009).The trend has continued and only God with your assistance can save the ugly situation. I hired laborers to build a fence made out of local bush materials that cost ₦120,000, which was constructed early January 2010. I brought a pay loader caterpillar to check the erosion but they asked for ₦180,000 which I could not afford. The work has not been done due to lack of finance. So far, I solicit for your assistance. God bless you please.

Aguiyi Ozoalor ACP (RTD)
Okwe Amankwo Ngwo
Udi LGA

5. COSTS OF IMPACT AND ADAPTATION

Table 31 The mean household costs of impact (CI) and adaptation (CA) for erosion (E), flood (F), head stress (H) and cold (C)

GENDER																
	MEN								WOMEN							
State	Erosion		Flood		Heat		Cold		Erosion		Flood		Heat		Cold	
	CI	CA	CI	CA	CI	CA	CI	CA	CI	CA	CI	CA	CI	CA	CI	CA
Abia	42,785.71	33,250.0	12,636.36	16,363.64	6000.0	10,500.0	5000.00	500.00	49,307.2	76,614.7	45,591.9	100,508.7	20,134.6	18,068.5	816,985.3	37,586.8
Anambra	320,375.0	125,219.4	361,452.0	146,913.3	31,880.4	16,782.1	16,668.9	98,306.1	160,825.7	120,700	79,221.6	123,916.8	36,105.1	23,755.3	23,203.8	18,414.9
Enugu	453,666.7	60,744.2	441,068.96	37,590.7	25,000.0	3,272.1	48,555.6	14,258.1	144,000	38,650	158,250	55,947.37	47,500.0	21,200.0	38,750	23,722.2
Imo	66,466.67	69,419.01	70,942.87	81,624.62	33,398.97	26,492.71	25,925.31	203.82	71,729.7	190,365.9	89,722.2	164,292.7	109,648.6	66,046.5	92,055.6	86,208.7

6. CONCLUSION AND POLICY IMPLICATIONS

From the results presented, it is concluded that:

1. Respondents in the various communities are aware of impacts of climate change and trend analysis of rainfall and temperature confirms that climate change is occurring. Respondents perceived climate change as unpredictable rainfall patterns, heat stress, late onset of rains and high intensity rainstorms.
2. Climate change hazards/impacts identified in the study area include gully erosion, landslide, flooding, heat stress, changes in the onset and cessation of rainfall, and wind damage.
3. Vulnerability of households to the impacts of climate change in the study area is determined by age of household head, access to credit, income of household, dependency ratio, value of farm output, land ownership status and medical expenses. Men and women are equally vulnerable to the impacts of climate change.
4. Measures taken by communities to adapt to climate change include tree planting, construction of gutters and flood reception pits, dumping refuse inside gullies, use of sand bags as well as setting local rules that prohibit actions that lead to erosion or flooding.
5. The cost of impacts of climate change hazards such as flooding, erosion, heat and cold was higher for women than for men. Also the cost of adaptation to climate change impact was higher for women than for men.
6. In the study area in general, the town unions, age grade associations, cooperatives, savings and credit associations and professional groups are sustainable platforms for enhancing the adaptive capacities of men and women to climate change impacts. The major constraints to enhancing adaptive capacities particularly at the community level are economic (lack of finance) and technological (Lack of expertise or skill and equipment).

Policy Implications

The impact of climate change hazards was the most significant on the physical environment that people encounter in their daily lives. The threat to the environment by climate change is an assault on human existence, especially in developing countries such as Nigeria where the livelihoods of the majority of the population are based on natural resources. There is ample evidence that unless the deleterious impact of climate change on the environment is mitigated, attaining the MDG of reducing extreme poverty especially in natural resource dependent economics will be impossible.

A national policy on climate change and adaptation to climate change impact is imperative. The thrust of such a policy should be the protection and conservation of the environment. A behavioural change campaign and awareness programme is needed at the community level to create awareness among people of the relationship between the degradation of the physical environment and climate change and the consequent threat to their livelihoods, as well as the need for people to protect and respect their environment. The town unions and age grade associations are the most important platforms for the implementation of such a policy at the community level.

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Appendix A. Logical framework

Objective	Sub-Objective	Data Used	Analytical tool
Analyze the trends of climatic variables in the study area	Trend analysis of rainfall Trend analysis of temperature	Climatic data collected from NIMET and NRCRI meteorological station	Least squares regression
Identify the major climate change hazards and describe the processes by which they impact on human livelihoods in the study area	Identify major climate change hazards in the study area Describe the processes by which identified hazards impact on livelihoods	Physical evidence from field observations in communities Qualitative information in literature	Pictorial Descriptive
Determine gender differences in awareness and perception of the impacts of climate variability and climate change	Determine gender differences in awareness to climate change Determine gender differences in perception of climate related hazards	Quantitative primary data from field survey Quantitative primary data from field survey	Frequency distribution and Chi-square test. Frequency distribution and Chi-square test
Determine gender differences in vulnerability to identified climate change hazards and the effect of economic wellbeing, dependence on agriculture, education, health, poverty, access to resources, food security and gender on vulnerability	Determine the effect of economic wellbeing, dependence on agriculture, education, health, poverty, access to resources, food security and gender on vulnerability Determine gender differences in vulnerability to identified climate change hazards	Quantitative primary data from field survey Quantitative primary data from field survey	Multiple regression Chow's test
Identify measures taken by communities in adaptation to impacts of major climate change hazards and assess differences between males and females in terms of responses and adaptation needs	Identify measures taken by communities in adaptation to impacts of major climate change hazards Assess differences between males and females in terms of responses and adaptation needs	Physical evidences from field observation in communities Qualitative primary data from field survey	Pictorial Descriptive
Determine economic, social, cultural, technological and institutional constraints and opportunities for enhancing adaptive capacities of men and women to climate change impacts	Constraints to enhancing adaptive capacity Opportunities for enhancing adaptive capacity	Qualitative primary data from field surveys Qualitative primary data from field surveys	Descriptive Descriptive
On the basis of identified major climate change hazards, evaluate the costs of impacts and adaptation measures	Cost of impacts Cost of adaptation measures	Quantitative primary data from field survey Qualitative primary data from field survey	Table Table

Appendix B. Communications and Media Engagement

The following communications were part of the research project:

1. Seminar Presentation at the Department of Soil Science and Meteorology, Michael Okpara University of Agriculture on "Climate Change: Impacts and Adaptations".

2. Seminar Presentation to Full Gospel Business Mens' Fellowship, Umuahia Chapter on "Climate Change in Nigeria: Impacts and Adaptations".

3. Poster Presentation at National Universities Research and Development Fair, held at the University of Nigeria, Nsukka on the topic "Agriculture and Indigenous Knowledge Systems for Adaptation to Climate Change in the Southeast Agroecological Zone of Nigeria."

4. Consultations with sectoral specialists to interpret data/results

5. Dialogue with community leaders (see Figure 34 to Figure 39 below)

Figure 34 HRH Eze Awa Nwosu Iroh and Elders of Akanu-ukwu received the project team members

Figure 35 Cross section of elders from Ekeluogo, Eziukwu and Mgbaga communities received members of research team

Figure 36 HRH Eze Morrison S. Eke and some elders of Umuoma received research team members

Figure 37 HRH Eze A. E. A. Durueburuo and Town Union Executive received research team to Okwudor

Figure 38 HRH Eze V. C. Duru and Chiefs received research team in Okpunakuma

Figure 39 HRH Igwe Laz Ekwueme, Town Union president and some community leaders received research team at Oko

Appendix C. Questionnaire, in-depth interview schedule and focused group discussion material

I. Gender Dimensions and Indigenous Knowledge Systems For Adaptation To Climate Change In The Southeast Agroecological Zone Of Nigeria

Interview guide used in survey
Name of community ------------------------ State ----------------------------
Date of interview ---------------------------- Name of interviewer -------------------

PERSONAL CHARACTERISTICS

1. Sex ____Male ____Female
2. Age ____Years (completed years)
3. Age at marriage _____Years
4. Age of spouse ___ Years
5. Age of spouse at marriage ___Years
6. Marital Status ___Single, ___Married, ___widowed, ___divorced, ___Separated.
7. Number of biological Children ____Male ____Female
8. Number of dependants (Household size) _____
9. What is your educational qualification? ____No formal education ____Primary incomplete ____Primary complete ____Secondary incomplete ____Secondary incomplete ____Tertiary incomplete ____Tertiary complete
10. How many years did you spend in school altogether ____ years
11. Occupation Primary Secondary
12. Level of education of spouse ____No formal education ____Primary incomplete ____Primary complete ____Secondary incomplete ____Secondary complete ____Tertiary incomplete ____Tertiary complete

13. How many years did your spouse spend in school altogether ________
14. Occupation of spouse ____ Primary ____ Secondary

IDENTIFICATION OF CLIMATE CHANGE HAZARDS

15. Which of the following weather related problems occur in your community?
____Soil Erosion ____Flooding ____Heavy Rainfall ____Early Rainfall
____Late Rainfall ____Long dry season ____Short dry season
____High wind that damage houses, trees, electric poles
____Heavy rainfall that cause massive flooding, damage roads and other facilities
____Too much heat that cause excessive sweating and itching.
____Drying up of streams
____Disappearance of some plants
____Prevalence of disease (s) (specify)-------------------------------------
____ Others (Specify)
16. Compared to 10 yrs ago, what is the size of the area covered by ___erosion? ___Flooding?
17. When there is heavy rainfall, what is the duration compared to 10 yrs ago?

18. Compared to 10 yrs ago, In what month do you have the _____first rain? ___ Last rain?
19. In your opinion, what is the present duration of the rainy season________ dry season______ compared to about 10 years ago.
20. Compared to 10 yrs ago, do you think there is heat stress now? ___Yes ___No. If yes, when do you experience heat stress most?

21. Are there other changes in weather conditions you have noticed in your community? ____ Yes
____ No
22. If yes, please list them

23. Is there any indigenous food crop or medicinal plant your people consumed that no longer exist? ___Yes
___No . If yes, please list them ____
24. What other valuable resources (eg. Firewood) are now scarce compared to 10 yrs ago
____
25. In your opinion, why are these crops/resources no more ____________________________
____

IMPACT ON LIVELIHOODS AND WELFARE

26. How do these hazards affect livelihood activities and welfare of people in this community?

Hazards	Effect on Livelihood activities	Effect on welfare
Erosion		
Flooding		
Heavy Rainfall		
Late Rainfall		
Long dry season		
Heavy wind		
Very hot weather		
Others (specify)		

GENDER DIFFERENCES IN AWARENESS AND PERCEPTION
26. Are you aware of what is called climate change? ___ Yes ___ No
27. How did you become aware of climate change? ________________________
28. Do you believe that there is climate change? ___ Yes ___ No
28. If yes, does it cause any trouble? ___ Yes ___ No
29. If yes, list the problems it caused

30. Have you experienced any problem caused by climate change? ___ Yes ___ No

31. If yes, what problems did you experience?

32. What loss or damage or ill-health did you suffer as a result of the problem?

33. How much did it cost you to repair the damage or replace the loss? ____________________
34. How much did you spend to treat or cure the ailment? _______________________________

GENDER DIFFERENCES IN VULNERABILITY

35. How much income do you realize from: Primary occupation(specify)

Secondary occupation (specify) _____________ Gifts from friends and relations ____________

36. Other sources (specify) ____

37. How much does your family spend on the following?

_______Education _______Health _______Food _______Water ___ Housing
_______Light _______Transport _______Contributions in the village/church
_______Others (specify)

38. Do you have access to credit ____Yes ____No
39. Did you obtain credit this year? ____ Yes ____ No
40. If yes, how much credit did you obtain? ______________________________
41. What is the source of the credit? __________________________________
42. How much land do you own? ______________
43. How much land is allocated to you for farming? : by the family______ by the community ____
44. How much land did you cultivate this year? _________

45. What food crops do you grow or livestock do you keep? Fill in the table below, indicating the crop you grow or livestock you keep and the importance of each to you by ranking (5 = most important, 4 = very important, 3 = important, 2 = fairly important, 1 = not important). Also indicate whether you use agro-inputs like fertilizer for each crop and whether the crop is grown for sale(S) or household consumption (C) or both (B).

Type of crop / Livestock	**Quantity Produced**	**Rank in terms of importance to family income**	**Value of produce consumed**	**Use of Crop/livestock (S/C/B)**
Yam				
Cassava				
Maize				
Cocoyam				
Beans/legumes				
Vegetables				
Spices				
Oil palm				
Fruits				
Pigs				
Sheep				
Goats				
Poultry				

46. How much did you realize from the sale of your farm produce last year?
Crops ______________ Livestock ______________

47. In your agricultural activities, which of these problems do you encounter, what are their causes and how severe are these problems to you? (severity: 4 =very severe, 3 = severe, 2 = mild, 1 = no problem)

Agricultural problems	**Cause (s)**	**Severity**
Insufficient land		
Poor quality land (low fertility)		
Hilly/gravelly land		
Low water quality /quantity		
Lack of good planting materials		
Lack of fertilizers/chemicals		
Weeds		
Pests/ Diseases		
Lack of capital		
Lack of labour		
Lack of storage facility		
Low processing capacity		
Poor marketing channels		
Inadequate extension services		
Poor quality of planting materials		
Lack of grazing land		
High cost of inputs		
High mortality rate		
Erosion		
Flooding		

48. What type of house do you live in?
___Mud/thatch roof ___Mud /zinc roof ___Cement/thatch roof ___Cement/zinc roof
49. What is the distance from your house to the source of water? ________________________
50. What is the source of your water supply? __Pipe borne __Borehole ___Stream ___Spring
___River ___Rain water __Others (specify)
51. What is your source of electricity? ___ Generator ___NEPA ___ Others (specify)
52. What type of road lead to your village ___ All season earth road ___ All season tarred road
___ seasonal earth road Others (specify)
53. Do you have a hospital or health center in your community? ___ Yes ___ No
54. What is the distance from your home to the nearest Hospital/Health center _____________________
55. In what market do you sale your farm products? When does the market convene?

	Nearby Market			**Distant Market**	
Market	**Duration**	**Distance**	**Market**	**Duration**	**Distance**

ADAPTATION MEASURES/TRADITIONAL COPING STRATEGIES

56. What measures do you adopt to check the following?
Erosion ____
Excessive heat ____
Flooding ____
Excessive cold ____

57. Which of these practices do you do?
___Sand harvesting from gutters ___cementing compounds ___Bush burning
___Refuse burning ___zinc roofing ___Thatch roofing ___Bush clearing

___Cutting big trees ___Use of firewood for cooking
58. How do you cope with water when the streams dry up? ___________________________
59. How do you cope when important plants for food or herb is no more? _______________

60. What do you do when the weather becomes too hot (heat stress)?

CONSTRAINTS AND OPPORTUNITIES FOR ADAPTATION TO CLIMATE CHANGE

61. What are the constraints you face in adapting to changes in weather conditions?
62. What are the opportunities open to you for adaption to changes in weather conditions?
63. Are there local rules and regulations governing certain activities in this community?
__Yes __No
64. If yes, give an example.

COSTS OF IMPACTS / ADAPTATION

65. Do you incur any costs when weather related hazards occur? What measures do you take to control weather related hazards? What is the cost to you of putting control measures against weather induced hazards?

Hazard	**Impact**	**Cost of impact**	**Adaptation**	**Cost of adaptation**
Erosion				
Flood				
Heat				
Cold				

II. Gender Dimensions and Indigenous Knowledge Systems For Adaptation To Climate Change In The Southeast Agroecological Zone Of Nigeria

(In-depth Interview schedule for key Informants)

Name of Community_______________________
Date of interview ______________________ Name of interviewer ________________

INFORMATION ON KEY INFORMANT
Name of local leader _______________________________
Type of Leader ___Traditional leader ___Town Union ___Women Leader
___Youth Leader ___Age grade Leader ___Social group Leader ___Others (specify)
How long have you been in this leadership position? _____ (In years)
Age _____ (in Years) Gender ___Male ___Female
What is your educational qualification? ____No formal education ____Primary incomplete
____Primary complete ____Secondary incomplete ____Secondary incomplete
____Tertiary incomplete ____Tertiary complete

INFORMATION ON THE COMMUNITY

What can you tell me about your community? What is your community recognized for?

____

____

Probe for social, cultural, religious, or professional groups in this community using the table below

Type of group	Available? Yes or No	Membership?*	Functions of the group
Town Union			
Age grade			
Cooperative			
Fadama Association			
Savings & Credit (isusu)			
Religious groups			
Professional groups			
Cultural groups			
Social groups			
Others (specify)			

*= Males (M) , Females (F) , Children (C), Both men and women (B)

What can you tell about the infrastructure facilities in your community?

Probe further using the table below

	Present		Condition			
Facilities	Yes	No	Good	Fair	Poor	Remarks
Access road						
Public transportation						
Local market						
Primary school						
Secondary School						
Clinic/Hospital						
Electricity						
Stream						
Borehole						
Well						
Pipe borne water						
Others						

What are the common income-generating activities of people in this community?

Probe & rank in order of importance (1 = not important, 2 = important , 3 = very important.) using the table below

Activity		Ranking
Crop farming		
Trading / marketing		
Livestock rearing		
Civil Service		
Company worker		
Processing crop /Products		
Skilled labour / Handicraft		
Daily paid labour		
Artisans		
Gathering Fire wood		
Hunting		
Others (Specify)		

CLIMATE VARIABILITY AND CLIMATE-INDUCED HAZARDS

How will you describe the present weather conditions in this community compared to the situation about 10 yrs ago? ____

Have you heard about climate change before? Yes___ No ___
If yes, what is your understanding of it? ____
____
How did you become aware of it? ____

How will you rate the present weather conditions in this community compared to the situation about 10 years ago?

Weather Condition	Increasing	Decreasing	No Change
Rainfall amount			
Rainfall intensity (light ; heavy)			
Rainfall frequency			
Sunshine intensity/heat			
Wind speed			
Harmattan period			
August break period			
Rainy season period			
Dry season period			
Others			

How will you describe the conditions of land, forest and water resources of this village compared to the situation about 10 years ago?

Probe further using the table below as a guide to summarize answers.

Resource	Improved	Degraded	No change
Land / Soil			
Forests			
Water			

What are the weather related problems that occurs in your community?

How do the problems/ hazards affect livelihood activities and welfare of people in this community? (use the table below as a guide to summarize response)

Hazard	Effect on livelihoods	Effect on welfare
Soil Erosion		
Flooding		
Early rainfall		
Late rainfall		
Long dry season		
Short dry season		
High wind speed		
Excessive heat		
Others (specify)		

What is the length of fallow in this community? Presently____ 10 yrs ago ______

What measures are adopted by people in this community to check the following?

Hazard	Measures adopted
Soil Erosion	
Flooding	
Early rainfall	
Late rainfall	
Long dry season	
Short dry season	
High wind speed	
Excessive heat	
Others (specify)	

What constraints do you have in coping with climate related hazards?
____
____

What opportunities have enabled you to cope with climate related hazards?
____

What can be done to enhance your capacity to cope with weather related hazards?
____
What activities of people in this village promote climate induced hazards like
Erosion ____
Flooding ____
Heat stress ____
Damages by wind ____
Others (specify)________________ ____

About how much loss do you incur when weather related hazards occur?
How much does it cost you to cope /adapt when weather related problems occur?
How does harmattan affect fruit production in your locality? (probe for mechanism & coping strategy)

III. Gender Dimensions and Indigenous Knowledge Systems For Adaptation To Climate Change In The Southeast Agroecological Zone Of Nigeria

Focused Discussion Group Guide

Name of Community________________________________
Type of group ___Adult males ___Adult females ___Young men ___Young women
Number of participants in FGD _________
Name of Moderator _______________________ _____________________
Name of Recorder ____
Date: ____

INFORMATION ON THE COMMUNITY

What are the important social groups in this community? (Probe further about membership and function using the table below)

Type of group	**Available? Yes or No**	**Membership?***	**Functions of the group**
Town Union			
Age grade			
Cooperative			
Fadama Association			
Savings & Credit (isusu)			
Religious groups			
Professional groups			
Cultural groups			
Social groups			
Others (specify)			

*= Males (M) , Females (F) , Children (C), Both men and women (B)

2. What infrastructural facilities are present in this community? (Use the table below to probe for the type and condition of the facility).

	Present		**Condition**			
Facilities	**Yes**	**No**	**Good**	**Fair**	**Poor**	**Remarks**
Access road						
Public transportation						
Local market						
Primary school						
Secondary School						
Clinic/Hospital						
Electricity						
Stream						
Borehole						
Well						
Pipe borne water						
Others						

3. What are the common income-generating activities of people in this community?

(Probe further on relative importance to family income)

Activity	Ranking
Crop farming	
Trading / marketing	
Livestock rearing	
Civil Service	
Company worker	
Processing crop /Products	
Skilled labour / Handicraft	
Daily paid labour	
Artisans	
Gathering Fire wood	
Hunting	
Others (Specify)	

CLIMATE VARIABILITY AND CLIMATE-INDUCED HAZARDS

4. How will you describe the present weather conditions in this community compared to the situation about 10 years ago?
5. Have you heard about climate change before? Yes___ No ___
If yes, what is your understanding of it? ____

How did you become aware of it? ____

How will you rate the present weather conditions in this community compared to the situation about 10 years ago? (use table below to summarize the answers)

Weather Condition	Increasing	Decreasing	No Change
Rainfall amount			
Rainfall intensity (light ; heavy)			
Rainfall frequency			
Sunshine intensity/heat			
Wind speed			
Harmattan period			
August break period			
Rainy season period			
Dry season period			
Others			

How would you describe the conditions of land, forest and water resources of this village compared to the situation about 10 years ago? (summarize answers with the table below)

Resource	Improved	Degraded	No change
Land / Soil			
Forests			
Water			

What are the weather related problems that occurs in your community? ___________________

How do these weather related hazards affect livelihood activities and welfare of people in this community? (use table below to summarize answers)

Hazard	Livelihoods	Welfare
Soil Erosion		
Flooding		
Early rainfall		
Late rainfall		
Long dry season		
Short dry season		
High wind speed		
Excessive heat		
Others (specify)		

What is the length of fallow in this community? Presently____ 10 yrs ago ______

What measures are adopted by people in this community to check the following?

Hazard	Measures adopted
Soil Erosion	
Flooding	
Early rainfall	
Late rainfall	
Long dry season	
Short dry season	
High wind speed	
Excessive heat	
Others (specify)	

What constraints do you have in coping with climate related hazards? _______________
What opportunities have enabled you to cope with climate related hazards?

What can be done to enhance your capacity to cope with weather related hazards?
What do you do to cope when the weather becomes too hot (heat stress)?
About how much loss do you incur when weather related hazards occur?
How much does it cost you to cope /adapt when weather related problems occur?

What activities of people in this village promote climate induced hazards like
Erosion ____
Flooding ____
Heat stress ____
Damages by wind ____
Others (specify)____

How does harmattan affect fruit production in your locality? (probe for mechanism & coping strategy)

Appendix D. Impact-Vulnerability-Adaptation Matrix

Table 32 Impact-Vulnerability-Adaptation Matrix

Climate Change Hazards or Impacts	Climate Change Impacts	Vulnerability Assessment	Adaptation Options or Coping Mechanisms (C)
Erosion	Rood erosion hampering social and economic activities Gully erosion on farms leading to loss of farmlands Gully erosion in homesteads leading to displacement of vulnerable people	Extremely high vulnerability	Planting of trees Use of sand bags (C) Dumping refuse in gullies (C) Local legislation against sand harvesting on roads
Flood	Flooding of roads limiting traffic and socio-economic activities Flooding of residential area causing displacement of people Flooding of farms leading to crop failure and food insecurity	Extremely high vulnerability	Digging flood reception pits Construction of gutters Local legislation against blocking drainage ways
Extreme heat	Heat-related illnesses such as measles and heat rashes Heat-induced crop desiccation resulting in crop failure Heat stress on poultry Poor crop harvest	Medium	Planting shade trees Use of fans (C)
Extreme cold	Poor heath	Medium	Warm clothing
Late rains	Poor harvest	High	
Heavy short duration rains		Low	Nil
Longer dry season	Poor harvest	high	Mulching

Appendix E. Climate change adaptation policies and programs

Table 33 Policies, Programs, Adaptation Options Addressed, Implementing Agency and Cost

Proposed CCA Policies	**Proposed CCA Programs**	**CCA Options Addressed by Proposed Policies and Programs**	**Implementing Agency(s)**
Immediate Needs			
Awareness and enlightenment	Awareness campaign		Governments - National, state, local
Local capacity building	Training	Drainage construction, sand filling, tree planting, flood harvesting, etc.	Governments
Long Term Needs			
Governmental conservation	Conservation programme	Same	Governments
Local legislation	Local legislation campaign	Workable legislation by communities should be recognized at LGA levels	Local Government legislature

Appendix F. Summary of Focus Group Discussions and Interviews

Table 34 Summary of FGD and IDI conducted during the study

State, community FGDs	**Socio-cultural groups and activities**	**Infrastructural facilities**	**Major income generating activities**	**Aware-ness**	**Source of Awareness**	**Changes in weather conditions observed in the community**	**Current state of natural resources relative to 20 yrs ago**	**Weather related hazards in the community**	**How hazards affect livelihood activities**	**Coping measures adopted against climate hazards**	**Activities that promote climate hazards and impacts**
NRI Women	All groups exist for women except age grade, fadama & social groups. Their main activities: community development entertainment, economic wellbeing of members	All facilities exist except wells. The access road is in bad condition due to erosion	Farming, trading	Aware	Community people, radio	The weather is harsh: rains are erratic. Rainfall amount, intensity, frequency, wind speed, harmattan and August break are decreasing. Sunshine intensity and dry season periods are increasing	Water resources, forest and soils degraded	Roads destroyed by erosion	Poor crop yield, no access road to the farms and relations, increased hunger and ill health and discomfort	Use big stones and cement to block gullies, and catchment pits. Vegetable production along river banks Stay under trees Rub powder, kaolin on skin	Sand harvesting along road sides. Blocking of water ways with houses Cutting of trees
NRI Youth	Same as above, Students union for males and females; provide work force /task force in the community and also entertainment	Poor condition of secondary school buildings with roofs blown off. No access road to the stream, cut by erosion.	Outmigration to source for livelihoods: Hair dressing and trading	Aware	Community people, Radio	High sunshine intensity and late rainfall season. Rainfall amounts, frequency, harmattan period August break, rainy season season are decreasing while rainfall intensity, sunshine intensity increasing. No change in wind speed	Degraded	Streams silted, gullies, school buildings destroyed	Farm lands destroyed, poor crop yield, hunger, starvation. No income to pay school fees. Increased disease and sickness, untimely death.	Sand bags, catchment pit, growing of bamboo, grasses, cross bars on buildings, filling up of pits, Planting of cassava which is more weather tolerant than yam. Propping up plants like plantain, banana, going half naked	Blocking of gutters, sand mining, tree cutting, blocked drains and poor ventilation

State, community FGDs	Socio-cultural groups and activities	Infrastructural facilities	Major income generating activities	Aware-ness	Source of Awareness	Changes in weather conditions observed in the community	Current state of natural resources relative to 20 yrs ago	Weather related hazards in the community	How hazards affect livelihood activities	Coping measures adopted against climate hazards	Activities that promote climate hazards and impacts
Ire Ojoto (Women)	All groups exist for women except age grade, fadama & social group. Their main activities: community development, entertainment, economic wellbeing of members	All facilities exist except pipe born water and they are in very poor condition. Roads not motor able in rainy season, no access road to the schools, ill equipped clinic/hosp.	Farming/ trading	Aware	Radio, personal experience	Past years are better b/c there is food. Excessive heat/skin disease, there is crack in the sun that led to cocoyam disease. Rainfall amt. intensity, frequency, wind speed, august break &rainy season period are decreasing while sunshine intensity &dry season are decreasing	degraded	Hardship starvation, unemploy-ment diseases, sickness &discomfort	Frequent sickness, poor crop yield, reduced vigour and working hours. Poor standard of living	Sand bags, dumping of refuse in gullies, early cropping, replacement of damaged crops, tree planting, use of hand fan, sleep outside/under shade	Sand mining and cutting down of trees
Ire Ojoto (Youth)	Same as above	Same as above	Civil services, Trading, skilled labour	Aware	Radio, personal experience	Irregular rainfall. rainfall amount, intensity, frequency, wind speed, harmattan period august break & rainy season are decreasing while sunshine intensity & dry season are increasing	Degraded	Erosion, flooding excessive heat	Farming land, houses destroyed. homelessness, poor standard of living	Sand bags, opening up drains, channel floods to stream, remove water with motorised pumps, open windows at night, stay under shade, use fans	Sand mining, cutting down trees

State, community FGDs	Socio-cultural groups and activities	Infrastructural facilities	Major income generating activities	Aware-ness	Source of Awareness	Changes in weather conditions observed in the community	Current state of natural resources relative to 20 yrs ago	Weather related hazards in the community	How hazards affect livelihood activities	Coping measures adopted against climate hazards	Activities that promote climate hazards and impacts
OKo (Adult men)	All groups are for community development and conflict resolution	The only facilities listed that are not in the community are streams and pipe borne water	Crop farming, trading and company work	Aware	Radio, personal experience	Serious erosion problems, the community cut-off by erosion. Increasing, sunshine intensity. Decreasing rainfall amount, intensity, frequency, wind speed, August break period, rainy season, and dry season period	Land/soil degraded, require fertilizer for agriculture, degraded forests	Flooding, no more shifting cultivation due to reduced farm land by erosion	Poor crop yield affects income and family nutrition, lack of good sleep die to heat, rashes; transportation affected. Late Benedict Ezehanonu and Daniel Onwuasonya died as a result of floods	Each compound built catchment pit to reduce run-off, erosion; built water channels, plant trees (bamboo, cashew); proper ventilation in homes and use of hand fans. People advised to plant carpet grass in place of cement floor, build ridges along the roads	Cementing of compounds, cutting trees.
Oko (Youth)	All groups are for community development and conflict resolution	The only facility listed that are not in the community are stream and pipe borne water	Trading, hair dressing, fashion	Aware	Discomfort in the body	Increasing sunshine intensity. Decreasing rainfall amount, harmattan, August break, rainy season	Land/soil degraded	Erosion	Affects food production and health, sleeplessness	Catchment pit, plant palm trees, cashew, construct gutters, use hand fan & open windows	Zinc roofs, cemented compounds increased population tree felling
Igbokwu (Adult women)	All groups are for community development and conflict resolution, entertainment	The facilities in the community are in fair condition	Farming, trading	Aware	Through SMS, from NASA about acid rain, radio and changes on crops	Increasing rainfall amount, rainfall intensity, frequency, and sunshine intensity & wind speed. Decreasing harmattan, August break, rainy season, dry season	Land/soil, forest and water degraded	Sickness, hot weather lack of farm produce, bad road due to heavy rains	People are rendered homeless, crop failure, increased disease, sickness	Planting trees e.g. bamboo, bahama grasses, mulching, catchment pits, use powder, plant small sized yam	Sand excavation, cutting down trees, heavy traffic of heavy duty vehicles
Isuofia (Adult men)	All groups are for community development, conflict resolution and entertainment	The facilities in the community are in good condition	Cropping and farming	Aware	Personal experience	Increasing rain amt, rainfall intensity, frequency, sunshine intensity &rainy season period. Decreasing harmattan period, August break period &dry season period	Land/soil, forest and water degraded	Flooding destroy roads farms, heat stress	People are rendered homeless, crop failure, increased disease, sickness	catchment pit, Planting trees	nil

State, community FGDs	Socio-cultural groups and activities	Infrastructural facilities	Major income generating activities	Aware-ness	Source of Awareness	Changes in weather conditions observed in the community	Current state of natural resources relative to 20 yrs ago	Weather related hazards in the community	How hazards affect livelihood activities	Coping measures adopted against climate hazards	Activities that promote climate hazards and impacts
Enugu State FGDs											
Umuabi (Men)	All groups exist except town union that is exclusive of men. All for community development and conflict resolution	All facilities exist except clinic, stream, borehole and well. All in poor condition b/c roads destroyed by erosion, school building destroyed by wind/erosion	Palm tapping, farming, artisans	Aware	Personal Experience	Hotter sunshine, no harmanttan. decreasing rainfall amount, rainfall intensity, frequency harmattan period, august break, rainy season. Increasing sunshine, wind speed & dry season	Degraded land/soil and forest. No change in water	Erosion, roofs blown off, thunder storms destroy electric poles and palm trees	Hunger, increased poverty, poor crop yield. late cropping, money spent in renovating houses, elders weak, post harvest loss (yams, cocoyam)	Catchment pits, embankments, tree planting, sand bags. Mr Okeke Nwaozoagu very popular and handy as a rain maker. Hand fans, electric fans, sleep outside	Arbitrary building of houses, sand mining, heavy vehicle traffic, deforestation
Umuabi (Adult women)	All groups exist except town union that is exclusive of men. All for community development conflict resolution	Same as above	Crop farming and livestock rearing	Aware	Personal Experience	Increasing rainfall, rainfall intensity, wind speed and dry season. Decreasing harmattan august break and rainy season	Degraded land/soil and forest. No change in water	Heat stress causing measles and other diseases	Roads are damaged due to erosion. Hunger, increased poverty, poor crop yield, late cropping. Money spent in renovating houses, aged ones are too weak, post harvest loss(yams, cocoyam)	Same as above	Same as above
Ngwo Uno (Adult men)	All social groups exist and they are for community development	Only access road and borehole existed in the community and they are in poor condition	Palm wine tapping and farming	Aware	nil	Rains do not start on time. Increasing sunshine intensity, wind speed and dry season. Decreasing rainfall amount & intensity, harmattan period, August break and rainy season	Land/soil, forest and water degraded. Water degraded due to coal mining	nil	Movement retarded, increasing incidence of malaria.	Catchment pit, use palm fronds	nil

State, community FGDs	Socio-cultural groups and activities	Infrastructural facilities	Major income generating activities	Aware-ness	Source of Awareness	Changes in weather conditions observed in the community	Current state of natural resources relative to 20 yrs ago	Weather related hazards in the community	How hazards affect livelihood activities	Coping measures adopted against climate hazards	Activities that promote climate hazards and impacts
Ngwo Uno (Adult women)	All social groups exist and they are for community development	Only access road and borehole existed in the community and they are in poor condition	Crop farming and livestock rearing	Aware	nil	Same as above	Degraded land/soil. No change in forests and water	Heat stress causing measles	Destroy crops, reduces yield, destroys buildings, restlessness, disease and reduced income. Increased child drop out in schools, crops submerged in water, people are rendered homeless, increased incidence of meningitis & measles	Sand bags, sand filling, use palm fronds, mulching. People dress lightly	Zinc roofing, use of generators and tree cutting
Ngwo Uno (Youth)	All social group are for community development	Roads destroyed by erosion	Crop farming, trading	Aware	Experience, radio		Land/soil, forest and water are degraded	Poor access road, intense heat, washing of soil texture	Same as above	Same as above	Same as above
Ebe (Adult women)	All social groups are for both men and women to foster development and conflict resolution in the community	The facilities in the community are a local market, primary school & borehole. They are in poor condition. Roads damaged by erosion, road leading to the primary school not accessible due to flooding and gullies	Crop farming and trading	Aware	nil	Climate change is affecting food production: onset of rains which affect cropping season, increasing rainfall intensity and sunshine (cocoyam farms destroyed due to intense sunshine). Decreasing rainfall amount, wind speed, harmattan period, August break, rainy season and dry season	Land/soil and forest degraded. There is over-grazing by Fulani herdsmen. No change in water	Intense heat, poor crop yield esp. Cocoyam. Poor health conditions	Same as above	Use of sand and palm leaves, building of gutters, use straw hats to reduce sun heat, pray to God & bath very often	Sand excavation from gutters, build house in wrong place blocking water ways, poor ventilation, cutting down trees

State, community FGDs	Socio-cultural groups and activities	Infrastructural facilities	Major income generating activities	Aware-ness	Source of Awareness	Changes in weather conditions observed in the community	Current state of natural resources relative to 20 yrs ago	Weather related hazards in the community	How hazards affect livelihood activities	Coping measures adopted against climate hazards	Activities that promote climate hazards and impacts
Eke (Adult women)	All social groups are for both men and women to foster development and conflict resolution in the community	The facilities in the community are an access road, public transportation, primary & secondary school, clinic/hospital & electricity. The roads in the community are in poor condition due to erosion	Crop farming, trading and civil service. The crops are damaged by cattle	Aware	Radio Enugu State broadcasting Service (ESBS)	Climate change destroyed cocoyam production. Decreasing rain fall frequency, harmattan period, August break & rainy season	Land/soil, forest and water degraded	Poor health, poor crop yield, degraded land	Same as above	Planting of grasses, sand bags, creating gutters, planting drought resistant crops, praying and fasting, rubbing powder and staying outside	Same as above
Udi (Adult women)	All groups exist except town union that is exclusive of men. All for community development & conflict resolution	All facilities exist and they are in good condition	Crop farming, livestock rearing & trading	Aware	Personal experience	"Something has removed from the sun" (Ozone layer deletion). Decreasing rainfall amount, frequency, wind speed, harmattan period, August break and rainy season. Increasing rainfall intensity, sunshine intensity, dry season and hailstones	Land/soil and forest degraded No change in water	Poor health condition leading to deaths. Variation in cropping season	Poor access road leading to reduced commerce. Too many mosquitoes giving rise to malaria, crop failure leading to starvation, sickness, poor income, damaged houses, people are homeless	Sand bags, use of tree trunks to block gullies to create drainage, plant enegbe yam that does well in rain & sun, plant dry season yam, pruning of trees near compounds, cutting down old trees, use hand fan, frequent bathing, sleeping outside & rubbing of powder	People violated traditions esp. widows going to the farm without performing traditional rites (trad. belief). Overgrazing of farmland, harvesting of sand along the road, cutting of trees, smoke from generators, poor ventilation

State, community FGDs	Socio-cultural groups and activities	Infrastructural facilities	Major income generating activities	Aware-ness	Source of Awareness	Changes in weather conditions observed in the community	Current state of natural resources relative to 20 yrs ago	Weather related hazards in the community	How hazards affect livelihood activities	Coping measures adopted against climate hazards	Activities that promote climate hazards and impacts
Abia											
Elu Ohafia (Adult women)	All social groups exist with membership for both men and women except cultural group that is strictly for women. They all function mainly for community development and cultural entertainment	All facilities exist except wells; all in poor condition due to gully erosion (school, roads are the worst)	Crop farming, trading	nil	nil	Increase in rainfall, poor crop yield. Decreasing rainfall frequency, harmattan period, August break and rainy season. Increasing rain fall amount, intensity, sunshine intensity	Land/soil, forest and water resources degraded	Soil erosion. most homes pulled down, heavy rainfall heat & stress	Soil erosion destroys houses, farms leading to starvation, homelessness, incidence of diseases and sickness	Creating barriers with bamboo, sand bags, construction of drainages, to reduce heat stress, dress lightly bath frequently, stay outside	Zinc houses, tree cutting and crowded settlements
Elu Ohafia (Adult men)	Same as above	Same as above	Crop farming, trading, marketing	Aware	Experience from farm produce	Same as above	Same as above	Same as above	Same as above	Same as above	Zinc houses, tree cutting and crowded settlements. Sand excavations from the roads
Ekelogu Ohafia (Adult women)	Social groups exist for community envelopment	Poor access road, primary school cut-off due to erosion	Crop farming, trading and livestock rearing	Aware	Radio and People	Rainfall amount, rainfall intensity, wind speed, rain fall frequency sunshine intensity and dry season are increasing while only harmattan is decreasing	Land/soil, forest and water resources degraded.	Soil erosion causes most homes to be pulled down, heavy rainfall heat & stress	Erosion destroys the roads so difficult to get to farm, crops are flooded so low harvest, low income. Increased hunger, starvation. Excess heat lead to sickness and disease	Plant trees (*Melina* & Indian bamboo), use concrete blocks, sand bags. For heat stress provides enough ventilation, rub kaolin, plant trees. Enforce laws against sand harvesting	Over -crowded living conditions

State, community FGDs	Socio-cultural groups and activities	Infrastructural facilities	Major income generating activities	Aware-ness	Source of Awareness	Changes in weather conditions observed in the community	Current state of natural resources relative to 20 yrs ago	Weather related hazards in the community	How hazards affect livelihood activities	Coping measures adopted against climate hazards	Activities that promote climate hazards and impacts
Ekelogu Ohafia (Adult men)	Social groups exist for community envelopment	Poor access road, primary school cut-off by erosion	Crop farming trading and civil service	Aware	Radio and People	Changes in rainfall & sunshine considered an act of God. Increasing sunshine intensity & heat, wind speed, August break, dry season. Decreasing rainfall amount, intensity (light or heavy), frequency, harmattan, rainy season	Land/soil, forest and water resources degraded. Water degraded due to flooding	Soil erosion, heat stress, heavy rainfall, high winds	Same as above	Same as above	nil
Mgbaga Ebem (Adult women)	Social groups exist for community envelopment	Poor access road, primary school cut-off by erosion	Crop farming, trading and daily paid labour	Aware	Radio	Increasing sunshine intensity/heat, wind speed, rainfall amount, rainfall intensity and frequency. Decreasing hamattan, August break	Land/soil, forest and water resources degraded	Soil erosion, heat stress, heavy rainfall, high winds	Crops and livestock destroyed	Plant trees, bamboo, sand bags. Use of kaolin, frequent bathing	nil
Mgbaga Ebem (Adult men)	Social groups exist for community envelopment	Poor access road, primary school cut-off by erosion.	Crop farming and trading	Aware	Radio and experience	Increasing rainfall amount, intensity (light, heavy), frequency, sunshine intensity/heat, wind speed, rainy season. Decreasing harmattan period, August break, dry season.	Land/soil, forest and water resources degraded	Soil erosion, heat stress, heavy rainfall, high winds	Plants and houses destroyed	Plant trees, bamboo, sand bags. Use of kaolin, frequent bathing, stay under trees.	Zinc roofing, blocking water ways, crowded residence, tree cutting
Eziukwu Ebem Ohafia (Adult women)	Social groups exist for community envelopment	Poor facilities in the community, access road to the farm closed due to gully erosion	Crop farming and trading	Aware	Radio and situation around them	Increasing rainfall intensity, frequency, sunshine intensity, and dry season. Decreasing rainfall amount, harmattan & rainy season	Land/soil, forest and water resources degraded. Water body silted up by erosion	Soil erosion, high wind storms, heavy rain, heat stress	nil	Building with concrete on erosion sites, planting of Indian bamboo trees	nil

State, community FGDs	Socio-cultural groups and activities	Infrastructural facilities	Major income generating activities	Aware-ness	Source of Awareness	Changes in weather conditions observed in the community	Current state of natural resources relative to 20 yrs ago	Weather related hazards in the community	How hazards affect livelihood activities	Coping measures adopted against climate hazards	Activities that promote climate hazards and impacts
Eziukwu Ebem Ohafia (Adult men)	Social groups exist for community envelopment	Poor facilities in the community, access road to clinic & primary school eroded	Crop farming trading and skilled labour	Aware	Radio, TV, News paper	Climate change as a result of cosmic change (trad belief). Decreasing harmattan, August break &dry season. Increasing rainfall amount, intensity, frequency, sunshine intensity, wind speed and rainy season	Land/soil, forest and water resources degraded. Water body silted up by erosion	Soil erosion, high wind storms, heavy rain, heat stress	Crops are washed away leading to hunger, starvation	Sand filling, planting of grasses, stay outside	Sand escalation & over crowding
Akanu Ukwu Ohafia (Adult women)	Social groups exist for community envelopment	Poor facilities in the community, access road to clinic & primary school eroded	Crop farming, trading	Not aware	NIL	Increasing rainfall amount, intensity, sunshine intensity, wind speed. Decreasing rainfall frequency & harmattan	Land/soil, forest and water resources degraded. Water body silted up by erosion	Soil erosion, flooding, heat stress	Increased sickness	Plant Indian bamboo, use of sand bags, early planting, replanting damaged plants, praying and fasting, frequent bathing, staying outside	Bush burning, building houses without approved plan
Amucha (Adult women)	All groups exist for both male and female and they serve as avenues for community development and conflict resolution	Facilities available in the community are in bad condition. Erosion has destroyed roads, schools and electric poles	Crop farming, trading, marketing	aware	Personal experience	Increasing rainfall amount, sunshine intensity and rainy season. Decreasing rainfall intensity, frequency, harmattan, August break and dry season. No change in wind speed	Land/soil, forests and water degraded	Erosion, flooding	Poor nutrition, poor crop harvest sleeplessness, low income. High cost of living	Clearing of gutters, planting of carpet grasses, creating channels, early cropping. Prayers for God's intervention. Sleep outside	Blocking of water ways
Amucha (Adult men)	Same as above	Same as above	Same as above	Aware	Radio, discussion from community people	Increasing rainfall intensity, sunshine intensity/heat, rainy season and dry season. Decreasing rainfall amount	Land/soil forests water degraded	Erosion from flooding	Poor crop yield, poor nutrition and sleeplessness	Clearing of gutters, planting of carpet grass, prayers, sleep outside	Blocking of drainage with buildings

State, community FGDs	Socio-cultural groups and activities	Infrastructural facilities	Major income generating activities	Aware-ness	Source of Awareness	Changes in weather conditions observed in the community	Current state of natural resources relative to 20 yrs ago	Weather related hazards in the community	How hazards affect livelihood activities	Coping measures adopted against climate hazards	Activities that promote climate hazards and impacts
Umueze Obazu (Youth)	Same as above	Same as above	Same as above	aware	Radio discussion with friends	Increasing sunshine intensity/heat, wind speed, dry season. Decreasing rainfall amount, intensity and frequency. Decreasing harmattan, rainy season. No change in August break	Land/soil and water degraded. No change in water	Erosion, poor roads due to flooding	Destruction of crops, poor crop yield. Food scarcity and poor nutrition. Increased sickness. Destruction of buildings. Poor quality of life	Sand filling, planting of trees. Constant bathing and use of fans	Sand excavation, digging of fence along the road
Umueze Obazu (Adult men)	Same as above	Same as above	Same as above	Aware	Radio and community members	Increasing rainfall amount, intensity, frequency and sunshine intensity. Increase in wind speed and dry season. Decreasing Harmattan August break and rainy season	Land/soil forest, water all degraded	Erosion due to flooding	High cost of transportation, poor crop yield, destruction of houses and increased sickness	Construction of embankment and pits, sand filling and sand bags. Early planting, wait on God. Use of powder and stay outside	Blocking water ways and drainage
Okwudor (Adult women)	All groups exist for both male and female and they serve as avenue for community development and conflict resolution	Same as above	Trading, marketing and crop farming	Aware	Radio, TV, newspaper and church	Increasing rainfall amount, intensity, frequency and sunshine intensity. Increase in wind speed and dry season. Decreasing Harmattan, August break and rainy season.	Land/soil forest water all degraded	Erosion due to flooding	Same as above	Same as above	Blocking water ways and drainage
Umueze obazu (Adult women)	Social groups exist for community envelopment	Poor facilities in the community, access road to clinic & primary school eroded	Crop farming, trading, marketing	Aware	Personal experience, Radio & community members	Same as above	Land/soil, forest and water resources degraded	Soil erosion and flooding that carries human beings, bad roads	Same as above	Planting Indian bamboo, use of sand bags, early planting, replanting damaged plants, praying and fasting, frequent bathing and staying outside	Bush burning, building houses without approved plan

State, community FGDs	Socio-cultural groups and activities	Infrastructural facilities	Major income generating activities	Aware-ness	Source of Awareness	Changes in weather conditions observed in the community	Current state of natural resources relative to 20 yrs ago	Weather related hazards in the community	How hazards affect livelihood activities	Coping measures adopted against climate hazards	Activities that promote climate hazards and impacts
State/communities IDI (Interviews)	Socio-cultural/groups and activities	Infrastructural facilities	Major income generating activities of men/F			Changes in weather conditions observed in the community	Current state of land, forest and water resources relative to 20 yrs ago	Weather related hazards in the community	How the hazards affect livelihood activities	Coping measures adopted against climate related hazards	Activities that promote climate related hazards
Anambara											
NRI (Okeke) F 50yrs (Women's leader)	All the groups exist for both genders except Isusu and Town Union that are basically male and female respectively. All groups are for community development and conflict resolution	All the facilities existed and they are fairly in good condition, the primary school lacked seats and toilet facilities	Farming Trading	Aware	Radio, TV	The weather is presently very harsh, rainy season changed. Decrease in rainfall amount, intensity and frequency. Increase in sunshine intensity, wind speed, dry season , harmantan, August break & rainy season	Land, forest & water greatly degraded	Sickness esp. malaria, heat stress, gullies	Lack of access to farm & market, poor crop yield, hunger, increased child-related sickness, untimely death	Sand bags, drainage, cropping along river banks, mulching of crops, irrigation, planting of trees, Stay outside, use hand fans	Sand mining along the road, building without approved plan, roofing with zinc, tree cutting
NRI (Egolum) (Male)	Same as above	Same as above	M Farming/ trading	Aware	News Paper, Radio, Personal experience	Weather not what it used to be. Sunshine, wind speed and dry season are increasing. Harmattan, August break and rainy season are decreasing	Land, soil and forest degraded	Road destroyed. Poor crop yields	Destroyed roads and buildings, families cut off. Out migration of young people. Sleeplessness and increase malaria, meningitis	Community mobilised to fill erosion sites, sleep outside and use hand fans	Blocking of drainage, sand mining, crowing of buildings and poor ventilation

State, community FGDs	Socio-cultural groups and activities	Infrastructural facilities	Major income generating activities	Aware-ness	Source of Awareness	Changes in weather conditions observed in the community	Current state of natural resources relative to 20 yrs ago	Weather related hazards in the community	How hazards affect livelihood activities	Coping measures adopted against climate hazards	Activities that promote climate hazards and impacts
Ojoto Ire(Maria Nwajugo) F 58yrs (Women's leader)	All groups existed except professional and social groups. Membership in co-op, *Isusu* and religious groups are for women. Town unions, Fadama are for men & women. All are involved in community development conflict resolution and entertainment	All facilities existed except public transportation and they are in fairly good condition. Roads destroyed by erosion. Secondary schools and bore holes privately owned	Farming & trading	Aware	Newspaper Radio, Personal experience	The weather is very harsh and affects cocoyam production. Sunshine intensity very high affecting crop yield. Rainfall intensity, wind speed increasing. Rainfall amount, frequency, harmattan, August break and rainy season are decreasing	Land, soil & forest greatly degraded	Crops & economic trees destroyed. Trees do not fruit as before	Collapse of buildings, increase mosquito bites, hardship, hunger and ill health	Creating of gutters, catchment pits. Trading in other crops, cropping along river banks, mulching of crops, planting of trees. Domestication of forest products like *uzuza* and *utazi*. stay under shade, dress lightly and rub kaolin	No proper channelling of water. Indiscriminate building of houses, cutting down of trees.
Ojoto Ire (Engr Onuchukwu) Male 65 yrs, (member of Town union)	Masquerade group entirely for men; provides entertainment	Pipe-borne water no longer functional, low patronage of market due to nearby bigger market. Erratic power supply	Farming, trading	Aware	NewsPaper Radio, Personal experience	Experienced hail stones in the past. Rainfall intensity very high with short duration. Rainfall frequency, harmattan period, august break, rainy season are decreasing. Sunshine intensity, wind speed, dry season are increasing. No change in rain fall amount	Land, soil, forest and water greatly degraded	Soil erosion	Access roads cut-off, houses destroyed. People rendered homeless. Poor crop yield esp. cocoyam. Increased termite infestations.	Grassing of compounds. Engage rain makers to stop rains during ceremonies. Irrigation, planting of trees, stay outside, use hand fans and bath more frequently	Road constructions, blocking of water ways and drainages and cutting of trees.
Igbokwu (Okoye Callistus) Male 63 yrs (Town Union)	All the groups exist and membership for both male & female. Provide platform for community development and conflict resolution	All facilities exist except stream. Well & pipe borne water fairly good condition.	Trading	Aware	News Paper, Radio, Personal experience	Things are falling apart & no longer easy in the community. People are afraid of the impending acid rain. The weather is unpredictable, decreasing rainfall, intensity, frequency harmattan, august break, rainy season and dry season	Land, soil degraded No stream	Increased health- related problems	Movement of people affected due to damaged roads, increased transportation cost, poor commerce. Food scarcity, hunger untimely death	Tree planting, catchment pit, wait on nature for rains, stay indoors to avoid storms, open windows	Sand mining, hunting by digging deep into the soil, bush burning, poor ventilation,. Cutting down of trees/bushes.

State, community FGDs	Socio-cultural groups and activities	Infrastructural facilities	Major income generating activities	Aware-ness	Source of Awareness	Changes in weather conditions observed in the community	Current state of natural resources relative to 20 yrs ago	Weather related hazards in the community	How hazards affect livelihood activities	Coping measures adopted against climate hazards	Activities that promote climate hazards and impacts
Igbokwu (Enenmuo P) F (Women's leader)	All groups exist except coop, *Isusu* is for women. Function for community development	Road in poor condition due to floods, schools lack facilities, no stream in the community	Farming & trading	Aware	Radio, experience	Increasing rainfall amount, intensity, sunshine intensity, rainy and dry seasons. Decreasing harmattan and august break. No change in rainfall frequency and wind speed	Land/soil and forest degraded No natural stream	Erosion, poor crop yield, flooding	Threat to buildings and crops, no access road to farm/market. Set back to community development, more hunger homelessness, sickness & weakness. Destruction of economic tees, roof tops	Sand bags, local bumps, catchment pits, stay under trees, cross bars in the farm. Construction of embankments, zinc gutters, Indian bamboo	Indiscriminate building of houses, sand mining, tree felling, poor ventilation, over crowding in homes, cutting of trees.
Oko (okeke Caroline) F 68 yrs (Women's leader)	All groups exist for both genders except cultural groups which are for women. Engage in community development, sanitation conflict resolution.	All facilities in fairly good condition, except a well and pipe borne water	Trading, farming	Aware	Personal experience	Present weather very hot, rain delayed. Decreasing rainfall amount, frequency, wind speed, harmattan, august break and rainy season. Increasing rainfall intensity, sunshine intensity and dry season	Increased pressure on land due to population. Land/soil forest degraded	Rashes, sleepless nights, flooding & erosion	Washes soil and road away causing hardship and starvation, delayed planting, dislodging of economic plants, illness among children. Increased expenditure on food and medication	Catchment pit, plant bamboo, early farming, irrigation tree planting, ventilation of houses, bathing frequently and going to hospital	Building of houses without plan, crowding of houses, bush burning, use of power generating sets
OKO (M)											
Isuofia (F) Pauline Umazuoke	*Isusu* & cultural groups is women only. They foster community development	Facilities are adequate	Farming, trading	Aware	Personal experience	Feels like the sun is closer as it is too hot. Increasing rainfall amount, sunshine intensity & rainy season. Decreasing rainfall intensity, frequency wind speed, harmattan, August & dry season	Soil too hot to support forest growth, increase pop. Land/soil forest degraded No change in water	Excessive heat, lack of farm land, poverty, sickness like convulsion	Erosion reduces farm land, puts farmers under stress, traffic hold ups, causing people to waste useful time. Sleeplessness reduced crop yield	Catchment pit, gutters, wait until rains come before farming, wait on God, use cover crops, mulch, use powder, bath frequently	Sand mining, crowding buildings together

State, community FGDs	Socio-cultural groups and activities	Infrastructural facilities	Major income generating activities	Aware-ness	Source of Awareness	Changes in weather conditions observed in the community	Current state of natural resources relative to 20 yrs ago	Weather related hazards in the community	How hazards affect livelihood activities	Coping measures adopted against climate hazards	Activities that promote climate hazards and impacts
ISUOFIA (M)	All social groups are for both men and women except cultural group that is for men. They foster development and entertainment	Facilities are adequate	Trading, farming	Aware	News paper, Radio	Increasing rainfall amount, sunshine intensity & rainy season. Decreasing rainfall intensity, frequency, wind speed, harmattan, August break & dry season	Land/soil and forest degraded No change in water	Increased poverty, sickness, measles	Same as above	Same as above	Sand mining, crowding buildings together
ENUGU											
Umuabi (M) Paul Ugwoeji Councillor 46yrs	Same as above	Facilities are in poor condition, roads and school buildings destroyed by erosion and wind	Crop farming, trading and palm wine tapping	Aware	News paper, Radio	Cocoyam production affected. Increasing sunshine intensity and dry season. Decreasing rainfall amount, intensity, frequency, wind speed, harmattan period, August break	Land/soil and water resources degraded No change in forest	Heat, lack of fertile land, lack of food and palm wine	Increase in transportation costs, low income, poor crop yield, high cost of living. Spend more money on renovation, & hospital bills	Sand bags, use palm tree trunk to bridge gully, catchment pit, planting of trees, use of fans, stay outside	Sand mining along the road, blocking of water ways, cutting down trees. Use of zinc roofing, cooking inside the living rooms increase heat.
Umuabi (F) Amaka Eneh	Same as above	Same as above		Aware	Natural events	Same as above	Land/soil degraded No change in forests and water	Flooding, erosion and too much sunshine	Same as above	Same as above	Sand mining along the road, blocking of water ways, cutting down trees. Use of zinc roofing, cooking inside the living rooms increase heat.
Ngwouno (F) Regina Agu (Women's leader)	Coop and religious groups are for women. They foster development peace in the community	All facilities exist except a well. All in poor condition. Roads, public transportation school buildings threaten by erosion	Farming, trading and oil palm processing	Aware	Personal experience	Crops are no longer doing well. Decreasing rainfall amount, frequency, harmattan, august break, rainy and dry seasons. Increasing rainfall intensity, sunshine intensity, and wind speed	Land/soil water & forest degraded	People are dying due to diseases associated with heat stress	Hunger, poor health, poor harvest	Same as above	Sand mining along the road, blocking of water ways, cutting down trees

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Ngwouno (M) Chief E Agualor 52yrs	Membership for both male & female for community development & entertainment	No stream. Bore hole, well & pipe borne water all in bad condition	Trading, farming	Aware	Personal experience	Increasing rainfall amount, intensity, frequency, sunshine intensity & wind speed. Decreasing harmattan, august break, rainy season and dry season	Increased activities influence erosion, deforestation Land/soil forest & water degraded	Weather very uncomfortable	Reduction in agricultural land, more hunger, poor crop yields destroyed houses, people are homeless, cut-off from their kin, ill health.	nil	Sand mining
UDI(M)HRH Igwe Chris Ogakwu 80yrs		Good amenities but lack of potable water	Farming, palm wine tapping	Aware	News paper, TV, Radio	More mosquitoes. Presently Udi is very hot. Decreasing harmattan, august break and dry season. Increasing rainfall amount, frequency, sunshine intensity. No change in wind speed	Soil/land, forest and water degraded	Heat stress, diseases, malaria, typhoid, floods and erosion	Damage to houses, roads, crops, discomfort, sickness	Drainage construction, catchment pit, use of hand fans, place seats under trees	The problems are natural so we do not contribute to the problem.
UDI(F) Aneke Modesta 43yrs (Women's leader)	Community development	Facilities in adequate condition	Trading, farming	Aware	Experience	Weather condition bad, sickness, poor crop yield	Erosion and floods taking over community, land/soil, forest and water degraded	Wind speed high causing sickness	Poor crop yield, hunger, poverty, sickness, homelessness, stress, damaged roofs	Sand bags, planting of dry season yam (*munyeye*),planting of cassava	Sand mining, felling of trees, smoke from generating sets.
EBE (M)Chief Chris e. Ugwu Igwe (Cabinet member)		Modern use of zinc creating problems	Palm wine Tapping	Aware	Experience	High heat, no more harmattan, decreasing rainfall amount, harmattan, and august break, rainy season period. Increasing rainfall intensity, sunshine intensity, wind speed, dry season	Not clear	Heat stress	Restricted movement, road from Ebe to Eke no longer passable, increased ill health	Gutters, drainage, tree planting	NIL

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EBE Florence Isingwu (F) (Women's leader)	Community development	Poor facilities in the community	Farming, trading	Aware	Radio, TV	Crops are no longer doing well, decreasing rainfall frequency, wind speed, harmattan, August break and rainy season. Increasing rainfall amount, rainfall intensity and sun shine intensity	Land/soil and forest degraded	Erosion, heat stress, flooding and wind speed	Lack of road affects community dev't, loss of crops lack of food, no planting, standard of living affected, roofs blown off rendering families homeless, poor health	Building of gutters, planting of trees, staying under shade	Sand mining along the road, poor ventilation, tree cutting
Imo State											
Umuoma Nekede (M) Mr. Charles Opara 80yrs (Opinion leader)	nil	nil	Farming, trading & civil service	Aware	Experience other people	"The world is growing old", changes in rainfall, and sunshine leading to erosion. Increasing rainfall amount, rainfall intensity, increasing sun shine, wind speed and rainy season. Decreasing harmattan & August break	Land, soil degraded	Measles, cough, malaria, jaundice all increasing	Destroy farms, culverts, destroy track roads, farms & houses, lack of sleep, restlessness	Create gutter, make ridges across slope	Quest for development, sand mining
Umuoma Nkede(F) Nwaneri Stella A 42yrs (Social group leader)	All groups exist for community development and conflict resolution	Roads destroyed by erosion	Trading and farming	Aware	Personal experience	Increased sunshine intensity, rainfall amount, intensity, frequency, wind speed, rainy season period and dry season period. Decreasing harmattan and august break.	Land/soil and forest degradedNo change in water	Cassava leaves are not fresh, pests leaves, poor crop yield	Destroys buildings and farms, more stress on people, more money spent, no food, increased sickness, heat stress, more spending than income	Sand bags, planting of cashew trees, early planting, look up to God, use fans, bath frequently	Sand mining, poor road noise from generating set

State, community FGDs	Socio-cultural groups and activities	Infrastructural facilities	Major income generating activities	Aware-ness	Source of Awareness	Changes in weather conditions observed in the community	Current state of natural resources relative to 20 yrs ago	Weather related hazards in the community	How hazards affect livelihood activities	Coping measures adopted against climate hazards	Activities that promote climate hazards and impacts
Umuoma Nekede (Y) Dr. B Udeh (Town union)	All groups exist. Important cultural groups are *Ogbom, nwaokorgbo* for entertainment	Same as above		Aware	Personal experience, TV, Radio	No more harmattan, heat stress severe, so people hardly sleep well. Increasing sunshine intensity and dry season. Decreasing rainfall amount, intensity, wind speed, harmattan period, august break, rainy and dry seasons	Land/soil and water resources degraded	Higher mortality due to sickness induced by heat	Flooding due to lack of planning of houses. Restlessness due to lack of sleep	Use of sand bags, people stay outside for a long time at night, use hand fans	Sand harvesting from Otamiri river
Opkona Nkume (M) (75yrs) Chief C. Iwuala (Trad PM)		All facilities exist except access road, public transportation, well & pipe- borne water. The only link road is damaged by erosion	All activities are important	Aware	Radio, TV	Weather is hot now with unpredicted rainfall. Increasing rainfall intensity, frequency, sunshine intensity. Decreasing harmattan, rainy season	Only the land/soil degraded	nil	Washed out road makes movement difficult. People sleep outside due to heat	Create Channels, sleep outside, dress moderately and stay under shade	nil
Umuduruogba Okwudor (F) Chika Duru 35yrs (Women's leader)	All groups exist for both men and women. Main functions are community development, entertainment and conflict resolution	All facilities exist except borehole, well and pip- borne water. The road, local market and secondary school destroyed by erosion. No road leading to clinic and stream due to cut-off by gully erosion	Crop farming, processing and gathering of fire wood major economic activities	Aware	Radio, TV	Heavy rainfall and flooding. Increasing rainfall amount, intensity, frequency, sunshine intensity and wind speed. Decreasing harmattan, august break and dry season period, no change in rainy season period	Land/soil, forest and water degraded	Soil erosion, flooding, high wind speed, and heat stress	Damage to economic trees, poor crop yield, farming calendar affected	Us of sand bags, create gutters, no remedy for early rainfall, long dry season and short dry season. Tree planting and proper ventilation	Sand harvesting, bush burning, tree cutting and zinc roofing

State, community FGDs	Socio-cultural groups and activities	Infrastructural facilities	Major income generating activities	Aware-ness	Source of Awareness	Changes in weather conditions observed in the community	Current state of natural resources relative to 20 yrs ago	Weather related hazards in the community	How hazards affect livelihood activities	Coping measures adopted against climate hazards	Activities that promote climate hazards and impacts
Okwudor (Ihebinao-werre) (F)	All groups exist except Fadama and cooperative. Both men and women are members of various groups. Functions are centred on self help and community development	Most of the facilities are available except borehole well, pipe-borne water. No health clinic. The remaining facilities are in poor condition due to erosion and flooding and destruction by wind	Crop farming, gathering of fire wood and crop processing are the major economic activities	Aware	Radio, TV	Fruiting of plants and crop yield affected	Land/soil, forest and water resources are degraded	Soil erosion flooding, heat stress, heavy rainfall	Poor health due to sleeplessness caused by excess heat	Creation of gutters, building houses with good ventilation, planting of trees, reduce sand harvesting	Sand mining from roads, zinc roofing, cutting of tresses cementing of compounds, bush burning.
Okwudor Eze Duruebur (ObI of Okwudor) 70 yrs	All the various groups listed exist for both men & women. Groups engaged in community development conflict resolution, farming, religious and cultural activities	All the facilities are generally in poor condition	Crop farming	Majority of them have heard about climate change	Change in rainfall pattern	Increase in the amount and frequency of rainfall, increased sunshine/heat intensity, no August break. Forest, soil and water resources degraded. Short harmattan resulting in lack of fruiting of economics trees	Land, water resources and forest degraded	Excessive heat causes fatigue and debilitating health conditions and loss of labour productivity	Erosion/flooding damage roads, causing accessibility problems to farm and markets. Leaching of soil nutrients resulting in poor farm yields and income reduction	Planting of trees & grasses – Indian bamboo, bahama grass, sand bags, dig trenches, mulching after planting of crops, (fadama) planting along river banks	Zinc roofing, cutting of trees, poor farming practices, population pressure on land. Blocking of water ways, unplanned settlement pattern, cutting of trees and bush burning
Amucha (Ezinne G Nzekwueme (Women's leader) 60 yrs	All groups exist except fadama and cooperative, both men and women are members of various groups. The functions of the group centred on self help and community development	Facilities are better now compared to the past. Entrance to the community is bad	Trading, crop farming	Aware	Radio, TV	Increasing sunshine intensity and dry season period. Decreasing rainfall amount, intensity, frequency, wind speed, harmattan period, August break and rainy season	Land/soil, forest and water resources degraded	Hunger, increased death and sickness	Poor food production leading to hunger. Heat stress causing rashes, child related illness. More money spent on medication	Planting of trees and grasses, sand filling with bags, stay outside	Cutting down of tress, building houses together, poor ventilation

State, community FGDs	Socio-cultural groups and activities	Infrastructural facilities	Major income generating activities	Aware-ness	Source of Awareness	Changes in weather conditions observed in the community	Current state of natural resources relative to 20 yrs ago	Weather related hazards in the community	How hazards affect livelihood activities	Coping measures adopted against climate hazards	Activities that promote climate hazards and impacts
Abia State											
Ekelogu- Ebem. Chief Ezera Asoghuka (Community leader) (M)77yrs	All groups exist in the community. Their main functions are community development and self help	All facilities exist except access road, clinic and well. Others are in poor condition. Roads, secondary school destroyed by erosion. Stream silted up by erosion and flooding	Crop farming, trading and skilled labour/handicraft	Aware	Radio, TV	In the past they experienced thick forest that could reduce flooding. Now flooding cannot be stopped. Increasing sunshine intensity and wind speed.	Land/soil less fertile and degraded. Forest degraded. Some water bodies degraded; others no change	Soil erosion, seasonal heat stress	Washes away crops, poor crop yield, damage to crops such as yams, sleeplessness	Use of *Melina* tree trunks to stop erosion, construct gutters, plant trees, bath more regularly, open windows & sleep outside	Sand harvesting, cutting down of trees
Ekelogu Ebem .Mrs. Rose K. Obiansi (Women's leader) (F) 74yrs	All groups are available except professional cultural & social groups. They function as agents of fostering peace and development	The facilities that are not available are secondary schools, clinic, electricity, borehole, well & pipe- borne water. All facilities are in very bad condition	Farming and trading	Aware	Radio, TV, personal experience	Increasing sunshine intensity and wind speed. No change in rainfall amount, intensity, frequency rainy season and dry season but slight change in harmattan and august break	Much use of chemical fertiliser has destroyed the land/soil, forest. Water degraded due to erosion	Soil erosion heat stress	Washing away of crops bringing hunger and poverty, houses brought down making people homeless	Planting wild grasses on the erosion sites, planting trees. Bath more frequently & expose body to fresh air. Apply powder and kaolin	Sand harvesting along the road
Ebem-Oha HRH Eze (Elder) S. A. Okorie (M) 73yrs	All groups in the community are for both men & women and are for community development	The facilities that are not in the community are electricity, public transportation well and pipe- born water. Available facilities are in very poor condition	Crop farming and trading	Aware	Radio, TV and Newspaper	Climate is causing poor crop harvest. Decreasing rainfall, intensity, harmattan, August break, rainy season. Decreasing sun shine intensity wind speed & dry season	Degraded soil/land and improved water	Excessive heat causes rashes. Soil erosion, damage to houses, facilities	Roads are damaged and crops washed away causing hunger and hardship	Build wooden bridge across gullies, clean out silted stream, construct gutters, plant trees, enforce legislation on tree planting, build with approved plan	Sand mining, over- grazing by Fulani cattle herders, bush burning, zinc roofing.

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Ebem (F)											
Akanu Ohafia Mrs. Rose Okoroeke (F) (Women's leader) 65yrs	All groups exist. They foster community development	No electricity, borehole, well & pipe- borne water. Available facilities in very poor condition. Roads destroyed by erosion, stream silted up by erosion.	Crop farming and trading as well as processing crop products	Aware	Radio, TV and personal experience	Sun intensity is very high compared to past. Increasing rainfall intensity, sunshine intensity and dry season period. Decreasing rainfall, intensity, wind speed, August break and rainy season	Degraded land/soil, forest and water	Excessive heat causes rashes, increased disease and ill heath	Farming activities affected leading to reduced crop yield, family nutrition and poor income. Heat affects productive hours. Increased disease, more expenditure on medication.	Grass planting, planting of trees, mulching, wait for rain before planting, stay outside & frequent bathing. Light dressing, stay under trees, shade	Sand harvesting, bush burning, cutting down trees & zinc roofing
Akanu(F)											
Elu Ohafia Mrs. G. Emetu (Social group leader) 40yrs	All groups exist and they foster community development	All facilities exist except a well. They are in fairly good condition. Roads not accessible in rainy season	Crop farming trading/marketin g and processing crop/products	Aware	Radio and TV	Harmattan no longer intense, no more august break. Increasing rainfall, intensity, frequency , sunshine and dry season	Degraded land/soil, forest and water	Same as above	Same as above	Sand bags, build gutters and channels, depend on food products from outside, stay outside, bath more frequently dress lightly	Sand harvesting, bush burning, cutting down trees & zinc roofing
Elu Ohafia HRH Eze R Kalu Udonsi Anya (M) 72yrs	Same as above	Facilities exist and in good condition	Crop farming. trading & livestock rearing	Aware	TV and radio	Increasing rainfall amount, intensity, sunshine intensity, wind speed and rainy season	Degraded land/soil, forest & water	Sand harvesting, bush burning, cutting down trees & zinc roofing	Damage to crops, poor income, increased poverty and sickness	Sand bags, stay outside, stay under shade	Same as above

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Elu Ohafia (M)											
Eziukwu HRH. Sir Sam O. Ogba (Traditional leader)	Same as above	Facilities exist and in good condition	Crop farming, trading and teaching	Aware	Radio, TV	Increasing rainfall amount, intensity and frequency. Decreasing harmattan, August break and rainy season. No change in sunshine intensity, wind speed and dry season period	Degraded land/soil, forest no change in water	Sand harvesting, bush burning, cutting down trees & zinc roofing	Damage to crops, poor income, increased poverty and sickness	Plant trees, sleep naked	Sand harvesting, bush burning, cutting down trees & zinc roofing
Eziukwu Ohafia Mrs. Oyidiya O. Ezra (F) (Women's leader)	Same as above	Facilities exist but in poor condition. No good road, stream very far from the community	Crop farming, trading and artisans	Aware	Radio, TV and personal experience	Increasing in sunshine intensity, decreasing rainfall amount, frequency, harmattan, rainy & dry seasons. No change in wind speed	Degraded land/soil, forest & water resources	Sand harvesting, bush burning, cutting down trees & zinc roofing	Damage to crops, poor income, increased poverty and sickness	Sand bags, stay outside, under shade	Sand harvesting, bush burning, cutting down trees & zinc roofing

Appendix G. Research Team

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