CLIMATE SHOCKS, ENVIRONMENTAL DEGRADATION AND RESOURCE CONFLICT: IMPLICATIONS FOR AGRICULTURAL LIVELIHOODS AND FOOD SECURITY IN NIGER DELTA REGION OF NIGERIA

BY

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A THESIS SUBMITTED TO THE SCHOOL OF GRADUATE STUDIES IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF DOCTOR OF PHILOSOPHY IN APPLIED AGRICULTURAL ECONOMICS AND POLICY

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DECLARATION

I, Chinasa Sylvia Onyenekwe, author of the thesis titled "CLIMATE SHOCKS, ENVIRONMENTAL DEGRADATION AND RESOURCE CONFLICTS: IMPLICATIONS FOR AGRICULTURAL LIVELIHOODS AND FOOD SECURITY IN NIGER DELTA REGION OF NIGERIA" do hereby declare that with the exception of references to past and current literature duly cited, this thesis is a result of research solely conducted by me in the Department of Agricultural Economics and Agribusiness, College of Basic and Applied Sciences, University of Ghana, Legon from March 2017 to October 2018. This work has never been presented either in whole or in part for any other degree of this University or elsewhere.

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DEDICATION

I dedicate this work to the Almighty God who is the reason for my living, to my beloved husband Okechukwu, and to my lovely children David-Wonder and Deborah.

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ABSTRACT

There is an overwhelming evidence to suggest that environmental change drives conflicts, and that resource depletion and degradation undermine food security and livelihood wellbeing in communities where people are dependent on land and water resources. Therefore, understanding the vulnerability, food security, adaptation and resilience aspects of climate shocks in the context of land degradation and conflicts has immense practical significance particularly in the climate-impacted and conflict-afflicted Niger Delta region. Employing survey data collected from Rivers and Bayelsa States, this study investigates the vulnerability of the farming and fishing households to the triple challenge of climate shock, resource conflict and environmental degradation, and how these challenges undermine food security needs of various occupation groups in the Niger Delta Region of Nigeria. The study also investigated the range of adaptation practices prevalent in the region, as well as factors influencing the adoption of these adaptation strategies. Five hundred and three (503) households were selected using multi-stage sampling techniques. Ratio analysis was used to analyse the vulnerability levels of the households, ordered logit model was employed to access the effect of vulnerability on the food security status of households and multinomial logit model was used to determine factors affecting the household choice of adaptation strategies. The results show that farming and fishing households have the similar vulnerability score, 0.42 and 0.43 respectively. Although, the farming households were more exposed to the triple stressors; the fishing households seem to be more sensitive to the triple stressors owing to their poor physical and natural asset base. The two groups share similar adaptive capacity. Vulnerability to the triple stressors and having high dependency ratio increase the probability of being in the higher categories of food insecurity while household annual income, household size, access to social network, farm size and participation in non-farm work increases the probability of being food secure. Adaptation strategies adopted by farming households were soil and water management, crop management and livelihood diversification. Factors influencing their choice of adaptation strategies were age, gender, household size, education, extension and farm size. The adaptation strategies employed by the fishing households were intensification (which include use of improved fishing gears, putting more effort and time in fishing) and livelihood diversification. Factors affecting their choice of adaptation strategies were education, access to climate information, extension, household income, perception of shift in rainfall and location. To reduce food insecurity policy makers should focus on efforts that are aimed at reducing vulnerability of agricultural household to the triple stressors such as mitigation and adaptation efforts and providing opportunities for livelihood diversification. To promote the adoption of adaptation strategies among the two livelihood groups attention should focus on education, skills training and extension.

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ABBREVIATIONS AND ACRONYMS

ADB	Asian Development Bank
ANEEJ	African Network for Environmental and Economic Justice
CBN	Central Bank of Nigeria
CRED	Centre for Research on the Epidemiology of Disasters
FAO	Food and Agriculture Organization
FEWS NET	Famine Early Warning System Network
HRW	Human Right Watch
IPCC	Intergovernmental Panel on Climate Change
NBS	National Bureau of Statistics
NIMET	Nigerian Meteorological Agency
NDDC	Niger Delta Development Commission
NNPC	Nigerian National Petroleum Commission
PDNA	Post Disaster Needs Assessment
SSA	Sub-Saharan Africa
TAR	Third Assessment Report
UNDP	United Nations Development Programme
UNEP	United Nations Environmental Programme
USAID	United States Agency for International Development
WFP	World Food Programme

CHAPTER ONE
INTRODUCTION

1.1 Background of the Study

At the time of independence, in the 1960s, most sub-Saharan African (SSA) countries were self-sufficient in food production. However, years after independence, SSA swung from being net-exporter of food items to dependence on food imports and food aids (Djurfeldt, Holmen, Jirstrom, & Larsson, 2005). For instance, between 1966-1970 average export of food items from SSA was about 1.3 metric tonnes/year. By 1970s an average import of about 4.4 million tons/year was recorded which increased to 10 million in the 1980s. At the same time population since independence has been rising in SSA (Djurfeldt, Holmen, Jirstrom, & Larsson, 2005). Food supply is not keeping pace with the increasing demand for food. This poses serious threat to food security and could lead to food crisis in the SSA. This is further exacerbated by the rapidly changing climatic, economic and social conditions.

Climate variability and shocks, environmental degradation and resource conflict are the greatest threats to agricultural livelihoods and food security in fragile states globally and these in turn deepens poverty (Raleigh & Urdal, 2007). Climate shocks, in particular have become a serious global challenge. Existing evidence shows that global temperatures are rising, patterns of rainfall are changing and the frequencies and intensity of climate-related disasters such as floods, storms, drought and heat waves are increasing (IPCC, 2007; Songok, Kipkorir, & Mugalavai, 2011; Tschakert, Sagoe, Ofori-Darko, & Codjoe, 2010). The 1995-2015 statistics reported by CRED (2015) show that of all these disasters, the most frequently occurring is floods (43%) followed by storms (28%), extreme temperature (6%) and drought (5%). Although these disasters occur more

frequently in high income countries, the low-income countries are more adversely affected. The continent most affected is Asia followed by Africa. A few examples include the great flood in Thailand in 2011, Bangladesh in 2007, Pakistan, China, Niger and Benin in 2010, India in 2013 and Nigeria in 2012 (CRED, 2015; Ogbonna, Albrecht, & Schönfelder, 2017; Thomas & López, 2015). In 2017, Ethiopia and Somalia were hit by drought (OXFAM, 2017; FEWS NET, 2017).

The increasing frequency of these climate-related disasters undermine economic development as they negatively impact on environmental, social, and agricultural sectors, but more critically on the agricultural sector. The effects include agricultural crop failures, loss of livestock, water shortages, outbreak of epidemic diseases, hunger and poverty. Other direct impacts include death, injury, disruption of economic activities, damage and destruction of properties and natural resources. CRED (2015) reported that between 1995-2015, 87 million homes and 130,000 health and education facilities have been destroyed by disasters.

Estimates show that globally, the number of people at risk of hunger due to climate shocks will increase by 10-20% by 2050 and 65% of this will be in Africa (Parry, Evans, Rosegrant, & Wheeler, 2009). In 2010, a number of climate-related disasters demonstrated the vulnerability of African nations to food insecurity. A few examples include the drought in Niger which was followed by heavy rains, destroying crops and livestock and resulted in the worst food crisis in that nation's history (Sasson, 2012). Also, heavy rains caused the overflow of Queme and Mono Rivers flooding two thirds of the West African nation of Benin (Miyan, 2015). In 2012 a devastating flood occurred in Nigeria which affected nearly 4 million people, with 363 people killed and 5851 injured (PNDA, 2013) as cited in (Ogbonna et al., 2017). Looking into the future there is increased risk of disasters as a result of climate change and rise in the global population as

these predispose people to live in harm's way by settling in areas such as low lying coastal areas and flood plains which are prone to hazards thereby increasing their vulnerability. CRED (2015) reported that the overall annual economic losses from disasters in Africa are estimated at about $250-$300 billion. These figures are higher when urbanization and climate change are incorporated.

According to proponents of the climate-conflict nexus, extreme temperature and drought could result in scarcity of water, food and arable land, which in turn leads to inter-group competition and grievances over the remaining resources (Homer-Dixon & Blitt, 1998 and Schilling Opiyo, & Scheffran, 2012). Secondly, Climate shocks could result in famine, displacement of people, outbreak of disease and reduction in agricultural productivity of an area thereby resulting in migration. Where the host community is also resource constrained it could result in struggle for the limited resources (Gleditsch & Nordås, 2014)

Another phenomenon seriously affecting agricultural livelihoods is environmental degradation. It is often linked to climate change and poverty. While environmental degradation could occur naturally, it is often exacerbated by human activities. Land degradation, for instance, is caused by soil erosion, desertification and poor land management (including deforestation, overgrazing, inappropriate use of irrigation water and pollution resulting from industrial and mining activities). Oil, gas and minerals are increasingly being discovered across Africa. However, the exploration of these natural resources is often accompanied by negative externalities, which if not properly managed could trigger conflict. It has often been a source of debate among scholars and policy circles that the oil boom will likely spread oil curse or Dutch disease across Africa (Annan, 2012; Diamond & Mosbacher, 2013). Some authors have argued in favour of the oil curse or Dutch

disease alluding to oil being a source of violent conflict, corruption and failure of state institutions in Africa, citing examples of Nigeria, Sudan, Angola, and Equatorial Guinea (Alao, 2007; Kopiński, Polus, & Tycholiz, 2013; Le Billon, 2007, 2010; Yates, 2012). However, Obi (2014) pointed out that oil endowment per se does not necessarily cause conflict but may only be a factor among several other factors depending on the different contextual and structural factors. Hence, oil endowment could combine with other factors to result in conflict. Obi (2014) further reiterated that in the case of Niger Delta, Nigeria, there was already pre-existing ethnic tensions and agitation over marginalization of the ethnic minority even before the discovery of oil, and that the discovery of oil only added a rather volatile dimension to it.

The resource conflict prevalent in the Niger Delta include struggle over agricultural lands, lands with oil deposits and this conflict is usually about resource control. For conflicts involving struggle over lands with oil deposits is usually between the communities and the federal government or between the communities and multinational oil companies while struggle over agricultural lands are usually between communities or individuals. The root cause of conflict in the Niger Delta has been attributed to be connected with the way oil is extracted isolating the locals from their land and livelihoods and the extremely skewed sharing of the proceeds and malicious liabilities (Obi, 2009, Ikelegbe, 2010 and Obi & Rustad, 2011) . The activities of the multinational oil companies in the region spur oil spillage and gas flaring. Spilled oil on farmlands and water bodies destroy fish ecosystems, vegetation and natural habitat. This in turn undermine rural livelihoods and spur local grievances. For instance, between 1976 and 1996, about 4,600-7,000 oil spills were recorded with a total volume of 2.4 - 3.6 million barrel of oil wasted (Agbola & Olurin, 2003; Iyayi, 2004). It has been reported that the highest gas flaring activities in the world takes place in the Niger Delta region as about 75% gas produced is flared (UNDP, 2006). Besides

contributing to greenhouse gas emission, gas flaring breeds serious health challenges, a condition that increases livelihood underperformance and poverty.

Climate shocks and environmental degradation undermine human security now and even in the future. Firstly, it impacts most on agriculture by undermining the social and economic life of those who depend on agriculture ultimately affecting the income and food security of a large percentage of the population. Secondly, the increased competition for declining or degraded resource could lead to conflict within and between states; These three interacting factors, climate shocks, environmental degradation, and resource conflict together, pose a serious threat to the agricultural and fishery livelihood on which about 60% of the Niger Delta population depend and this in turn deepens poverty and vulnerability among the people (UNDP, 2006).

Vulnerability relates to the degree to which socio-ecological systems are affected by some forms of hazards or simply put, the capacity to be wounded (Turner et al., 2003 and Proag, 2014). Vulnerability has been shown to be a function of exposure, sensitivity and adaptive capacity (IPCC, 2001 and McCarthy et al. 2001). Vulnerability increases when exposure and sensitivity to hazards increase beyond the adaptive capacity of a socio-ecological systems or region. Sub-Saharan Africa, and in particular coastal regions, are highly susceptible to climate disturbances because of exposure to extreme weather events, high dependence on climate sensitive sectors and activities such as agriculture, fishery and forestry (Cline, 2007; Zewdie, 2014 and Connolly-Boutin & Smit, 2016) and prevalence of weak support systems and lack of economic development (IPCC, 2007; Preston et al., 2008 and Pachauri et al., 2014). The Niger Delta region is predominantly a coastal area prone to flooding and coastal erosion. The region is vulnerable as it is faced with the menace of degraded environment and resource conflict exposure.

Several studies (Hahn, Riederer, & Foster, 2009 and Antwi-Agyei, Fraser, Dougill, Stringer, & Simelton, 2012) have sought to understand how climate variability and shocks spur vulnerability in developing world contexts but fail to account for several stressors ranging from political to socioeconomic to conflict that shape vulnerabilities in such contexts (Turner et al., 2003; Smit & Wandel, 2006 and Tschakert, 2007). For instance, Hahn et al., (2009) investigated the differential vulnerabilities of two regions in Mozambique to climate variability. Antwi-Agyei et al., (2012) measured the differential vulnerabilities of different regions and districts in Ghana to drought. O'brien and Leichenko (2000) who introduced the concept of double exposure suggests the combination of two overriding stressors in the study of vulnerability, yet there is a dearth of studies that examine climate shocks in combination with environmental degradation and conflict – particularly in the climate-impacted and conflict-afflicted Niger Delta region. This is particularly important in developing nations, which are faced with array of stressors ranging from political, economic, social and climatic conditions which together shape vulnerability. O'brien and Leichenko (2000) asserted that climate change is taking place alongside other stressors and most of these studies have rarely considered these multiple stressors and highlighted how vulnerable a group, sector or ecosystem might change when jointly considered.

1.2 Problem Statement

Agriculture constitutes the main economic activity of rural people especially in Sub-Saharan Africa where it is a source of livelihood to about 70-80% of the population, accounts for 30% of GDP and 40% foreign exchange earnings (FAO, 2006; Toulmin, Huq, & Rockstrom, 2005). In Niger Delta of Nigeria, with a large population of rural people, it constitutes a major source of

their livelihood where about 60% of the population depend on natural environment for their life sustenance (UNDP, 2006).

According to Tamuno and Edoumekumo (2012), before independence and discovery of oil, the Niger Delta to a large extent contributed immensely to the Nigerian economy for about 297years through its rich agricultural potential, especially in palm oil production. The contribution of agriculture to the GDP in the 1960s before the discovery of oil was between 60-65% (Lawal, 1997). But with the discovery of oil, agriculture suffered significant neglect and so its contribution to GDP declined in the 1970s to 50%, 34% in 2003 (CBN, 2003) and in 2017 to 24.14% (CBN, 2017).

Attention was shifted to crude oil production and so the contribution of crude oil to GDP rose from rose from 0.3% (1960s) to 32.43% (2013) and has since continued to rise (Adedipe, 2004). In 2017, 95% foreign exchange earnings and 70% revenue of the Nigerian economy comes from the oil sector. Although the contribution of agriculture to GDP has dropped drastically it is still the dominant economic activity employing a significant number of the population and linking with other sectors of the economy (NNPC, 2004).

In Niger Delta, the decrease in the share of agriculture to GDP could be attributed to a number of factors. First, the available land for agriculture was reduced as massive lands were taken by the state through the Land Use Act of 1978 and Petroleum Act of 1969 and given to the oil companies (Idemudia, 2009; Idemudia & Ite, 2006). According to Human Right Watch (2002), over 14,500 families lost their farmlands to either installation of oil infrastructure or oil spills.

Most of these displaced persons could not secure jobs in the oil companies as a result of low level of education and capital-intensive nature of these oil companies. Oil sector employment constitutes

1.3% of the overall employment in the nation. This spurred inter and intra community competition for the available resources. Hence, there are cases of conflict within ethnic groups and between ethnic groups and usually these conflicts are spurred by struggle over resources especially land. Von Kemedi (2003) blamed the resource conflicts to grabbing of land by the state for the oil companies and the resultant degradation of the environment by the oil companies. This problem to some extent forced people to settle in low lying coastal areas and flood prone plains. Given population increase, there are more and more people settling in such areas.

Climate shocks have become a menace in the Niger delta region. Most of the areas in Niger Delta region are coastal areas and as such are bedeviled with a number of environmental challenges and flood related disasters. These range from coastal erosion to flooding resulting from sea level rise. Udofa & Fajemirokun (1978) reported a mean sea level rise of about 0.462m along the Nigerian coastal water. It has been predicted that Niger Delta could lose about 15,000 km^2 of land with a meter rise in sea level by 2100 and at least 80% of the population rendered homeless as a result of the low level of the region (Uyigue & Agho, 2007).

Miguel, Satyanath, & Sergenti (2004) predicted that sea level rise will not only aggravate the problems of coastal erosion which is already a menace in Niger Delta but the associated inundation will increase the problem of flood, intrusion of sea water into fresh water sources, ecosystem destruction which will in turn affect agriculture, fisheries and general livelihoods (Okali & Eleri, 2004). This menace is already being felt in the region. For instance the flood event of 2006 as reported by Douglas et al., (2008) (cited in IPCC, 2014) rendered 10,000 people homeless and caused wide spread traffic chaos in Port-Harcourt city. This flooding submerged houses, crippled

economic activities and displaced some residents of Mgbuoba, Diobu and Nkpolu communities (Zabbey, 2007).

Also, in 2012 another devastating flood occurred which affected the whole nation including the Niger Delta region. According to National Emergency Management Agency (NEMA) this affected almost 4 million people, with 363 people killed and 6000 injured (PNDA, 2013) as cited in (Ogbonna et al., 2017). Also flooding leads to increased risk of communicable diseases such as malaria, cholera, typhoid and acute lower respiratory tract infection (PNDA, 2013). In addition, it poses threat to city infrastructure such as electricity and roads.

The links between the climatic and non-climatic factors that threaten livelihoods are depicted in the conceptual framework for this study (Figure 1.1). It consists of three main segments: drivers, vulnerability context and consequences. The first segment comprising of climate shocks and non-climatic factors shows how different factors operating at different spatial and temporal scale trigger vulnerability. There is general consensus that a number of interacting factors or stressors (biophysical and socio-economic factors) shape vulnerability hence, it will be incomplete to focus on one (Casale, Drimie, Quinlan, & Ziervogel, 2010; O'Brien & Leichenko, 2000; Reed et al., 2013). The biophysical drivers are factors related to biology and physical environment such as climate variability and change, land and water degradation, etc. while the socio-economic drivers are factors such as demographics, economics, institutions, policies, culture and conflicts.

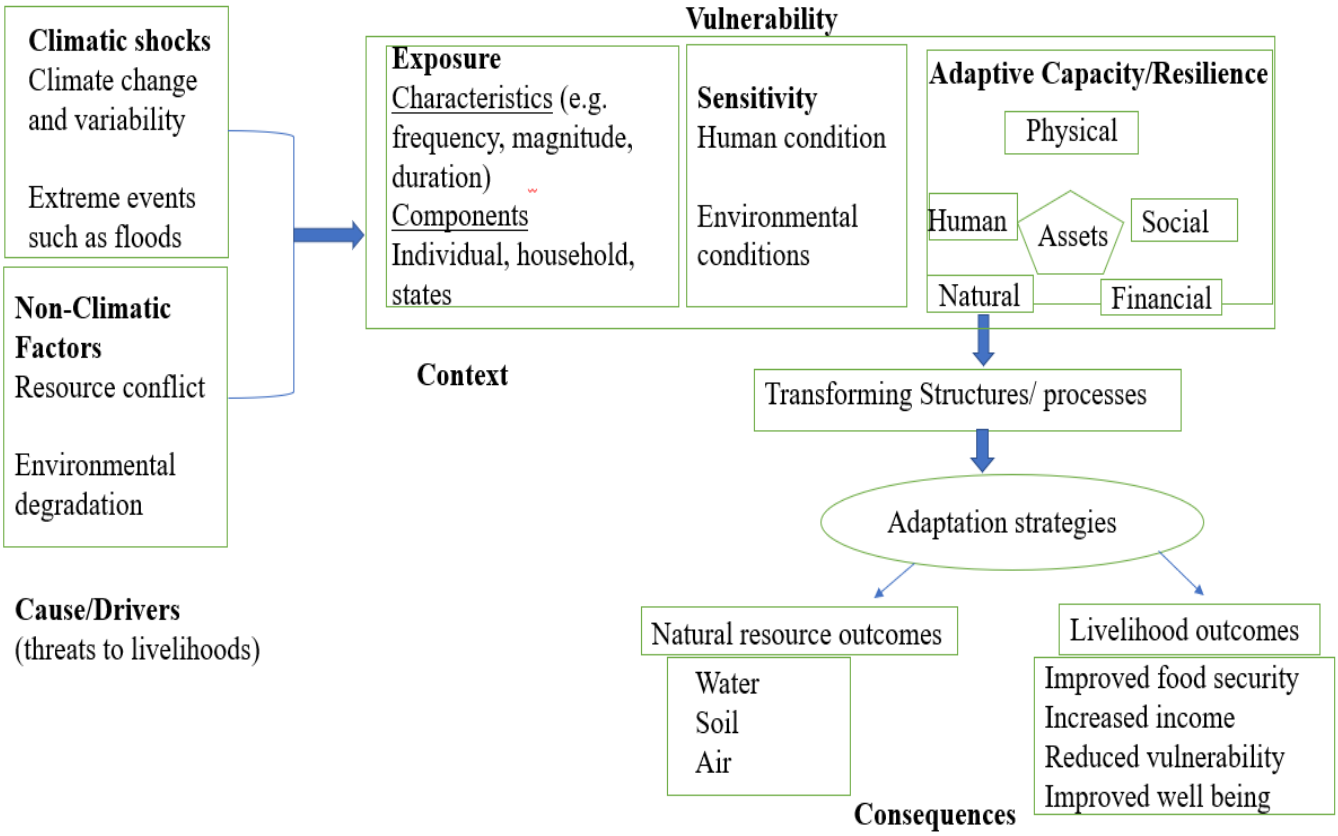


Figure 1. 1 Conceptual framework linking climate shocks, environmental degradation and resource conflict to vulnerability and food security

Source: Adapted from (Connolly-Boutin & Smit 2016; Turner et al., 2003)

The second segment describes the vulnerability context. Vulnerability has been noted to be "place-based and context-specific" (Cutter, Boruff, & Shirley, 2003). This study adopts the working definition of vulnerability by IPCC TAR which is similar to Turner II et al., (2003) place-based conceptualization of vulnerability, which points out 3 components that make up vulnerability as exposure, sensitivity and adaptive capacity (resilience). The first component is concerned with the external side of risks, shocks and stress to which a system is subjected to while the last two components capture the internal side which refers to the response and means of coping or adapting to the stress (Chambers, 1989; Füssel & Klein, 2006).

Exposure is the nature and degree to which a system experiences stress (Adger, 2006). The important characteristics of these stresses are magnitude, frequency and duration (Burton, 1993). According to Ajibade and McBean (2014) exposure can be defined as the location of people, livelihoods, resources, infrastructures in areas that are prone to hazards.

Sensitivity is the degree to which a system is affected by perturbations or stressors (Adger, 2006). Adaptive capacity is the ability of a system to adjust to accommodate or cope with stress (Füssel & Klein, 2006; Turner et al., 2003). This is a prerequisite for adaptation to occur and it involves the ability to harness a set of available assets to cope with stress. Assets are a set of livelihood resources that individuals harness to build their livelihood adaptation strategies (Scoones, 1998). Adaptive capacity is similar to the concept of resilience (Nelson, Adger, & Brown, 2007).

In other words, the framework illustrates that vulnerability of the household is a function of their exposure to stressors in terms of magnitude, frequency and duration, their sensitivity to the stress which is dependent on the human and environmental condition; and their adaptive capacity (capacity to cope with the stress) which is a function of the assets at the disposal of the households. This framework also draws on the sustainable livelihood framework which explains that adapting to stresses could be done through incremental adaptation and/or transformation in institutional structures and processes. Adaptation strategies refer to those actions taken by people to adapt to stresses (e.g changes in management decisions, improvement of agricultural systems etc.) and these are often done by drawing on their asset endowment. Transformational changes on the other hand refers to top level adjustments in policies, programs, initiatives, interventions, institutions or crossing thresholds in socio-ecological and political economy system (Nelson et al., 2007).

The adaptation and transformational changes undertaken translates into various outcomes. Livelihood outcomes include changes in food security, income, health and human well-being while natural resource outcomes include changes in water, soil or air quality and biodiversity. These two outcomes interact with each other (Connolly-Boutin & Smit, 2016). For instance, an adaptation strategy that contributes to food security could lead to air pollution or soil fertility depletion.

While there is empirical evidence of climate shocks, environmental degradation and resource conflict in the Niger Delta region (Zabbey, 2007; Douglas et al., 2008; Ikelegbe, 2010; UNEP, 2011, Ekpebu & Ukpong, 2013) the vulnerabilities of the households depending on fisheries and farming as a means of livelihoods to these stresses have not been empirically measured. The mechanisms farmers and fishers are using to adapt to these impacts as well as how their vulnerability to these stressors influence their food security are also not well documented. For instance, Zabbey (2007) investigated how climate change and flooding affect riverine communities in Niger Delta region; Ikelegbe (2010) focused on resource conflict and conflict resolution in Niger Delta while Ekpebu & Ukpong investigated the impact of crude oil production on agriculture and rural development.

Only few studies have looked at climate shocks and conflict jointly as stressors affecting vulnerability. Busby, Smith, & Krishnan (2014) carried out a study at the sub-national level using vulnerability indicators developed from secondary data to map areas in Africa that are most vulnerable. The result showed that Nigeria (northern, coastal and riverine) was among the countries most vulnerable. There is need for further study at the local scale where views from the vulnerable are captured to help explore the drivers of vulnerability to serve as a way of "ground vetting" (Antwi-Agyei, Fraser, Dougill, Stringer, & Simelton, 2012).

Previous research in the study area have focused on climate, degradation and conflict as a standalone subject. For instance, the study by Idemudia and Ite (2006), Obi (2009), Obi (2014) explained the factors responsible for the violent conflict in the region; Nzeadibe et al. (2011) assessed the level of awareness about climate change in the region; Ikehi et al (2014) measured the impact of climate change on farming families. No study has either combined the three stressors in a single vulnerability study or captured them in a single analytical framework. This presents a knowledge gap which the present study intends to fill. There is need to understand how these three stressors drive vulnerability amongst different livelihood groups in the region, and the ways in which adaptive capacities might be built to spur resilience or reduce vulnerability. From the foregoing arguments, this study therefore seeks to provide answers to the following research questions:

1. Which of the livelihood group (farmers or fishermen) are most affected by the three stressors - climate shocks, environmental degradation and resource conflict?

2. How are the livelihood groups adapting to the stressors?

3. What drives the adaptation mechanisms adopted by the livelihood groups?

4. How does the vulnerability to the stressors affect the food security of the livelihood groups?

1.3 Objectives of the Study

The main objective of the study is to assess the differential vulnerability of two livelihood groups in the Niger Delta region of Nigeria, to the triple stressors of climate shocks, environmental degradation and conflict. The specific objectives are to:

1. Determine vulnerability levels of two livelihood groups (farmers and fishermen) to climate shock, environmental degradation and resource conflict.

2. Identify adaptation strategies employed by the two livelihood groups.

3. Determine factors influencing the choice of adaptation strategies by the two livelihood groups.

4. Estimate food security levels of the two livelihood groups.

5. Determine the effect of vulnerability to the stressors on food security status of the two livelihood groups.

1.4 Hypotheses of the Study

The hypotheses to be tested are as follows:

1. Null hypothesis (Ho_1): Vulnerability to climate shocks, environmental degradation and resource conflict do not have any significant influence on the food security of households;

   Alternative hypothesis: (H_{A1}): Vulnerability to climate shocks, environmental degradation and resource conflict have significant negative influence on the food security of households;

2. Null hypothesis (Ho_2): There is no significant difference in the food security levels of farming and fishing households.

   Alternative hypothesis: (H_{A2}): There is significant difference in the food security levels of farming and fishing households;

3. Null hypothesis (Ho_3): Socio-economic and institutional factors do not significantly influence the choice of adaptation strategies employed by farming and fishing households

   Alternative hypothesis: (H_{A3}): Socio-economic and institutional factors significantly influence the choice of adaptation strategies employed by farming and fishing households.

1.5 Relevance of the Study

The relevance of investigating the vulnerabilities of agricultural livelihoods to climate change and environmental degradation and conflict is simply based on the fact that these factors pose serious threat to agricultural livelihoods in the region which in turn undermine developmental efforts. This study is particularly important because meaningful development cannot take place where there is constant conflicts and threats on livelihoods.

Assessment of the vulnerability of the two livelihood groups (farmers and fishers) in the Niger Delta region of Nigeria is particularly relevant given that these two livelihood groups are the main livelihoods of the people and the exposure of the region to these triple stressors. This study provides insights as to which of the livelihood groups requires urgent attention/assistance in terms of adaptation aids/livelihood assistance and what developmental actors can be of help. It is expected that findings from this study on the vulnerability of the two livelihood groups to the triple stressors and components influencing vulnerability will help policy makers design workable policy interventions to help reduce vulnerability in the region. Since, resources are scarce policy makers

and developmental agencies need to know where to channel the limited resources for effective results.

Also, understanding adaptation strategies adopted by the livelihood groups and factors affecting choice of adaptation strategies is useful in designing effective adaptation initiatives in the region. This is important for policy makers, development partners and other stakeholders to equip them with information on adaptation strategies and factors to target in order to promote adaptation. Adaptation has been considered a viable option for reducing vulnerability especially to environmental changes.

The significance of investigating the food security status of the households and the effect of vulnerability on food security is attractive as food security has increasingly become important for most governments and people. Therefore, efforts aimed at reducing food insecurity must be evidence-based making the result of this study useful for policy makers and other relevant stakeholders.

Moreover, the results from this study will add to literature on vulnerability, adaptation and food security and provide a starting point for future research. Other stakeholders who can benefit from the results of this study are donor agencies, NGOs and even extension workers.

1.6 Organization of the Thesis

This thesis is organized into five chapters. Chapter one begins with an overview of the background to the study, this is followed by the problem statement, objectives of the study, hypotheses of the study, relevance of the study and concludes with organization of the thesis. The second chapter

reviews pertinent literature related to the study objectives. Chapter three presents the theoretical framework underpinning the study, data collection and sampling procedure, information on the study area and methods of data analysis. The results and discussion were presented in the fourth chapter. The last chapter presents the summary of the study, conclusion and recommendations stemming from the research findings.

CHAPTER TWO
LITERATURE REVIEW

2.1 Introduction

This chapter reviews literature on the concept of vulnerability, adaptation and food security. The first section reviews literature on environmental degradation and its effects on agricultural production in Niger Delta region. This is followed by a review of literature on drivers of conflict and climate variability and change in Niger Delta region. The third section reviews literature on vulnerability and the methodology and analytical framework used in vulnerability assessments. The fourth section reviews literature on adaptation strategies and factors influencing adaptation strategies. The chapter ends with a review of literature on the concept of food security, the indicators and methods of measurements.

2.2 Environmental Degradation in Niger Delta Region (ND)

The oil exploration and exploitative activities result in negative externalities such as oil spillage, gas flaring, gas leakage, pollution of air, water and land and its attendant health implications. In the case of oil spills, Ekpebu and Ukpong (2013) reported that between 1976-1996 there have been a total of 4,647 oil spills in which 2,369,470.04 barrels of oil was spilled and between 1997-2001, a total of 2,097 oil spill incidences were recorded all of which resulted in destruction of natural resources and coastal environment. This is tabulated in Table 2.1.

Table 2.1 Some severely polluted sites in Niger Delta region

Location	Environment	Area affected	Nature of incidence
Bayelsa State	Biseni	Fresh water swamp	20 oil spills incidence
	Atama/Nembe	Forest	20 oil spills incidence and fire outbreak
	Etelebu	Forest	30 oil spills incidence
	Perembabiri	Forest	30 oil spills incidence
	Adebawa	Forest	10 oil spills incidence
	Diebu	Forest	20 oil spills incidence
	Tebidaba	Fresh water swamp	30 oil spills incidence
	Nembe creek	Forest mangrove	10 oil spills incidence
	Azuzuama	Mangrove forest	50 oil spills incidence
Total	9 sites in Bayelsa State		
Delta State			
	Ouekebe	Barrier forest island	50 oil spills incidence
	Salt water intrusion jones creek	Mangrove forest	35 oil spills and burning
	Ugbeji	Mangrove	2 oil spills incidence
	Refinery waste Ughelli	Fresh water swamp forest	10 oil spillage-well head leak
	Jesse	Fresh water	8 products leak/burning
	Ajato	Mangrove	Oil spillage incidence
	Ajala	Fresh water swamp forest	Oil spillage incidence
	Uzere	Fresh water swamp forest	Oil spillage incidence
	Afieser	Fresh water swamp forest	Oil spillage incidence
	Kwale	Fresh water swamp forest	Oil spillage incidence
	Olomoro	Fresh water swamp forest	Oil spillage incidence
	Ughelli	Fresh water swamp forest	Oil spillage incidence
	Akakpare	Fresh water swamp forest	Oil spillage incidence
	Ughuvwughe	Fresh water swamp forest	Oil spillage incidence
	Ekerejegbe	Fresh water swamp forest	Oil spillage incidence
	Uzoro	Fresh water swamp forest	Oil spillage incidence
	Odimodi	Mangrove forest	Oil spillage incidence
	Ogulagha	Mangrove forest	Oil spillage incidence
	Otorogu	Mangrove forest	Oil spillage incidence
	Macraba	Mangrove forest	Oil spillage incidence
Total	20 sites oil spillage incidence		
Rivers State			
	Rumuokwurusi	Fresh water swamp	20 oil spillage incidence
	Rukpoku	Fresh water swamp	10 oil spillage incidence

Source: (Ekanem & Nwachukwu, 2015)

2.2.1 Effects of environmental degradation on agricultural production

Ekpebu and Ukpong (2013) investigated the effects of oil exploration to agricultural livelihoods in the ND and reported the following:

"It causes reduction in arable lands as oil wells are being discovered. The land is taken away from the people and oil infrastructures are installed on the lands. This is made possible under the pipeline Act which excludes the land from use for agricultural purposes. It also leads to soil erosion and destruction of biodiversity as forest are being destroyed."

Oil spillage leads to pollution of air, land and water resources which adversely affects humans, crops and aquatic lives. It constitutes serious health hazard to humans when they drink this contaminated water. Gas flaring destroys vegetation around, soils and forest resources. In addition, it heats up surrounding environment and creates unfavorable atmosphere for both plants and animals. Gas leakage is dangerous to farmers health and aquatic life. It could lead to explosion and fire which in turn destroy farm lands and human lives and properties.

Idemudia (2009) reported the perceived impact of oil production on surveyed villages in Akwa Ibom to include: low crop yield (81%), loss of fish (92%), high cost of living (66%), health problems (79%), damage to roof tops (94%) and house vibration and cracks (10%). Ninety one percent (91%) of the respondents perceived the source of environmental degradation to be gas flaring, while 50% perceived oil spillage as the source.

2.2.2 Socio-economic effects of environmental degradation in the ND

Oil exploration has impacted on the social and economic life of the people. It has led to environmental degradation, displacement of people, loss of livelihoods, rural to urban drift, unemployment, poverty, poor human health and antisocial activities (Omajemite, 2008; Ugbomeh, 2008). Oil pollution negatively impact on human health, agricultural lands and fresh water bodies. This leads to destruction of crops and aquatic lives thereby disrupting the social and economic life of the households whose livelihoods depend on these natural resources. This subjects the people to hunger and poor living standard. Therefore, there is prevalence of poverty, malnutrition and disease in the ND region.

Most of the communities in the ND lack basic social amenities such as water, electricity, health care facility, lack of jobs for majority of displaced farmers and fishers who have lost their livelihood sources to activities of these multinational oil companies (UNEP, 2011). The women folk are the worst hit who are excluded from any kind of employment and compensation by the oil companies. Few men are hired to provide manual labour such as oil dredging, laying of oil pipes, security personnel, and daily paid labour to help oil technocrats. And because these jobs pay higher wages than income from other sectors such as public service, it has led to many of the youth dropping out from schools to secure such jobs. Also, there is high level of school drop outs among teenage girls, early child marriage and trafficking of girls for prostitution and as domestic house helps in urban centers. The long term implication is lowering of the self-esteem of the women folk and high susceptibility to STDs such as HIV/AIDS (Omorodion, 2004).

2.3 Drivers of Conflict in Niger Delta

There are theories that purport that oil drives conflict in many African nations i.e the popular Dutch disease. However, Watts (2005) and Obi (2014) debunked that theory that oil drive conflict. They assert that political as well as economic factors rather trigger conflict. The conflict in ND has been linked to a number of factors ranging from political, economic, environment and social factors (Idemudia and Ite, 2006).

2.3.1 Political factors

Idemudia and Ite (2006) asserted that the political dimension to the conflict in the ND region is connected to the interplay between ethnicity, statehood formation and corruption. It takes it's root from the 1914 amalgamation of the northern and southern protectorates to form what is known as Nigeria. A union which Chief Obafemi Awolowo criticized as being state-nation rather than nation-state given the multi-ethnic constituent of Nigeria, the religious division and the forced nature of the union (Olojede, Fajonyemi, Akhape, & Mudashiru, 2000). The ND has before independence always felt a sense of marginalization by the majority Igbo and Yoruba ethnic groups (Naanen, 1995 and Obi, 1997). The region lacked basic socio-economic and developmental infrastructures, which were found in other regions as a result of minority status ascribed to them. This political exclusion and fear of continued socio-economic exclusion led to their clamour for self-determination and a state of their own at independence and eventual break out of the 1967-1970 civil war.

However, after the war two things happened that brought false hope to the people: creation of states and discovery of oil. The creation of states rather weakened the regions and strengthened centre (federal level). This condition fostered corruption, competitive communalism and over-

dependence of other tiers of government (such as state and local governments) on the centre and further delineated the people of the region from the proceeds of oil exploration. Hence, government failure to deliver developmental benefits to the people of the region despite huge proceeds from crude oil coming from the region became the major cause of the conflict between the people of the region and the Nigerian State (Idemudia & Ite, 2006). The protests were not given attention but rather the Nigerian government resorted to the use of military force to resolve the civil issues, which further aggravated the conflict and what started as peaceful protest degenerated to violent conflict. Therefore, the political angle to the conflict in Niger Delta can be attributed to the failed state status, which Nigeria government earned through its inability to meet its social responsibility to the people and the inability to manage internal civil issues without resorting to the use of military force.

2.3.2 Economic factors

How economic factors contribute to the conflict in the region can be viewed from two nexuses: political-economic and economic-environmental nexus. The political-economic nexus is tied mainly to the way oil revenue is allocated and the rentier-predatory status of the Nigerian state. This rentier-predatory status of Nigeria contributed to the conflict in two ways. First it made the other tiers of government rely heavily on the centre for their sustenance thereby reducing the access to oil revenue by the people of Niger Delta and causing a feeling of deprivation among the people. Initially (from 1960-1966) revenue allocation was based on the principle of derivation, where 50% of whatever proceeds from a region goes back to that region and this produced healthy competition and development between regions from 1960-1966 (ANEEJ, 2004). However, as Nigeria attained rentier status the principle of derivation was revised from 50% to 20%, 0%, 2%, 1.5% and 13% in 1975, 1979, 1982, 1984, 1992 and 2001 respectively. This led to the five southern states from

where 90% of the oil revenue comes receiving only 19.3% while the five northern non-producing states received 26% (Ikporukpo, 1996).

The second way the rentier status of Nigeria contributed to the conflict lies in its failure to be a fair judge in mediating between different strata of the society. This has made it lose its credibility before the people of Niger Delta who see Nigeria as only serving her selfish interest at the detriment of the people of the region. This feeling is hinged on the fact that despite 50 years of oil exploration, oil wealth has not brought any significant development to the region rather than ecological destruction, social deprivation, political exclusion and granted that the oil companies enjoy state immunity and are therefore not held accountable (Watts, 1999). This lack of confidence that the polity of Niger Delta have for the government made it difficult for the government to manage internal aggression without resorting to the use of military force.

The economic-environmental nexus is linked to the role of poverty, location of oil within the region and the economic impact of environmental degradation on the host community. The location of oil within the region confers upon them the oil -owning identity and provides a sort of "economic power" that enables them to make some demands and claims of which includes political inclusion and economic development of the region.

2.3.3 Environmental factors

Environmental factors is seen by Idemudia and Ite (2006) as a proximate cause which interact with other pre-existing factors to trigger conflict. The contribution of environmental factors to the conflict in the region can be linked to the vulnerability of the Niger Delta ecology and the dependency of the people on the environment for their life sustenance. In order to understand how

environmental degradation, contribute to the conflict we need to look at the broader conceptualization of environmental degradation to include environmental changes resulting from overuse of renewable resources, overstrain of the environment sink capacity in addition to pollution resulting from oil spillage and gas flaring. The people of Niger Delta depend heavily on farming and fishing for their livelihood. According to Moffat and Lindén (1995) seasonal flooding and erosion have led to the loss of limited arable land. Also, evidence shows that fish stock in the region are being depleted due to overuse. All these combined with the oil spillage and gas flaring incidences that is constantly experienced there is fuelling the conflict as their means of livelihood is being undermined and there is competition for the available arable land among community members. Also, the oil companies acquire scarce arable lands to install oil infrastructures such as pipelines. This often comes with the issue of compensation and claims which often lead to corporate-community conflict.

According to Idemudia and Ite (2006) issues of environmental degradation is persistent due to the lack of commitment of the government to regulate the negative externalities that result from the activities of these oil companies and the oil companies pursuit of cost cutting policies at the detriment of the environment and the people. Another way environmental degradation fuel conflict can be understood from the interaction between poverty and environment change. Environmental degradation aggravates the impact of poverty on community. This becomes a useful tool for the elites to use in mobilizing the youth and entire community to confront the Nigerian state (Osaghae, 1995).

2.3.4 Social factors

The contribution of social factors to conflict in the region can be attributed to the heightened feeling of relative deprivation, mass youth unemployment and heightened realization that oil is a finite resource. Ibeanu (2002) reported that youth unemployment in the region is the highest in the country. This has resulted to youth restiveness and formation of militant groups as political elites' cash on their joblessness to pursue their own selfish interest. This has also made oil theft a lucrative business in the region.

Also, the heightened realization that oil is a finite resource dawned on the people when they see the situation of the Oloibori people where oil exploration started. The place is now desolate and a shadow of itself with the drying up of oil wells (Okoh, 1996). Hence, the people of Niger Delta suddenly realized that if they remain silent the same fate will befall them and this awakened them to stand up and act. 'Relative' deprivation can be explained from the feeling of being left behind compared with the ethnic majority, comparing their present situation with past and unmet expectation that the people had that oil revenue will help improve their situation (Rønnfeldt 1997).

So, whereas political and economic factors provided a breeding ground for the conflict in Niger Delta by provoking deep rooted feeling of deprivation via marginalization, environmental factors accentuated the conflict by spreading the cost of violence around and social factors provided the tools for violence.

2.4 Corporate-community relations in Niger Delta

Idemudia (2009) opined that the relationship between the multinational oil companies and the communities in the Niger Delta has evolved with time through three main phases. The first phase

was the pay-as-you-go approach implemented at the early years of oil discovery and exploration in 1956 where the community was kept at a distant. However, this was changed in 1990s following series of protests and conflict over environmental degradation and loss of livelihood in the Niger Delta and reluctance of oil companies to perform their social responsibility towards their host communities.

The oil companies opted for the second generation of corporate strategy to community relations which was based on the principle of corporate social responsibility and was labeled community development model. This approach was more like 'doling out gifts' to the community such as: water projects, health care projects, building of classrooms, scholarships programmes, micro-credit schemes, providing agricultural extension advisers to train farmers, setting up micro businesses such as aquaculture, rural electrification projects, land reclamation and skills acquisition projects like electrical and auto engineering, masonry, plumbing, welding, carpentry, plumbing, tailoring (Ite, 2002) (SPDC, 2001; Ite, 2002). The shortfall of this model was the top down approach which limited community participation in the decision making process thereby undermining the sustainability of such projects and the tendency of the projects to spur intra-inter community violence due to competition (Ekanem & Nwachukwu, 2014).

This led to the third phase which was based on the principle of partnership. The difference between the second and the third phase is that the former is mainly corporate driven whereas the latter is community driven and involves decision making with the communities with the assistance of a non-governmental organization who acts as the middleman. This fosters a sense of ownership and control by the community and in extension sustainability. Shell is one of the oil companies who implemented this approach in 2004 where they employ the services of private contractors (NGOs)

to partner with the community in developing projects. Some the agricultural related projects implemented include: setting up of poultry farms, aquaculture and agro processing mills such as cassava, palm oil and rice processing mills (Ekanem & Nwachukwu, 2014).

The extent to which this projects address community grievances and developmental expectation remain questionable. Idemudia (2009) revealed that the impact of these projects to community development is marginal in relation to the spread of the benefits and improvement in livelihoods of households. Two reasons that were attributed to this is wrong targeting of community development needs and failure to address negative externalities of oil production. So, while the oil companies are implementing community development projects, their failure to address negative externalities of oil exploration continue to destroy the traditional livelihoods sources such as fishing and farming which at the long run undermine all their developmental efforts.

2.4 Climate Variability and Change in Niger Delta and its Impact

Niger delta is bedeviled with a lot of environmental problems resulting from climate change and activities of multinational companies operating in the region. These problems ranges from coastal erosion, flooding, loss of vegetation cover agricultural land degradation and change in rainfall pattern. Coastal erosion has been reported by World Bank as needing moderate priority in the region (Agbola & Olurin, 2003). However, Uyigue & Agho (2007) posits that it should be given high priority. Climate change has been asserted to lead to sea level rise. Udofa and fajemirokun (1978) in Uyigue & Agho (2007) reported a rise in sea level of 0.462m along the Nigerian coastal water between 1960 and 1970. The Nigerian Environmental Study/Action Team (NEST, 2011) reiterated that this rise in sea level will aggravate coastal erosion which is already being observed in the region and the resulting inundation will further lead to floods, intrusion of sea-water into

fresh water bodies and destruction of ecosystem which will affect farming, fisheries and livelihoods generally. It has been predicted that Niger Delta could lose 15000 km^2 of land with a meter rise in sea level by 2100 and at least 80% of the population rendered homeless as a result of the low level of the region (Uyigue & Agho, 2007).

This is already being felt in the region. For instance, the flood event of 2006 as reported by Douglas et al., (2008) cited in IPCC (2014) rendered 10,000 people homeless and caused wide spread traffic chaos in Port-Harcourt city. This flooding submerged houses, crippled economic activities and displaced some residents of Mgbuoba, Diobu and Nkpolu communities (Zabbey, 2007). Also, in 2012 another devastating flood occurred which affected the whole nation including the Niger Delta region. The report by National Emergency Management Agency (NEMA) revealed that about 4 million people were affected, with 363 people killed and 5851 injured (PNDA, 2013). Also, flooding leads to increased risk of communicable diseases such as malaria, cholera, typhoid and acute lower respiratory tract infection (PNDA, 2013). In addition, it poses threat to city infrastructure such as electricity, roads etc.

2.5 Empirical Studies on Climate, Security, and Vulnerability

Africa is particularly considered to be more vulnerable to conflict resulting from climate change due to the continent's over reliance on rain-fed agriculture, prevalence of poverty and weak institutional factors that limit her adaptive capacity (Boko et al., 2007). Climate shocks and environmental degradation can increase the pressure on both physical and natural assets on which production depends on and most likely undermine agricultural productivity (Cline, 2007; Connolly-Boutin & Smit, 2016). This in turn could impact on a number of social phenomena such

as interpersonal conflicts, communal conflict, conflict between pastoralists and farmers and civil conflicts (Hendrix & Salehyan, 2012; Hsiang & Burke, 2014; Hsiang, Burke, & Miguel, 2013).

Most studies have focused on direct link between climate and conflict. The findings of the studies have been inconclusive regarding the causal relationship (Salehyan, 2008). While some authors like Fjelde & von Uexkull (2012) and Hendrix & Salehyan (2012) suggest that climate shocks increases the likelihood of conflict outbreak, other authors like Buhaug (2010) and Couttenier & Soubeyran (2014), do not find any significant link between climate and conflict. von Uexkull (2014) went beyond investigating links to focus on factors that reduce coping capacity to drought thereby accounting for local vulnerability and coping capacity that condition the effect of drought. The study showed that exposure to sustained drought and reliance on rainfed agriculture for income and food were two factors that influence the outbreak of civil conflict.

2.6 Methodologies in Vulnerability Assessment

2.6.1 Measures of vulnerability

Different authors have attempted to assess the vulnerability of communities and farming systems to climate change using different approaches (e.g. Turner et al., 2003; Fraser, 2007; Simelton et al., 2009). Some adopted quantitative crop modelling approach to ascertain where yields are likely to decrease or increase as a result of climate change (e.g. Challinor et. al., 2008, 2009, 2010). These quantitative models make it easy to communicate complex scientific information to policy makers (Fraser, 2006). However, the use of crop model in vulnerability assessment has a number of limitations. One of which is the adaptation used in these models are hypothetical and assume either “no adaptation” or “optimal adaptation” (Kandlikar and Risbey, 2000).

Another popular approach to assessing vulnerability is to define a set of proxy indicators and estimating indices for selected indicators (Luers et al., 2003; Gbetibouo, Ringler, Hassan, 2010). Indicators are suitable for monitoring and studying trends and can be applied across different scales (Gbetibouo et. al., 2010). However, the use of indictors is limited due to lack of information on the selection of suitable variables and the weighting method required to calculate the vulnerability index (Luers et al., 2003).

Assessment of vulnerability differentiates two main ontological approaches namely: theory-driven and data-driven approaches (Vincent, 2007). Theory-driven studies inductively use insights from the literature to select and aggregate indicating variables (Briguglio, 1995; Vincent, 2007). The limitation of this approach is that indicating variables are selected normatively. Hence, there is some level of uncertainty as to whether the variables represent what it is supposed to and the direction of the relationship (Vincent, 2007). On the other hand, data-driven studies deductively use expert judgment for selection and aggregation of indicating variables (Alberini et. al., 2006; Brooks et al., 2005). The limitation of this approach is the limited objectivity of experts.

As a result of the limitations mentioned above a third category of studies combine both empirical and theoretical insights in selecting and aggregating indicating variables. For instance, Hahn et al., (2009) constructed a composite vulnerability index for two districts in Mozambique by selecting indicating variables based on the literature and local expert knowledge. One limitation of the study is that the sub-components of the index were weighted equally. Gbetibouo et al., (2010) argued that weighting is very important but the use of expert in development of weight is often limited by the availability of expert knowledge and limited objectivity as earlier mentioned. Hence, their study tried to overcome the weighting problem by estimating the weights of the sub-components

of the index using principle component analysis. This approach is also limited in that the weights are determined by the data structure, which may easily result in paradoxical weights, if not correctly executed (kolinikov and Angeles, 2009). For instance, in the study by Gbetibouo et al., (2010) 11 out of the 19 indicating variables had no connection to climate which cast some doubt as to whether principal component is an appropriate approach in vulnerability assessment. This is because vulnerability or adaptation are site-specific phenomena and many authors suggest local level analysis to help understand underlying processes to vulnerability and development of well-targeted adaptation polices (Boko et al., 2007; Smit Wandel, 2006).

Hinkel (2011) posits that vulnerability indices should be developed for systems at the local scale where indicating variables can be selected deductively and inductive arguments used in aggregation (i.e weighting and combining). In this study the indicating variables for computing the vulnerability index will be selected deductively and validated in the field. Given the direct connection of indicating variables to local livelihood it will be easier for local experts to assign weights thereby avoiding the shortcomings of generating weights using principal component method.

2.6.2 Analytical frameworks to understand livelihood vulnerability to climate change

A number of interpretations exists on the concept of vulnerability to climate change (e.g. Adger 2006; Bohle et al., 1994; Downing et al., 2005; Kelly and Adger, 2000; Wisner et al., 2004). These authors are yet to come to a consensus as to the meaning of this concept. However, the concept as defined by Turner e al., (2003) generally refers to the degree to which a human and/or ecological system will be affected by any kind of hazard. Hazards here could either be in the form of perturbations which could trigger instantaneous pressure on the system (e.g. tsunami, earth quake)

or in the form of stressors which exerts pressure on the system at a continuous slow rate (e.g. environmental degradation). These hazards could come from within or outside the system (Kasperson et al., 2005; Turner et al., 2003).

Vulnerability have been considered to be a function of three components; exposure, sensitivity and adaptive capacity (Smit and Wandel, 2006). Exposure refers to the degree or extent to which a system is in contact with the hazard; sensitivity has to do with the degree to which the system is affected by the hazard and the adaptive capacity refers to the ability to cope or bounce back to original state after being hit by any kind of hazard.

There are a number of approaches used in assessment of vulnerability of climate. Fussel and Klein (2006) outlined four stages: initial impact assessment (which involves the evaluation of potential effect of climate change scenario and this has to do with the degree of exposure of the system); first and second-generation vulnerability assessments (involves estimation of climate change impacts as it relates to society and possible adaptive capacity) and adaptation policy assessments (involves evaluation to develop well targeted policy recommendation for implementation). There are no specific frameworks that have been proposed to exclusively analyse vulnerability to climate change and other environmental change as well as the interaction between the drivers of change. Hence, this study will integrate different analytical framework: the sustainable livelihood framework and IPCC vulnerability framework. This different framework will help give a more comprehensive view of the vulnerability of livelihoods to climate change and other environmental changes.

2.7 Empirical Studies on Adaptation Strategies to Climate Change

2.7.1 Types of adaptation strategies

Increasingly, adaptation has been identified as the policy option to help cope with the negative impact of climate change (Adger, Huq, Brown, Conway, & Hulme, 2003; Kurukulasuriya & Mendelsohn, 2008). Developing countries have been projected to be more impacted by climate change.

Adaptation has been defined differently by different authors. IPCC (2001) defined adaptation as the ability of a system to adjust in response to actual or expected climatic stimuli to reduce harm and cope with the resulting condition. Adger et al. (2007) defined adaptation as those actions, modification in practices, processes and capital in response to threat from climate change. Zilberman, Zhao, & Heiman (2012) defined it as modification in private and public decision-making process in resource allocation. While some of the adaptation strategies such as investment in irrigation infrastructure have public good characteristics, others such as adoption of improved varieties, crop diversification are inspired by private interest (Bréchet, Hritonenko, & Yatsenko, 2013).

There are different types of adaptation: transformational such as macro-level research programs aimed at development of new improved or resistant varieties. It could also be done at the micro-level and involve minor adjustment in farm management practices such as changing of planting and harvesting date. A number of studies have investigated the various adaptation strategies used by farmers to adapt to climate. Shimono, Kanno, & Sawano (2010) in their study investigated how cropping schedule of rice can be adapted to climate change using cool areas of northern Japan as case study, and the results show that future rice productivity can be increased by using an earlier

transplanting date, perhaps combined with the introduction of cultivars with a later maturity date and greater cold tolerance.

Bryan, Deressa, Gbetibouo, & Ringler (2009) found that the most common adaptation strategies used in Ethiopia and South Africa include: use of different crops or crop varieties, planting trees, soil conservation, changing planting dates, and irrigation. Bryan et al. (2013) also carried out a similar study in Kenya and reported that the adaptation strategies practiced in response to climate change were: changing crop variety; changing planting dates; changing crop type; planting trees; decreasing the number of livestock; diversifying, changing, or supplementing livestock feeds; changing fertilizer application and soil and water conservation practices. Acquah & Onumah (2011) assessed farmers' perception and adaptation to climate change in Ghana and reported that the adaptation strategies adopted by majority of the farmers include: changing planting dates, different crop varieties, soil conservation and water harvesting as the major adaptation measures to climate change impacts. A similar result was reported by Fosu-Mensah, Vlek, & MacCarthy (2012).

In Nigeria, Sofoluwe, Tijani, & Baruwa (2011) also assessed farmers' perception and adaptation to climate change and reported that the predominant adaptation strategies were late planting, planting trees, irrigation and soil conservation. For rice farmers in drought prone areas of Bangladesh Alauddin & Sarker (2014) found out that the use of drought tolerant rice variety and switching to other crops other than rice were some of the strategies adopted to cope with the effect of climate change. Alam et al., (2016) study in Bangladesh showed that the adaptation strategies employed by farming households include diversifying crops, tree plantation, home stead gardening and migration.

Deressa et al. (2009) found that farmers in Nile Basin of Ethiopia adopted strategies such tree planting, planting different crop varieties, early and late planting, soil conservation and irrigation to be able to cope with the influence of climate change. Amare & Simane (2017) found that small holder farmers in Nile basin of Ethiopia adopted small-scale irrigation, agronomic practices, livelihood diversification, and soil and water conservation measures to cope with climate change impact. Fosu-Mensah et al. (2012) found crop diversification, planting of short season varieties, change in crops species, and a shift in planting date as adaptation strategies employed by farmers in Sekyedumase district of Ashanti region of Ghana.

Juana, Kahaka, & Okurut (2013) conducted a review on farmers' perceptions and adaptations to climate change in Sub- Saharan Africa and reported that the strategies and coping mechanisms adopted by arable farmers in sub-Sahara Africa included:

i. Shifting from cultivating high water-requirement to low water-requirement crops especially those in regions with reduced precipitation (Bryan et al., 2009, 2013; Deressa et al., 2009; Gandure, Walker, & Botha, 2013; Hassan & Nhemachena, 2008), while those in regions with recurrent flooding cultivate short duration crops and have changed the planting and harvesting dates to avoid crop planting and harvesting during the periods of intensive rainfall (Acquah & Onumah, 2011; Fosu-Mensah et al., 2012).
ii. Majority of arable farmers have changed to planting diversified crops, adjusted planting dates to correspond to the variation in the rainfall pattern, mixed cropping, planting tree crops, and diversifying into off-farm activities (Acquah & Onumah, 2011; Deressa et al., 2009; Fosu-Mensah et al., 2012; Gandure et al., 2013; Gbetibouo, 2009; Kurukulasuriya &

Mendelsohn, 2007; Mengistu, 2011; Mertz, Mbow, Reenberg, & Diouf, 2009; Sofoluwe et al., 2011)

iii. Farmers in southern Africa and parts of East Africa, where most countries are water stressed, have developed water conservation methods such as water harvesting, waste water re-use in agriculture and irrigation (Deressa, Hassan, Ringler, Alemu, & Yesuf, 2009; Gandure et al., 2013; Kurukulasuriya & Mendelsohn, 2007; Mengistu, 2011; Mertz et al., 2009; Nyanga, Johnsen, Aune, & Kalinda, 2011) as well as switched from arable to livestock farming (Deressa et al., 2009; Kurukulasuriya & Mendelsohn, 2007; Mengistu, 2011), while farmers in West Africa, where most countries experience short intensive rainy season plant short duration crops, practice upland farming (instead of swamp farming) and soil conservation methods (Acquah & Onumah, 2011; Kurukulasuriya & Mendelsohn, 2007; Sofoluwe et al., 2011).

To cope with or adapt to climate change in sub-Sahara Africa, livestock or pastoral farmers have dug more boreholes in drier regions, switched to non-farm income generating activities and have decreased their herds, by selling them during periods of drought and replacing after the drought (Gandure et al., 2013; Mandleni & Anim, 2011; Mertz et al., 2009). Some other livestock farmers have changed to keeping livestock that can withstand water stress and increased temperatures (Mandleni & Anim, 2011; Nzeadibe, Egbule, Chukwuone, & Agu, 2011).

Some of the adaptation measures reported in the literature that fishing households use to adapt to the negative impacts of climate change includes fishing over large expanses, varying fishing location, using technologically advanced fishing gears and increasing working periods (Islam, Sallu, Hubacek, & Paavola, 2014b; Quentin Grafton, 2010). Blythe, Murray, & Flaherty (2014) in

their study found that fishers along the Mozambican coast adapt to climate change by intensifying their fishing efforts. This they do by investing in higher fishing gear, changing fishing location, and fishing for longer hours. The poor ones without the means to purchase sophisticated fishing gears adapt by diversifying their livelihoods. Senapati & Gupta (2017) study in Mumbai India revealed that fishing households adapted to climate change by targeting variety of species as well as fishing intensively for several days.

2.7.2 Measuring factors influencing adaptation strategies

Bryan et al., (2009) used a probit model to identify the factors influencing farmers' decision to adapt to perceived climate changes. Factors influencing farmers' decision to adapt include wealth, and access to extension, credit, and climate information in Ethiopia; and wealth, government farm support, and access to fertile land and credit in South Africa. In the Nile Basin of Ethopia Deressa et al. (2009) found education, age, sex, access to credit and extension, information on climate and social capital to be the factors that influenced the choice of adaptation strategy. Alemayehu & Bewket (2017) found perceived soil fertility status, perception of land tenure security, access to extension service, and ages of household heads to be factors affecting choice of adaptation strategies in the central highland of Ethiopia.

In Ghana Fosu-Mensah, Vlek, & MacCarthy (2012) found access to extension services, credit, soil fertility, and land tenure to be the major factors that influenced farmers' perception and adaptation. Opiyo et al. (2016) found that factors that influenced pastoralists choice of adaptation strategies in northwestern Kenya were gender and education level of the household head, household size, wealth in terms of livestock ownership, distance to markets, access to credit and extension services. Khanal, Wilson, Hoang, & Lee (2018) in a study carried out in Nepal found

out that education, access to credit, access to extension services, access to information on climate and experience with climate change impact such as floods, drought affect the decision of farmers to adopt adaptation strategies.

The table 2.2 summarizes the review of the various factors influencing adaptation as well as the reasoning behind them and references from the literature.

Table 2.2 Summary of empirical studies on determinants of adaptation strategies

Factors	References	Rationale
Access to credit (+)	Ethiopia (Deressa, Hassan, & Ringler, 2011; Deressa et al., 2009; Di Falco, Veronesi, & Yesuf, 2011) Nepal (Khanal et al., 2018) South Africa (Gbetibouo, 2009) Sudan (Osman-Elasha et al., 2006) Bangladesh ((Islam, Sallu, Hubacek, & Paavola, 2014a)	A number of studies have shown that access to credit is a very important factor that influences adoption of technologies. Climate shocks could result in income losses therefore farming and fishing households' ability to access credit can help build their adaptive capacity. A study in Sudan revealed that access to credit was instrumental in helping farmers adapt to climate shocks in the drought prone villages (Osman-Elasha et al., 2006).
Education (+)	Ethiopia (Deressa, Yehualashet, & Rajan, 2014; Deressa et al., 2009) Bangladesh (Alam et al., 2016; Alauddin & Sarker, 2014; Islam et al., 2014b, 2014a) Nepal (Khanal et al., 2018)	Education enhances better access to information about adaptation measures, weather forecast and how to access credit facility and network. It also provides better opportunities to gain employment outside farming and fishing which can be an adaptation measure. Thus, it positively influences adaptation choices.
Extension services (+)	Ethiopia (Alemayehu & Bewket, 2017; Deressa et al., 2009; Hassan & Nhemachena, 2008) Nepal (Khanal et al., 2018) Ghana (Fosu-Mensah et al., 2012)	This is an imperative source of information on climate change and adaptation strategies. Hence, it is expected to positively influence adaptation.

	Kenya (Opiyo et al., 2016)	
Social network (+)	Ethiopia (Adimassu & Kessler, 2016; Deressa et al., 2009) Tanzania (Mpogole, 2013) South Africa (Ortmann & King, 2007; Thomas, Twyman, Osbahr, & Hewitson, 2007)	A number of studies have shown that social capital such as family and friends, trust and cooperation among community positively and significantly influence the adoption of technologies as they play a crucial role in dissemination of information on technologies, and enhances access to loans and credits. Thomas & Twyman (2007) in their study in South Africa found that social network such as cooperative helped enhanced the adaptive capacity of the farmers.
Access to climate information (+)	Ethiopia (Adimassu & Kessler, 2016; Bryan et al., 2009; Deressa et al., 2009; Gebrehiwot & van der Veen, 2013) Bangladesh (Alam et al., 2016; Alauddin & Sarker, 2014) Nepal (Khanal et al., 2018) Sri Lanka (Gunathilaka, Smart, & Fleming, 2018)	Studies have shown that having access to climate change information increases the probability of adapting to it.
Experience with climate change impact	Bangladesh (Alauddin & Sarker, 2014) Nepal (Khanal et al., 2018) India (Malakar, Mishra, & Patwardhan, 2018)	People's perception of the impact of climate change and experiences with the negative impact of climate change as such drought and flood push them to want to adapt to avert these negative impacts (Grothmann & Reusswig, 2006).
Age (+)	Ethiopia (Adimassu & Kessler, 2016; Alemayehu & Bewket, 2017; Deressa et al., 2009) (Opiyo et al., 2016)	This increases the likelihood to adopt adaptation strategies. It is believed that older household heads have more experience and are more likely to notice changes in climate and therefore adopt adaptation strategies
Land tenure security (+)	Ethiopia (Alemayehu & Bewket, 2017) Ghana (Fosu-Mensah et al., 2012) South Africa (Gbetibouo, 2009)	Farmers with more secured tenure are more motivated to adopt soil and water conservation practices which are very beneficial in adapting to climate and are more willing to invest in technologies that help improve the soil fertility. Therefore, land tenure security positively

		influences the choice of adaptation strategies.
Gender (+/-)	Haiti (Bayard, Jolly, & Shannon, 2007; Dolisca, Carter, McDaniel, Shannon, & Jolly, 2006) Ethiopia (Asfaw & Admassie, 2004; Deressa et al., 2014)	The ability of male and female headed household to adapt to climate change differs because of the differences between them in relation to their education, access to assets and other resources such as credit, inputs and technology. The relationship to adaptation is mixed. Some studies have shown that Female headed households are more likely to adopt some adaptation strategies than male headed households and vice versa. For instance (Bayard et al., 2007; Dolisca et al., 2006) found that female farmers are more likely to adopt natural resource management and conservation practices. (Asfaw & Admassie, 2004; Deressa et al., 2014) found that male headed households are more likely to adopt agronomic practices such as crop diversification, use of drought-tolerant species and irrigation.
Soil fertility perception	Ethiopia (Alemayehu & Bewket, 2017) Ghana (Fosu-Mensah et al., 2012)	Farmers who perceive their soils to be fertile are more likely to take up adaptation strategies.
Farm size (+/-)	South Africa (Gbetibouo, 2009) Kenya (Nyangena, 2008) Ethiopia (Bazezew, Bewket, & Nicolau, 2013; Deressa et al., 2011; Gebreyesus, 2016)	The results of the relationship are mixed and depend on the adaptation strategies. For instance Gbetibouo, (2009) showed that farm size positively affects the likely to adopt irrigation as an adaptation option while Nyangena (2008) revealed that farmers with small farm size are more likely to adopt soil conservation practices that those with large farm size. Also, some studies (Bazezew et al., 2013; Deressa et al., 2011; Gebreyesus, 2016) have shown that farm size negatively affects the probability adaptation especially using

		livelihood diversification as an adaptation measure.
Household size (+/-)	Haiti (Dolisca et al., 2006) Ethiopia (Anley, Bogale, & Haile-Gabriel, 2007; Deressa et al., 2011; Tizale, 2007)	This has mixed effect on adaptation measures. Some studies (Anley et al., 2007; Deressa et al., 2011; Dolisca et al., 2006) have shown that large household tend to adopt adaptation measures that are labour-intensive such as soil and water conservation practices and irrigation. Some of the members can also engage in non-farm activities to generate extra income for the household (Tizale, 2007).

2.8 The Concept of Food Security

2.8.1 Evolution of the Concept

There have been a lot of evolutions in the concept of food security. Smith, Pointing , & Maxwell (1993) in their study outlined about 200 different definitions of food security. In the 1970's the focus was on availability of food supplies at the global and national level which led to the 1974 United Nation (UN) definition of food security. Food security was defined as "*availability at all times of adequate world food supplies of basic food stuffs to sustain a steady expansion of food consumption and to offset fluctuations in production and prices"* (United Nations, 1975).

There was an improvement to this definition by World Bank to include the access component. This was made evident after Sen's book on "Poverty and Famines" came to light in 1981 (Sen, 1981). He revealed that the problem of food insecurity was not that of availability rather it was that of accessibility. This led to the FAO definition of food security in 1983 as "…e*nsuring that all people at all times have both physical and economic access to the basic food they need"* (Food and Agriculture Organization of the United Nations (FAO), 1983).

By 1986, World Bank brought in the time element (stability) and they defined food security as "access of all people at all times to enough food for active, healthy life" (Reutlinger, 1986). The most generally accepted definition of food security is the World Food Summit's 1996 definition which includes the component of quality of food (utilization). They defined food security as a situation "that exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life". This definition incorporates the four pillars of food security: availability, accessibility, utilization and stability.

2.8.2 Food security measurements

There is no 'gold standard' to indicators that are used in measuring food security. Different indicators have been used at different times and by different authors. In fact, there are two problems usually encountered in food security studies and they are what food security measurement indicators to use and the econometric approach to adopt. This two are interwoven as the measurement determines the econometric model to be employed.

A lot of studies which use the quantitative measures of food security such as food security index and cost of calorie end up classifying households into two category, food secure or food insecure household. The classification informs the choice of binary logit (Arene & Anyaeji, 2010; Babatunde, Omotosho, & Sholotan, 2007; Beyene & Muche, 2010; Ojogho, 2010; Tefera & Tefera, 2014) and binary probit (Oluyole, Oni, Omonona, & Adenegan, 2009) models used in these studies. However, this is problematic as it obscures some vital information of households who fall into the middle category. Since food security indices are a continuum of values ranging from zero to some positive integer, it should be expected that at least there should be up to three categories

low, middle and high. This forms the basis for the ordering of food security levels of households. This is important in order to come up with appropriate policies than the limited information the binary categorization presents.

A number of indicators have been developed and used to measure food security. A summary of some of these indicators are shown in the Table 2.3. It should be noted that all the indicators have their strengths and weakness and so will be misleading to assert superiority to any particular indicator. The factors that determine the choice of a particular method/indicator are the questions to be answered and the resources available (Pérez-Escamilla & Segall-Corrêa, 2008). However, these methods could complement each other as no single method can capture all the food security dimensions since food security has been acknowledged by many as a multi-faceted phenomenon (Food and Agriculture Organization of the United Nations (FAO), 2003).

Some empirical studies such as Maitra & Rao (2017) and Ogundari (2017) compared different methods. Pérez-Escamilla & Segall-Corrêa (2008) noted that the experienced–based food insecurity measures could complement other food insecurity measurement measures. (Maitra & Rao (2017) carried out a research to establish the nutritional relevance of experienced-based food security indicator. They compared the results of a calorie-based food security method and an experienced-based food security method and found that both methods yielded same results.

Table 2.3 Indicators used for measuring food security at various scales, their advantage and disadvantages

Approach	Level of Measurement	Food security dimension	Metric/indicator	Advantages	Disadvantages	References
Indirect or Derived	National/global	Availability	FAO method (food balance sheet)	-Low cost -worldwide application -frequently updated on annual basis.	-Difficult to identify vulnerable household and individuals -does not account for dietary quality -high level of measurement error. -low standardization of methods of data collection across countries	(Jones, Ngure, Pelto, & Young, 2013; Kuwornu, Osei, Osei-Asare, & Porgo, 2018; Pérez-Escamilla & Segall-Corrêa, 2008)
			Global Hunger Index (GHI)	-global application -data updated on an annual basis thereby allowing for comparison of food insecurity across countries. -combines three indicators	-could result in double counting -insensitive to short term food and health shock -interpretation of GHI as a measure of food insecurity is complicated.	(Coates et al., 2013; Napoli, Muro, & Mazziotta, 2011)
		Utilization/ consumption	Anthropometry (height, weight),	-Low cost -widely applied in national surveys -highly standardized -evidenced based cutoffs -identifies vulnerable individuals or groups in need of intervention both at local and national levels.	-indirect proxy for food insecurity since it measures malnutrition which is a consequence of food insecurity -Food insecurity-obesity relationship hard to interpret.	(Jones et al., 2013; Setboonsarng, 2005)
			Global Hunger Index (GHI)	Same as above	Same as above	Same as above
		Access	Household Income and Expenditure Surveys	-Account for dietary quality	- expensive, -measures food availability and not necessarily food	(Babatunde et al., 2007; Charlton & Rose, 2002; Ogundari, 2017; Pérez-

				-useful in evaluating national food programs or poverty reduction programs	consumption, for instance it is difficult to capture foods consumed outside the home, fed to animals, given as gifts in exchange for work. -Data not collected on an annual basis. -methods of data collection not standardized across countries thereby making comparison difficult.	Escamilla & Segall-Corrêa, 2008)
			Dietary diversity • Food Consumption Score (FCS) • Household Dietary Diversity Score (HDDS)	-Measures directly food consumption not just availability -captures both dietary quantity and quality -identifies vulnerable households and individuals -highly correlated with other measures of food security such as per capita consumption, expenditure hence a proxy measure of food access and a good household food security indicator.	-memory recall bias -difficult to assess portion sizes -expensive and time consuming especially adopting for national survey -difficult to justify cutoffs -does not capture factors affecting changes in food consumption -requires highly trained researcher for data collection and entry.	(Ogundari, 2017; Pérez-Escamilla & Segall-Corrêa, 2008; Ruel, 2003; Swindale & Bilinsky, 2006; World Food Programme (WFP), 2008)
			Livelihood strategies • Coping Strategies Index (CSI) • Reduced Coping Strategy Index (rCSI)	-Useful in evaluating impact of household food access programs and for targeting programs	-Does not give direct indication of food gap. -difficult to differentiate between pre-crises coping strategies and crisis induced	(Boudreau, 1998; Maxwell, 1996) 2003, Hendricks 2005, Babatunde et al., 2008

				-useful for identifying vulnerable groups for food aid targeting - monitoring the impact of food aid -estimating both short- and long-term changes in food security.	coping strategies there making it hard to distinguish between transitory and chronic food insecurity. -because it draws largely from RRA technique such as FGD it is highly subjective and require high expertise on the part of the researcher.	
	Household	Utilization/ consumption	Anthropometry (height, weight)	Same as above	Same as above	Same as above
		Access	Household income and expenditure surveys **Dietary diversity** • Food Consumption Score (FCS) • Household Dietary Diversity Score (HDDS) **Livelihood strategies** • Coping Strategies Index (CSI) • Reduced Coping Strategy Index (rCSI) • Household Economy Approach (HEA)	Same as above Same as above Same as above	Same as above Same as above Same as above	Same as above Same as above Same as above
	Individual	Utilization/ consumption	Anthropometry (height, weight)	Same as above	Same as above	Same as above
		Access	**Dietary diversity**	Same as above	Same as above	Same as above

			• Individual Dietary Diversity Score (IDDS) **Livelihood strategies** • Coping Strategies Index (CSI) • Reduced Coping Strategy Index (rCSI)	Same as above	Same as above	Same as above
Direct or Fundamental						
	Household	Access	**Experientially based measures** U.S Household Food Security Survey Module (HFSSM); Latin American and Caribbean Food Security Scale (ELCSA); Household Food Insecurity Access Scale (HFIAS); Household Hunger Scale (HHS); Food Insecurity Experience Scale (FIES)	-Direct measure of food insecurity -Relatively easy and cheap -captures both the physical and psycho-emotional aspects of food insecurity -Valid across different socio-cultural context	-Hard to standardize cutoffs across different nations. -Different reference times and frequency response used in different context. -Does account for the food safety dimensions	(Bickel, Nord, Price, Hamilton, & Cook, 2000; Cafiero, Viviani, & Nord, 2018; Coates, Swindale, & Bilinsky, 2007; Cordero-Ahiman, Santellano-Estrada, & Garrido, 2017; Deitchler, Ballard, Swindale, & Coates, 2010; Jones et al., 2013; Nkegbe, Abu, & Issahaku, 2017; Obayelu, 2012; Sharaunga, Mudhara, & Bogale, 2016)

2.7.3 Empirical studies on determinants of food security

A number of studies have been done to ascertain factors that influence food security in different countries and among different groups. The table 2.4 summarizes these studies.

Table 2.4 Empirical studies on factors influencing food security and the rationale

Variable	Sign	Country	Authors	Reasons
Household size	+	Nigeria Ethiopia India	Ogundari (2017) Woldehanna & Behrman (2013) Maitra & Rao (2015)	This is possible where most of the household members are gainfully employed thereby generating additional income for the household to purchase food. Moreover, larger households are less vulnerable to shocks results from death or job loss of bread winner (Lipton, 1983).
	-	Nigeria South Africa Ethiopia	Asogwa & Umeh (2012) Maziya, Mudhara, & Chitja (2017) (Bogale & Shimelis, 2009; Gebre, 2012)	Larger household size means more mouths to feed and this exerts pressure on family resources and food stock which consequently lead to food insecurity.
Household income (on and off farm sources)	+	Nigeria South Africa Ethiopia Bangladesh Ghana Mexico Indonesia	(Arene & Anyaeji, 2010; Asogwa & Umeh, 2012) (Maziya et al., 2017) (Bogale & Shimelis, 2009) (Rashid, Smith, & Rahman, 2011) (Kuwornu, Suleyman, & Amegashie, 2013; Nata, Mjelde, & Boadu, 2014) (Cordero-Ahiman et al., 2017) (Diansari & Nanseki, 2015)	This is expected to increase food production and access to greater quantity and quality of food.
Off-farm work/non-farm income	+	Nigeria Ghana China	(Asogwa & Umeh, 2012; Babatunde & Qaim, 2010a) (Kuwornu et al., 2018; Owusu, Abdulai, & Abdul-Rahman, 2011; Zereyesus, Embaye, Tsiboe, & Amanor-Boadu, 2017)	This could have positive effect as engagement in Off-farm work is a coping strategy of households that provides additional income which can be used to increase consumption or production. Therefore, households who engage in off-farm activity tend to be more resilient in the face of food crisis than those engage in only farming.

		Vietnam	(Emran & Hou, 2013) (Hoang, Pham, & Ulubaşoğlu, 2014)	
	-			On the other hand, it could have negative effect if the household engage in off-farm activities at the detriment of the farm and especially if the income from such activities is not commensurate to the forgone income from the farm.
Farm size	+	Nigeria Ethiopia	(Asogwa & Umeh, 2012) (Bogale & Shimelis, 2009)	Food production can be increased through expansion of the land size. Large scale farmers tend to be more efficient in their use of resources than small scale farmers. Small farm holdings discourage the use of mechanization and modern inputs due to limited resources at the disposal of small-scale farmers. This results in low productivity and income and consequently affects food security.
Remittance	+	Nigeria	(Asogwa & Umeh, 2012)	The additional income received through remittances enhances the capacity of the households to consume more.
Age	+	Nigeria Ethiopia	(Adebayo, Olagunju, Kabir, & Adeyemi, 2016; Asogwa & Umeh, 2012) (Bogale & Shime elis, 2009)	It is assumed that the older the household head gets, the more experience they acquire, and the more risk averse they are, the more likely they are to diversify. Hence, the more food secure they become.
	-	Nigeria Mexico Ethiopia	(Babatunde et al., 2007) (Cordero-Ahiman et al., 2017) (Gebre, 2012)	Some studies show contrary result. This probably may be that as households' heads gets older they become less productive and hence rely more on gifts and remittances. Also, younger household heads tend to be more energetic and able to engage in many income generating activities than older ones. This in turn increases their food security level.
Education	+	Nigeria South Africa Zimbabwe Bangladesh Ghana Ethiopia	(Asogwa & Umeh, 2012) (Maziya et al., 2017) (Mango, Zamasiya, Makate, Nyikahadzoi, & Siziba, 2014) (Rashid et al., 2011) (Nkegbe et al., 2017)	Education positively affects the income earning capacity of households and their ability to manage resources efficiently and adopt technologies that enhances their productivity. This in turn enhances their food security status.

		Pakistan Kenya India Indonesia	(Gebre, 2012; Tefera & Tefera, 2014) (Bashir, Schilizzi, & Pandit, 2012) (Mutisya, Ngware, Kabiru, & Kandala, 2016a) (Sam et al., 2018) (Diansari & Nanseki, 2015) Endale et al., 2014	
Membership of association	+	Nigeria	(Asogwa & Umeh, 2012)	This could be as a result of the benefits they enjoy by belonging to such associations such as access to information, credit, marketing etc.
Extension services	+	Nigeria	(Asogwa & Umeh, 2012)	Contact with extension agents enhances the chances to better inputs and technologies that increases productivity and hence food security.
Marital Status	+	South Africa	(Maziya et al., 2017)	In most African settings couples play complementary roles in family welfare. Hence it is expected that households headed by married couples should be more food secure than single headed households. Also it could be attributed to the role marriage plays in enhancing access to productive resources such as land.
Access to credit	+ -	Ethiopia Ghana India Ethiopia South Africa	(Bogale & Shimelis, 2009) (Kuwornu et al., 2013) (Sam et al., 2018) (Gebre, 2012) (Maziya et al., 2017)	Credit obtained for consumption improves food security (R. O Babatunde et al., 2007). Also, credit obtained for purpose of production helps households obtain agricultural inputs which boost production and in turn food security. They could also invest it in other income generating activities to improve their livelihood. This could happen in cases where poor households eager to make a living obtain loans from informal institutions at high interest rate.
Farming experience	+	South Africa Nigeria	(Maziya et al., 2017) (Oluyole et al., 2009)	Experience enhances the willingness to take risks associated with technology adoption and more efficient decision-making process as well as the competence level. This in turn improves food security.

Sex (Male headed household)	+ -	India Bangladesh Kenya Nigeria	(Maitra & Rao, 2015) (Rashid et al., 2011) (Kassie, Ndiritu, & Stage, 2014) (Adebayo et al., 2016)	Most studies show that male headed households are able to source on-farm labour and other resources more than female headed household who have higher dependency ratio. Hence, the male headed households tend to be more food secure. Some studies show that female headed households are more secured. This could happen in cases where the men migrate to towns to work and send back remittances to the de factor female headed household which they left behind.
Dependency ratio	-	Kenya Nigeria Ghana	(Mutisya et al., 2016a) (Ojogho, 2010) (Kuwornu et al., 2013)	An increase in the proportion of household members not employed (the aged and children) exerts pressure on the limited resources of households and thereby increases food insecurity.

2.9 Summary and Conclusion

The following conclusion can be drawn from the review of literature:

Climate shocks, environmental degradation and resource conflict have been reported to be serious issues in the study area which affect agriculture. However, no study has been carried out in the study area to investigate the vulnerability of the main livelihood groups (farmers and fishers) to these three stressors in a single study. This presents a knowledge gap this present study intends to fill.

Secondly, Vulnerability has been measured using quantitative and indicator-based approaches. Despite the methodological issues associated with the use of the indicator-based approach it's still widely used as it accounts for multiple interacting factors and stressors and is very easy to

communicate findings to policy makers. Sustainability livelihood framework and IPCC framework are the commonly employed frameworks used in investigating livelihood vulnerability.

Review of literature showed that a number of studies have investigated factors that influence food security and have found factors such as socio-economic, farm characteristics and institutional factors to be significant in influencing food security. However, there is no study that have attempted to investigate how the three stressors (climate shocks, environmental degradation and resource conflict) investigated in this present study affect food security. There is no 'gold standard' to indicators that are used in measuring food security. However, the use of experienced based-measures or scales are increasing becoming popular. This is because it is a more direct measure of food security, captures both physical and psycho-emotional aspects of food insecurity and valid across different socio-cultural context. Hence, the present study will employ the Food insecurity experience scale to measure food insecurity.

Though there exist a number of studies that have investigated the adaptation strategies used by farmers to adapt to climate change, there appears to be scanty studies on adaptation strategies used by fisher folks and factors affecting the adoption especially in the study area, the few studies found were in other countries.

CHAPTER THREE
METHODOLOGY

3.1 Introduction

This chapter begins with an explanation of the theoretical framework underpinning the study. This is followed by a description of the methods of analysis. Finally, the method of data collection is described highlighting the sources of data, sampling procedure adopted in selecting the respondents for the study and description of the study area.

3.2 Theoretical Framework of the Study

3.2.1 Vulnerability assessment using sustainability livelihood framework

The theoretical framework for modeling the livelihood vulnerability assessment is built within the framework of sustainable livelihood. Chambers and Conway (1992) had already provided a definition on the sustainable livelihood as: "A livelihood comprises the capabilities, assets (stores, resources, claims and access) and activities required for a means of living; a livelihood is sustainable when it can cope with and recover from stress and shocks, maintain or enhance its capabilities and assets, and provide sustainable livelihood opportunities for the next generation; and which contributes net benefits to other livelihoods at the local and global levels and in the short and long-term.

Some salient points in the definition are the ability to "recover from stress and shocks" and "maintain and enhance" capabilities and assets into the future. This sustainable livelihood framework provides a holistic approach to understanding how people make a living (Scoones, 1998; Scoones, 2009). At its core is the assessment of the available capital or assets (natural,

human, social, physical and financial) at the disposal of people from which they make a living and an evaluation of the vulnerability context (shocks, stresses, trends and seasonality) in which this capital exists.

The framework is relevant in climate change vulnerability assessment as it provides an understanding of the how livelihoods adapt to shocks, seasonality and trends and how vulnerability can be reduced by making use of capital assets at the disposal of the households. Firstly, it provides understanding as to how livelihood strategies can build adaptive capacity to cope with change in the present and resilience for coping with likely changes in the future. Secondly, it recognizes that different stakeholders are affected by climate change differently and have different adaptive capacity depending on their reliance on and access to capital assets (Carr, 2008; Ziervogel, Bharwani, & Downing, 2006). Thirdly, the framework recognizes the need to tackle underlying causes of weak adaptive capacity such as lack of access to resources (Kelly & Adger, 2000). This is particularly important as the pool of assets at the disposal of individuals or groups from which they make a living is largely dependent on the contextual factors that determine access to them. So, on one hand is availability of these assets or resources and on the other hand is entitlement to draw from these resources.

3.2.2 Theory underlying determinants of adaptation strategies: utility Maximization and protection motivation

For explaining the choice of adaptation strategies adopted by households the utility maximization theory is used. Households are assumed to be rational beings; hence they choose adaptation options that maximize their expected utility among the available options (Amare & Simane, 2017 and

Gebrehiwot & van der Veen, 2013). Assuming that U_i and U_j represents household's utility for any two adaptation options. Following Greene (2000) the random utility model can be stated thus:

$U_{it} = V_{it} + \varepsilon_{it}$, $U_{jt} = V_{jt} + \varepsilon_{jt}$ ……...……...3.1

where U_{it} and U_{jt} are the perceived utility from choosing adaptation option i and j at time t respectively; V_{it} and V_{jt} are the deterministic component and ε_{it} and ε_{jt} are the error terms of the utility function which are independently and identically distributed. Utility cannot be directly observed, it is rather indirectly observed from the choices that households make. Choice experiments assume that a household m chooses an option i at time period t, only if this adaptation option generates at least as much utility as any other option for example j, represented as:

$U_{mit} > U_{mjt,}$ $j \neq i$, …….3.2

The probability of a household m choosing adaptation option i among the available adaptation strategies at time t can then be specified as:

$P_{mit} = P(U_{mit} > U_{mjt),}$ $j \neq i$…… 3.3

The second theory, which has been found to be valuable in explaining adaptive behaviours of individuals to climate change is the protection motivation theory (Cismaru, Cismaru, Ono, & Nelson, 2011). The theory of protection motivation originally postulated by Rogers (1975) and applied in the field of health to explain how individuals are motivated to act in a protective manner towards a perceived health risk. However, it has since been adapted and applied in other context such as environmental risk and natural hazards. For instance, it has been applied to the studies of natural hazards such as earthquake in the United States (Mulilis & Lippa, 1990), and flood in

Germany and the Netherlands (Grothmann & Reusswig, 2006 and Bubeck, Botzen, Kreibich, & Aerts, 2013) and even studies on climate change adaptation (Grothmann & Patt, 2005; Keshavarz & Karami, 2016; Koerth, Vafeidis, Hinkel, & Sterr, 2013; Bockarjova & Steg, 2014). This theory postulates that individuals will act to protect themselves against a perceived risk if they perceive that the threat of that hazard, they are exposed to is severe (threat appraisal) and if the coping appraisal are high. Threat appraisal is composed of two main components: 'perceived vulnerability' (probability) and 'perceived severity' (consequences). Coping appraisal on the other hand consist of three components namely: 'response efficacy', 'self-efficacy' and 'response cost'. The coping appraisal is considered high if individuals perceive the protective measures available to be effective i.e able to mitigate the threat (high 'response efficacy'), easy i.e the individuals perception of their ability to implement the required actions (high 'self-efficacy') and inexpensive (low 'response costs') (Floyd, Prentice-Dunn, & Rogers, 2000). The two appraisal processes influence an individual's protection motivation (Maddux & Rogers, 1983). However, Poussin et al. (2014) found that coping appraisal has a far reaching effect on self-protective bahaviours by individuals than threat appraisal. Grothmann & Reusswig (2006) in their study concluded that it is just not enough to communicate the threat or risk individuals are exposed to (threat appraisal) but the benefits and cost of precautionary measures (coping appraisal) should also be included.

In this study this theory can be adapted to explain the behavior of households to act in a protective manner towards the perceived threat to their livelihoods occasioned by environmental and social factors (climate shock, environmental degradation and conflict). There are two processes. In the first process, 'threat appraisal' the household assesses the threat probability for example of climate shocks and the severity of the damage that will be done say to their food security or income should they choose not to act. The second process is the 'adaptation appraisal' which has 3 components.

The first is the 'perceived adaptation efficacy' which is the perception of the effectiveness of the adaptive action in protecting one from the threat (e.g a judgment that changing of crop variety can protect one from climate shocks). The second component is the 'perceived self-efficacy which refers to the household perceived ability to implement the adaptive action (e.g a household might perceive that they lack the technical skills to implement a particular innovation). The third component is the 'perceived adaptation cost' which refers to the cost of taking the adaptive action (such as monetary, time, effort). Based on the outcome of these two processes the household responds to the threat. Two responses are possible: adaptation and maladaptation, while the former reduces the damage from the threat, the latter increases the damage. Some examples of maladaptive responses are denial of the threat and wishful thinking (Grothmann & Patt, 2005).

3.2.3 Theory for modelling the effect of vulnerability on household food security: household utility model

The theoretical framework for modeling the influence of vulnerability to climate shock, environmental degradation and conflict on the food security status of households is anchored within the framework of farm household model. According to (Singh, Squire, & Strauss (1986) this model postulates that households are both consumers and producers and thus the model is built within the theory of consumer demand and production theories as follows:

$$U_i = u[(C_f, C_{nf})', l_i | x_i] \quad \text{.....3.4}$$

where U_i is a utility function, which is a matrix of household food (C_f) and non-food consumption demand such as education, health, clothing (C_{nf}), time allocated for leisure l_i as well as a matrix

of household socio-demographic variables x_i, which added to illustrate that household utility is a product of combined decision of household members based on their preferences.

Since some households are both producers and consumers of food C_f, can be considered a matrix of food produced and consumed in the home and food purchased from the market and is stated as:

$$C_f = (f_{hp}, f_{mp}) \quad \text{..... 3.5}$$

The generalized utility function can be derived by substituting equation 3.5 into 3.4.

$$U_i = u[\left((f_{hp}, f_{mp})', C_{nf}\right)', l_i | x_i] \quad \text{..... 3.6}$$

Following Singh et al., (1986), the production, income and time constraint imposed in the optimization of equation 3.6 can be stated as follows:

Production constraint

$$F(Y_{hp,}\, L,\ M^0,\ S^0) = 0 \quad \text{..... 3.7}$$

Equation 3.7 is the household production function, Y_{hp} is food produced at home, L is the total labour used on the farm, M^0 is farm size and S^0 is fixed capital.

Income constraint

$$P_{hp}(Y_{hp} - f_{hp}) - P_{mp.}f_{mp} - P_{np.}C_{nf} - w(L - l_f) + N = 0 \quad \text{.....3.8}$$

Where P_{hp} is the price of food produced at home, $Y_{hp} - f_{hp}$ is the surplus of food produced at home which is sold, P_{mp} is the per unit price of food purchased, P_{np} is the per unit price of non-

food item purchased, w is the wage of hired labour, l_f is the total family labour used on the farm and N is the non-farm income.

Time constraint

$$T = l_f + l \quad \text{.....3.9a}$$

$$l_f = T - l \quad \text{.....3.9b}$$

T is the total time available to the household which can either be spent on working on the farm l_f or leisure l. Substituting equation 3.9b into 3.8 we get:

$$P_{hp}(Y_{hp} - f_{hp}) - P_{mp.}f_{mp} - P_{np.}C_{nf} - w(L - T - l) + N = 0 \quad \text{.....3.10a}$$

$$P_{hp}Y_{hp} - P_{hp}f_{hp} - P_{mp.}f_{mp} - P_{np.}C_{nf} - wL + wT + wl + N = 0 \quad \text{.....3.10b}$$

Rearranging equation 3.10b gives:

$$P_{hp}Y_{hp} + wT + N - wL = P_{hp}f_{hp} + P_{mp.}f_{mp} + P_{np.}C_{nf} - wl \quad \text{.....3.10c}$$

Household income household expenditure

The left-hand side is the household income which is made up of the value for food produced ($P_{hp}Y_{hp}$), value of household time endowment (wT), non-farm income (N) and value of labour used on the farm (wL). On the other hand the right hand side is the household expenditure which consist of the value of food produced at home which has been consumed by the household ($P_{hp}f_{hp}$), value of food purchased from the market $P_{mp.}f_{mp}$, value of non-food goods (such as clothing, health, housing, education etc.) purchased by the household ($P_{np.}C_{nf}$), value of money spent on leisure (wl). Considering food consumption or food security as similar to demand

for any other good, it follows that food consumption or food security will be influenced by income, prices, socio-demographic factors and other exogenous factors.

3.3 Methods of Data Analysis

Data collected was analysed using descriptive, statistical and econometric tools in order to achieve the specific objectives. The methods are described in the subsequent sections.

3.3.1 Determining vulnerability levels of the two livelihood groups

The composite index approach was used to calculate the vulnerability index. The IPCC definition which defines vulnerability as a function of exposure, sensitivity and adaptive capacity was adopted as a starting point in operationalizing vulnerability. Eight major indicators were used to operationalize the three main components. The exposure to (1) climate shocks (2) resource conflict and (3) environmental degradation were measured. Sensitivity was measured by considering two sub-components: (1) current state of food, water and health status and (2) physical/natural asset. Adaptive capacity was measured by considering three sub-components: (1) Socio-demographic profile, (2) livelihood income strategies (3) social and political networks. Each sub-component is made up of a number of indicators. Each of these indicators has been selected deductively from review of literature. The practicality of collecting data on each indicator was ascertained through an initial field visit. After the raw data has been collected for each sub-component because different units of measurement were used for each indicator, the first step was standardization to transform each indicator into a uniform scale to allow for comparison and aggregation into a single index. The maximum-minimum standardization technique used by Hahn et al., (2009) was adopted in standardizing the indicators. The formula is stated as:

$$Index_S = \frac{S - S_{min}}{S - S_{max}} \quad \text{.. (3.11)}$$

Where $Index_S$ = standardized indicator for each livelihood group, s = raw data for the indicator for each livelihood group, S_{min}, S_{max} = minimum and maximum value of the indicator. So, the standardized indicators were averaged to get the value for each sub-component using the formula in equation 3.12:

$$M_l = \frac{\sum_{i=1}^{n} index_{s_i}}{n} \quad \text{... (3.12)}$$

Where M_l = one of the eight sub-components for each livelihood group.

$index_{s_i}$= the standardized indicators that make up each sub-component

n = number of indicators in each sub-component.

Equation 3.12 was also used to aggregate the sub-components to get the major components exposure, sensitivity and adaptive capacity. In this case, M_l = one of the three major components for each livelihood group; $index_{s_i}$= the standardized sub-component that make up each major component and n = number of sub-components in each major component.

Finally, the major component was averaged using the formula in equation (3.13) to get the composite vulnerability index.

$$CVI_l = \frac{EP + SN + (1 - AC)}{3} \quad \text{....................................... (3.13)}$$

Where CVI_l = composite vulnerability index; EP= exposure; SN= sensitivity and AC= Adaptive capacity. The adaptive capacity was subtracted from one because it reduces vulnerability. The CVI was scaled from 0 (least vulnerable) to 1 (most vulnerable).

Decision Criteria

Classification into different groups was done following Asante et al. (2012) as follows:

Low vulnerability (CVI <0.33)

Moderate vulnerability (0.33≤CVI<0.66)

High vulnerability (0.66≤CVI≤1.0)

The analytical framework is illustrated in figure 3.1. The analytical framework shows the links between the vulnerability and the three stressors, all the major and sub-components and indicators that make up each sub-component used in operationalizing vulnerability. Also, a summary of the indicators used in computing the composite vulnerability index has been presented in Table 3.1. Table 3.1 gives a definition of all indicators used, the units and the rationale for selecting.

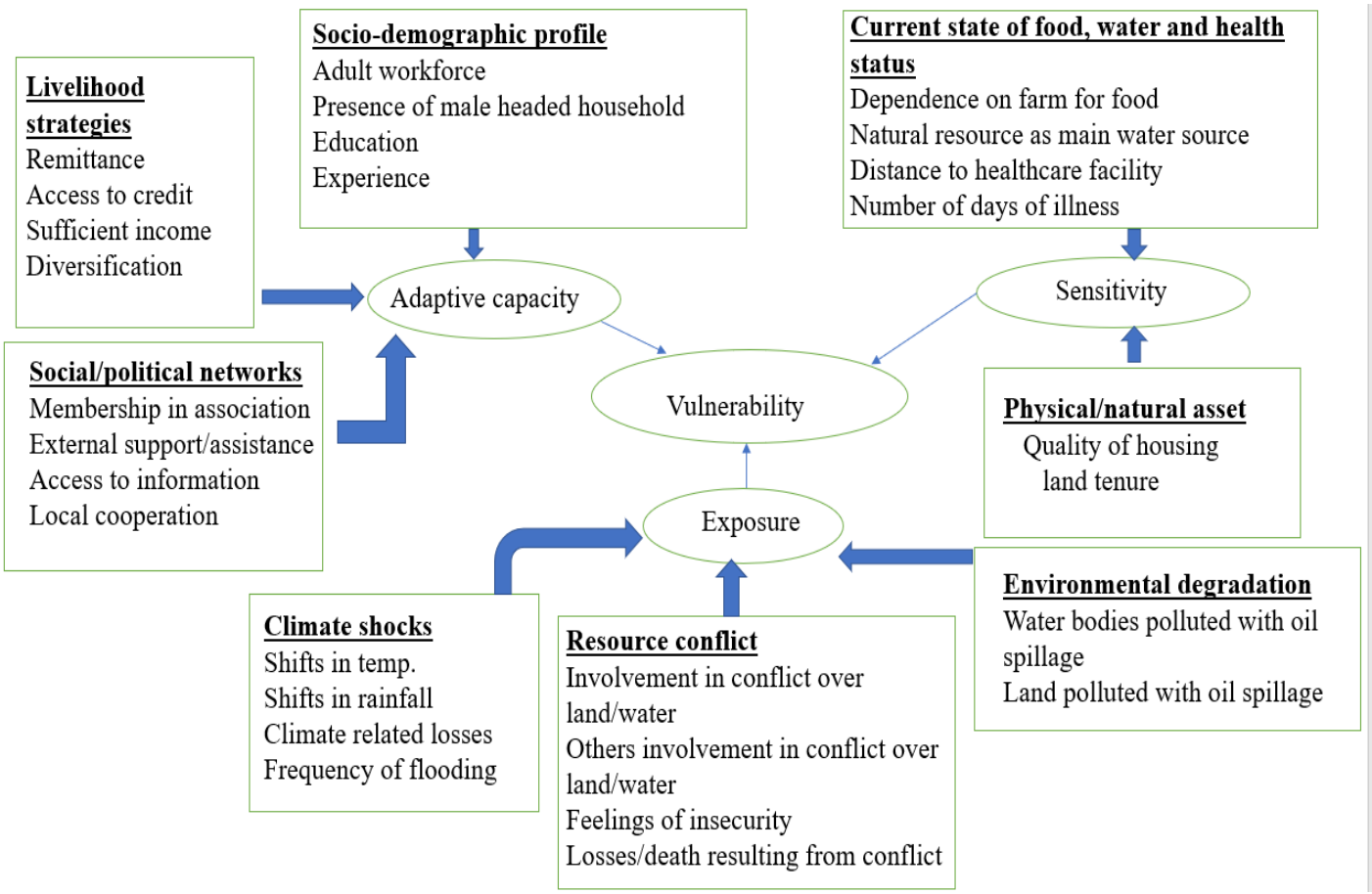


Figure 3. 1 Analytical framework for the vulnerability assessment

Source: Adapted from Okpara et al. (2016)

Table 3.1 Major components and sub-components used in calculating the composite vulnerability index, definition, rationale for their selection and units of measurement

Major component	Sub-component	Explanation of sub-component	Units	Rationale for selecting
Exposure				
Climate shocks	Shifts in temperature	% of households that report long term (>=20years) changes in temperature.	Percent	The perception of local people about climate variability offer insights for adaptation (Tambo and Abdoulaye, 2013). High temperatures and heavy rainfall affect crop productivity and fish catch (Kotir, 2011; Sarr, 2012). The resultant effect of reduced crop productivity and fish catch is low income. Hence, losses are used in this study to capture exposure.
	Shifts in rainfall	% of households that report long term (>=20years) changes in rainfall.	Percent	
	Climate related losses	% of households that report losses as a result of climate variability and flood	Percent	
	Number of floods	Average number of floods reported by households from 2012-2017	Count	
Resource Conflict	Involvement in conflict	% of households that report to being involved in conflict related to land and water resource	Percent	Conflict over resource is a stress factor in vulnerability index (Hahn et al. 2009). This is particularly evident in areas where the livelihood depends solely on the resource, as well as where rivers cross boundaries and institutions vested with the power to oversee the use of it is inefficient (Ludwig et al., 2011). Also, conflict sometimes results in injury, losses and sometimes death. It also has some psychological effect on individuals such as fear and feelings of insecurity.
	Others involvement in conflict	% of households that report to have heard about people fighting over land and water in their community	Percent	
	Feelings of insecurity	% of households that report having a feeling of insecurity in the community	Percent	
	Losses/death resulting from conflict	% of households that report to have suffered injury or death of a family member, relation or friend as a result of conflict.	Percent	
Environmental Degradation	Report on water bodies being polluted	% of households that report that their water bodies were being polluted	Percent	Pollution of water bodies and land with oil often leave the environment degraded with fauna and flora destroyed, biodiversity depleted, aquatic life destroyed and all these results in low productivity and income. It also has health implication for the household.
	Report on land being polluted	% of households that report that their lands were being polluted.	Percent	

	Pollution related losses	% of households that report losses due to pollution.	Percent	
Sensitivity Current state of health, food and water.	Distance to healthcare facility	% of households that report long distance (>=5km) to the health care facility.	Percent	
	Number of days of illness	Average number of days household head was sick and unable to carry out livelihood activities	Count	
	Dependence on farm for food	% of households who depend on farm as the main source of food	Percent	
	Natural resource as main water source	% of households who report stream/river/creek as the main source of water	Percent	
Physical and natural assets	Quality of house	Aggregate index of quality of house**a***.	Count	Households who live in houses that are of low quality are more likely to be affected by any extreme event such as floods or storm which will in turn disrupt their livelihood (Paavola, 2008; Geest and Warner, 2015). Also, households who are unable to access land or rent land are most likely to be sensitive to climate shocks and conflict situation (Butler and Gates, 2012)
	Land tenure	% of households who do not own or can't access land for agricultural purposes.	Percent	
Adaptive capacity Socio-demographic profile	Adult workforce	% of households with members between 15-60 years of age	Percent	In this study we assume that individuals between the ages of 15-60 are active and can engage in income generating activities. In the literature it's been shown that households which are being headed by male, have acquired some level of formal education and have some years of experience are less vulnerable to shocks (Scoones, 2009, Chambers 1992)
	Presence of male headed household	% of households where the head is a male.	Percent	
	Education	% of households where the head had attended at least secondary school	Percent	

	Experience	% of households where head had at least 3 years' experience in farming or fishing	Percent	
Livelihood strategies	Remittance	% of households receiving remittance from household members who live outside.	Percent	Remittances have been reported in the literature as a means of livelihood strategy (Hamza, 2014). Remittance here in in the form of cash and kind.
	Access to credit	% of households who were able to access credit in the last five years	Percent	Access to credit enables households to invest in new livelihood activities or enhance the existing ones.
	Sufficient income	% of households with enough income to cover important expenses	Percent	Making them less vulnerable to stress. Sufficient income are scaled from 1-3 where 1 =insufficient
	Diversification	Average number of income generating activities households are engaged in.	Count	income to cover basic needs; 2=just enough income to cover basic needs and 3=more than enough income to cover basic needs. Basic needs here refer to needs
Social/political network	Association membership	% of households who belong to some group/association	Percent	such as food, water, clothing, shelter, health care and education. The more diverse the household is the less vulnerable they are to stress.
	Access to external assistance	% of households living in communities that are able to access external assistance during difficult times	Percent	Social capital which form part of the adaptive capacity are important assets that households draw upon during difficult times and help reduce vulnerability to climate shocks and other stressors
	Access to information	% of households that report having access to climate information	Percent	(Baird and Gray, 2014; Thomas et. al, 2005).
	Local cooperation	% of households that report enjoying cooperation and support from village folks during difficult times.		

NB: a* was calculated from 4 variables: (i) number of adults who sleep in a room (0=<0.5 rooms per adult, 1=0.5-1 rooms per adult) and the score is scale from 0-1 where 0=insufficient, 1= good; (ii) Quality of walls (0=non-cemented material/mud, 1=corrugated tin, 2=cement/concrete); (iii) Quality of roof (0=straw, 1=corrugated tin) and (iv) Quality of floor (0=wood or non-cemented material, 1=concrete). The index is between 0 and 5.

The aggregate index for the quality of house was created because an increase in the value of this indicator, reduces sensitivity and hence vulnerability (for instance households with more quality house are less vulnerable). In order to capture this line of thought we take the inverse of the indicator which assigns higher value to households with lower house quality. So, household with highest value of 1/ (5+1) = 0.17.

3.3.2 Determining factors influencing choice of adaptation strategies

To identify adaptation strategies employed by the two livelihood groups descriptive statistics such as percentages was employed.

To determine factors influencing choice of adaptation strategies by the two livelihood groups the multinomial logit model was used. The multinomial logit and multinomial probit models are usually used to analyse adoption decision involving multiple choices such as adaptation decisions which are made jointly (Wooldridge, 2002 and Madalla, 1983). The choice of the multinomial logit model over the multinomial probit is because it is computationally easier to calculate the choice probabilities which are expressible in analytical form (Tse, 1987). It provides a suitable closed form for underlying choice probabilities, ruling out the need for multivariate integration and this makes it easy to compute choice situations with several alternatives. The computation is also made easier as a result of its likelihood function which is globally concave (Hausman & McFadden, 1984). The limitation of the model is the independence of irrelevant alternatives (IIA) property. This assumption states that the ratio of the probabilities of choosing any two alternatives is independent of the attributes of any other alternative in the choice set (Hausman & McFadden, 1984; Tse, 1987). Specifically, this assumption means that the probability of using a particular adaptation strategy by a household should be independent from the probability of choosing another adaptation strategy. Hausman test was used to judge the validity of the assumption. The test is based on the fact that if an alternative is irrelevant, removing an alternative or several alternatives from the model should not change the coefficients systematically.

To describe the multinomial logit model let A_i denote a random variable representing the adaptation strategy adopted by any household (already identified). We assume that each household

faces a set of discrete, mutually exclusive options of adaptation strategies. These strategies are assumed to depend on a number of household, institutional, environmental and other attributes X. The multinomial logit model specifies the relationship between the probability of choosing alternative A_i and the set of explanatory variables X as follows (Greene, 2003):

$$Prob(A_i = \text{j}) = \frac{e^{\beta_j x_i}}{1+\sum_{k=1}^{j} e^{\beta_k x_i}}, j = 1,2 \ldots . J \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3.14)$$

In this study the adaptation strategies employed by farmers have been grouped into three namely: soil and water management, crop management and livelihood diversification while adaptation strategies employed by fishermen have been grouped into two: intensification and livelihood diversification. The independent variables used in the model are listed in Table 3.2.

Estimating equation 3.14 gives the J log-odds ratio in equation 3.15

$$\ln\left(\frac{\partial P_j}{\partial x_i}\right) = x_i'\left(\beta_j - \beta_k\right) = x_i'\beta_j, \; if \; k = 0 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3.15)$$

The coefficient β_j, of the multinomial logit model only shows the direction of the effect of the explanatory variable on the dependent variables (adaptation option) and does not provide the actual magnitude of the change or probability. Therefore, differentiating equation (3.14) above with respect to the independent variables gives the marginal effects of the independent variables and is stated thus:

$$\frac{\partial P_j}{\partial x_i} = P_j\left(\beta_j - \sum_{k=0}^{J} P_k \beta_k\right) \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots . (3.16)$$

Marginal effects measure the expected change in the likelihood of a particular adaptation strategy being chosen with respect to a unit change in an explanatory variable from the mean (Greene, 2000). The signs of the marginal effects and respective parameter estimates may vary, this is because marginal effects depend on the sign and magnitude of all other parameter estimates.

Some studies (e.g Amare & Simane, 2017; Atinkut & Mebrat, 2016; Deressa, Hassan, Ringler, Alemu, & Yesuf, 2009; Gunathilaka, Smart, & Fleming, 2018) have adopted the multinomial logit model to assess the determinants of adaptation strategies employed.

Empirical specification of the multinomial model used.

Household socio-economic, institutional, farm level, environmental and location characteristics were hypothesized to influence the choice of adaptation strategies employed. The following explanatory variables were considered in the multinomial model: educational level, household size, age of household head, years of experience in farming/fishing, sex of household head, household income, access to extension services, membership of association, access to information on climate change, access to credit, farm size, perception of shift in temperature, perception of shift in rainfall and location. The empirical model is stated in equation 3.17.

$$\boldsymbol{ADS_i = \beta_0 + \beta_1 Educ + \beta_2 HHsize + \beta_3 Age + \beta_4 Exp + \beta_5 Sex + \beta_6 HHincome + \beta_7 Ext + \beta_8 Asso + \beta_9 Info + \beta_{10} Cred + \beta_{11} Fsize + \beta_{12} Temp + \beta_{13} Rain + \beta_{14} State} \ldots\ldots\ldots\ldots\ldots\ldots \quad (3.17)$$

Where ADS_i denote the adaptation strategies employed by farming or fishing households and $\beta_0 - \beta_{14}$ denotes parameters estimates. A description of the explanatory variables used in the model, the measurement and the apriori expectation has been presented in Table 3.2.

Table 3.2 Description of explanatory variable and hypothesized signs

Variable	Description	Measure	Apriori Expectation
Educ	Years of education	Continuous (years)	+
HHsize	Size of household	Continuous (number)	+/-
Age	Age of household head	Continuous (years)	+/-
Exp	Farming/fishing experience	Continuous (years)	+/-
Sex	Sex of household head	Dummy (1=male, 0=female)	+/-
HHincome	Household income	Continuous (naira)	+
Ext	Access to extension services	Dummy (1=yes, 0=no)	+
Asso	Membership of association	Dummy (1=yes, 0=no)	+
Info	Information on climate change	Dummy (1=yes, 0=no)	+
Cred	Access to credit	Dummy (1=yes, 0=no)	+
Fsize	Farm size	Continuous (heactares)	+/-
Temp	Perception of shift in temperature	Dummy (1=yes, 0=no)	+
Rain	Perception of shift in rainfall	Dummy (1=yes, 0=no)	+
State	Location	Dummy (1=Bayelsa, 0=Rivers)	+/-

Source: Author

Statement of hypotheses

The null hypothesis (H_0) of no effect and alternative hypothesis (H_A)of significant effect of explanatory variable on choice of adaptation strategies employed by farming and fishing group is stated thus:

1. H_0: $\beta_1 = \beta_6 = \beta_7 = \beta_8 = \beta_{10} = \beta_{12} = \beta_{13} = 0$; education of household head, household income, access to extension, membership of association, access to credit, perception of shift in temperature and rainfall have no significant effect on the choice of adaptation strategy adopted by farming ad fishing households;

H_A: $\beta_1 > 0$; $\beta_6 > 0$; $\beta_7 > 0$; $\beta_8 > 0$; $\beta_{10} > 0$; $\beta_{12} > 0$; $\beta_{13} > 0$; education of household head, household income, access to extension, membership of association, access to credit, perception of shift in temperature and rainfall have positive effect on the choice of adaptation strategy adopted by farming ad fishing households;

2. H_0: $\beta_2 = \beta_3 = \beta_4 = \beta_5 = \beta_9 = \beta_{11} = \beta_{14} = 0$; all the other explanatory variable had no significant effect on the choice of adaptation strategy adopted by farming ad fishing households;

H_A: $\beta_2 < 0$; $\beta_3 < 0$; $\beta_4 < 0$; $\beta_5 < 0$; $\beta_9 < 0$; $\beta_{11} < 0$; $\beta_{14} < 0$; all the other explanatory variable had negative effect on the choice of adaptation strategy adopted by farming ad fishing households;

Hypotheses validation and decision criteria

The stated hypotheses were validated using the z-test. The z cal was calculated using the equation 3.18

$$Zcal = \frac{\widehat{\beta}}{SE} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots .. 3.18$$

Where $\hat{\beta}$ are the estimated parameters and S.E denote the respective standard errors. The zcal was then compared with the z tabulated at (n-k) degrees of freedom, where k denotes number of estimated parameters and n represents the number of observations. The decision rule was, if z cal was greater than the z tabulated, then the null hypothesis (H_0) was rejected in favour of the alternative (H_A). On the other hand, if z cal was less than the z tabulated at a determined significant

level, the alternative hypothesis (H_A) was rejected in favour of the null hypothesis (H_0). STATA 14 software was used for the analysis.

3.3.3 Estimating the food security level of the two livelihood groups

The Food Insecurity Experience Scale (FIES) has been recognized as a reliable measure of food insecurity (Ballard, Kepple, & Cafiero, 2013). The FIES is a new, self-reported food insecurity measure based on methodology developed by Food and Agriculture Organization's (FAO) Voices of the Hungry (VoA) project. It is a global version of an experience based food insecurity scale that originated from United states (U.S. Household Food Security Survey Model, HFSSM) and Latin America (Escala Latinoamericana y Caribena de Seguridad Alimentaria, ELCSA) which was a regional initiative in Latin America and Caribbean (Cafiero et al., 2018) (Perez-Escamilla et al, 2007). The FIES has been adopted and validated by FAO not only as a good tool for measuring food insecurity but also could be used in monitoring food insecurity globally (Ballard et al., 2013).

FIES comprises of 8 questions (see table 3.3) that captures the household's behavioral and psychological responses to food insecurity. Out of the four pillars of food security: food availability, food access, food utilization and stability the FIES is designed to capture the food access dimension. The FIES covers three common domains of household food insecurity namely anxiety over food insecurity, insufficient quality and quantity of food (Deitchler, Ballard, Swindale, & Coates, 2011). Some of the advantages of the FIES is that it is a direct measure of food insecurity unlike the other indirect measures such as FAO's prevalence of undernourishment (food balance sheet), measures of food insecurity determinants such as food availability or income (household income and expenditure surveys) and potential outcome such as nutritional status (anthropometry). In addition is timely, easy to apply and low cost.

The theoretical underpinning of the scale is based on the Item Response Theory (IRT) model which is mostly used in the fields of education and psychology to measure "ability' (Cafiero et al., 2018).

Table 3.3 Questions that make up food insecurity experience scale

In the past 12 months was there a time you or any other member of your household
A1. Was worried your household would run out of food because of lack of money or other resources?
A2. Was unable to eat healthy and nutritious food because of lack of money or other resources?
A3. Ate only few kinds of food because of lack of money or other resources?
A4. Ate less than they should eat because of lack of money or other resources?
A5. Ran out of food because of lack of money or other resources?
A6. Skipped a meal because of lack of money or other resources?
A7. Went to bed at night hungry because of lack of money or other resources?
A8. Went a whole day and night without eating anything because of lack of money or other resources?

Source (Ballard et al., 2013)

The single parameter Rasch model which is type of non-linear factor analytic approach is the statistical model used in the estimation of the FIES (Cafiero et al., 2018). The underlying assumption of the Rasch model is that items within the questionnaire are uni-dimensional, continuous and unobservable.

The FIES score is a continuous measure of the level of food insecurity experienced by individuals or households in the past 12 months or 30 days. Each of the question in Table 3.3 is scored 1 when the household answer in the affirmative. The scores of the items is summed up and this ranges from zero to eight (0-8). The higher the score the higher the food insecurity experienced by the household. Households that did not answer on the affirmative to any of the questions score zero (0) and are considered highly food secure. Households that score between one and three (1-3) are categorized as mildly food insecure, those that score between four and six (4-6) are considered

moderately food insecure while those that score between seven and eight (7-8) are categorized as severely food insecure. This is depicted in figure 3.3.

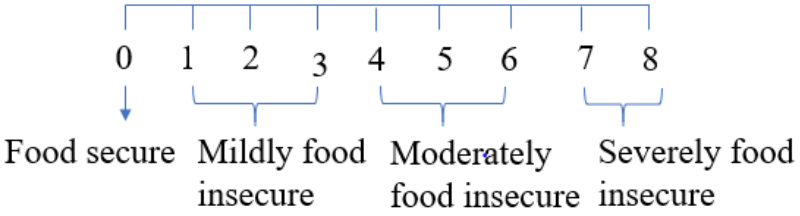


Figure 3. 2 Categorization of the food insecurity scale

3.3.4 determining the effect of vulnerability to the three stressors on food security status

In order to determine the effect of vulnerability to the three stressors on food security status of the farming and fishing households the ordered logit model was employed. The ordered logit model is considered appropriate as it accounts for the ordered nature of the dependent variable. The food security which is the dependent variable has four categories which is ordered. For example, a household in the moderate food insecure category is "worse off" than a household in mild food insecure and highly food secure category but is "better off" than a household in severe food insecure category. According to Greene (2003) the use of ordered logit or probit is an econometric approach when the dependent variable is ordered as in our case.

In the ordered logit there is an observed ordinal variable Y. Y in turn is a function of another continuous variable, Y*, that is not measured. Y* also has different cut off points (thresholds). Let FIS_i denote the observed food insecurity level in household i which is a proxy for the theoretical (unobserved) food insecurity FIS_i^*. The ordered logit model with the latent food insecurity measure FIS* is stated below:

$$FIS_i^* = \beta X_i + \varepsilon_i \quad \text{.....(3.19)}$$

Where i is the individual households, $i = 1,2\ldots.503$, X is the vector of independent variables representing vulnerability indices, socio-economic characteristics, β is the vector of unknown parameters to be estimated, ε_i is the error term which is identically and independently distributed (iid).

Let j represent the number of food insecurity categories which in our study is equal to four (j =1, 2, 3 and 4) and μ_k be the cutoff points (thresholds), since there are four categories three cutoff points will be estimated (k = 1, 2, and 3). Therefore, the relationship between the observed food insecurity FIS_i and latent food insecurity measure FIS_i^* can be represented as:

$$FIS_i = \begin{cases} 1 & if\ \ FIS_i^* \leq \mu_1\ (high\ food\ security) \\ 2 & if\ \mu_1 < FIS_i^* \leq \mu_2\ (mild\ food\ insecurity) \\ 3 & if\ \mu_2 < FIS_i^* \leq \mu_3\ (moderate\ food\ insecurity) \\ 4 & if\ \ FIS_i^* > \mu_3\ (severe\ food\ insecurity) \end{cases}$$

It should be noted that there is no constant. The unknown parameters (β, μ_1, μ_{12} and μ_3) are estimated by the maximum likelihood estimation technique in STATA 14 software. STATA sets the constant to zero and estimates the cut-off points for separating the various levels of food security. The cut-offs can be viewed as constants. The probability of food insecurity category j for a given household i is thus:

$$P(FIS_i > j) = P_{ij} = \frac{e^{(\alpha_j + \beta X_j)}}{1 + \sum e^{(\alpha_j + \beta X_j)}} \quad \text{.....(3.20)}$$

Where α is the constant for the j logit. Other variables in the equation have already been specified above. The marginal effects of changes in the independent variables are computed as specified in the equation below:

$$\frac{\delta prop\left(y=\frac{1}{X}\right)}{\delta_X} = -f\left(\mu_1 - X_\beta\right).\beta \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 3.21$$

$$\frac{\delta prop\left(y=\frac{2}{X}\right)}{\delta_X} = -\left[f\left(\mu_2 - X_\beta\right) - f\left(\mu_1 - X_\beta\right)\right].\beta, \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 3.22$$

$$\frac{\delta prop\left(y=\frac{3}{X}\right)}{\delta_X} = -\left[f\left(\mu_3 - X_\beta\right) - f\left(\mu_2 - X_\beta\right)\right].\beta \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 3.23$$

$$\frac{\delta prop\left(y=\frac{4}{X}\right)}{\delta_X} = f\left(\mu_3 - X_\beta\right).\beta \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 3.24$$

Where 1, 2 3 and 4 are the different categories of food insecurity, f is the cumulative probability function.

One key assumption of the ordered logit model is that the data must satisfy the proportional odds or parallel lines assumption which states that the relationship between two categories in the dependent variable is the same hence the coefficient (β) is the same across different categories of food insecurity (j = 1, 2, 3 and 4), differing only at the cut off points, (μ_1, μ_{12} and μ_3) (Long, 2014 and Train, 2009). There are several tests for this assumption namely Brant, gologit LR, Akaike Information Criterion (AIC), and Bayesian Information Criterion (BIC). In this study this assumption was tested using Brant test in STATA 14. Testing of the overall significance of the model was done using the chi-squared (χ^2) value and the log likelihood ratio criteria which is usually displaced with the regression output.

The estimated model is stated in equation 3.25

$$\boldsymbol{FIS_i = \alpha_0 + \alpha_1 VIn + \alpha_2 Ylog + \alpha_3 Mstat + \alpha_4 Save + \alpha_5 Non\_farm + \alpha_6 DepR + \alpha_7 Store + \alpha_8 help + \alpha_9 Fsize + \alpha_{10} Age + \alpha_{11} HHsize + \beta_{12} State + \beta_{13} LVG + \ldots\ldots\ldots\ldots\ldots\ldots\ldots 3.25}$$

The definition and apriori expectation of the explanatory variables used in the ordered logit model is presented in Table 3.4.

Interpretation of estimated parameters

The sign of the coefficient beta is the same with the sign of the marginal effect for the highest food insecurity category but is opposite the sign of the marginal effect for the lowest category. For the middle category the sign could go either way. For the coefficient only, the sign is interpreted and not the magnitude, the marginal effects are rather used to measure the magnitude of effect. The marginal effect can be interpreted to mean that for a unit increase in the independent variable, the dependent variable is expected to change by the corresponding magnitude while keeping the other variables in the model constant. In this study a significant negative coefficient simply means that a unit increase in the independent variable increases the probability that household will be food secured while a significant positive coefficient means that a unit increase in the independent variable decreases the probability that household will be food secured.

Table 3.4 Description of explanatory variables and hypothesized signs

Variable	Description	Measure	Apriori expectation
Dependent variable			
FIS_i	Food security level	Dummy (0=food secure 1=mildly food insecure 2=moderately food insecure 3=severely food insecure)	
Explanatory variables			
Vin	Vulnerability indices	Continuous	+
Ylog	Logarithm of household annual income	Continuous	-
Mstat		Dummy 0=single, 1= married, 2= others	+/-
Save	Households saves with formal institutions.	Dummy 1=yes, 0=no	-
Non_farm	Engagement in non-farm or non-fishing job	Dummy 1=yes, 0=no	-
DepR	Dependency ratio	Continuous	+
Store	Households store food	Dummy 1=yes, 0=no	-
Help	household receive help during difficult times	Dummy 1=yes, 0=no	-
Fsize	Total farm size cultivated (hectares)	Continuous	-
Age	Age of household head	Continuous	-
HHsize	Household size	Continuous	+/-
State	Location of household	Dummy 1=Bayelsa; 0=Rivers	+/-
LVG	Livelihood group	Dummy 1=Farming households, 0=Fishing households	+/-

Source: Author

NB: Single, Rivers and farmers are the omitted base category.

Statement of hypotheses

The null hypothesis (H_0) of no effect and alternative hypothesis (H_A)of significant effect of explanatory variable on food security level of the farming and fishing household is stated thus:

1. H_0: $\alpha_1 = 0$; vulnerability to the three stressors had no significant effect on the food security level of households; There is no significant difference between vulnerability to the three stressors and the food security level of households;

H_A: $\alpha_1 > 0$ vulnerability to the three stressors had positive effect on the food security level of households; There is a positive relationship between vulnerability to the three stressors and food security level of households;

2. H_0: $\alpha_{13} = 0$; there is no significant difference in the food security level of farming and fishing households;

H_A: $\alpha_{13} > 0$; there is a significant difference between the food security levels of farming and fishing households;

Hypotheses validation and decision criteria

The stated hypotheses were validated using the z-test which is states in equation 3.26

$$Z = \frac{\widehat{\alpha}}{SE(\alpha)} \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots 3.26$$

Where $\hat{\alpha}$ are the estimated parameters and SE (α) denote the respective standard errors. The zcal was then compared with the z tabulated at (n-k) degrees of freedom, where k denotes number of estimated parameters and n represents the number of observations. The decision rule was, if z cal was greater than the z tabulated at a determined significant level, then the null hypothesis (H_0) was rejected in favour of the alternative (H_A). On the other hand, if z cal was less than the z tabulated, the alternative hypothesis (H_A) was rejected in favour of the null hypothesis (H_0). STATA 14 software was used for the analysis.

3.4 Methods of Data Collection

3.4.1 Sources of data and instruments employed

Both secondary and primary data were collected for the study. The secondary data on temperature and rainfall was collected from the Nigerian Meteorological Agency (NIMET). The primary data on quantitative information was obtained from households of farmers and fishermen. Structured questionnaires were employed. The questionnaire was first pre-tested and modification done before the final data collection. The questionnaires were administered by the researcher and three trained enumerators between March and April, 2018. Questions were asked on all the relevant variables such as socio-economic characteristics, production input and output data, household assets, income and expenditure, environmental degradation, conflict, climate data, food security issues and adaptation issues. A sample questionnaire is attached as Appendix I.

3.4.2 Sampling procedure

A multi-stage sampling technique was used in selecting the households used in the study. In the first stage 2 states were purposively selected out of the nine states due to their dependence on farming and fishing, prevalence of conflict, pollution activities of oil companies which degrade

the soil and water bodies and the coastal nature of the states which predisposes it to frequent flooding and coastal erosion. In the second stage 13 local government areas (LGAs) out of 23 LGAs was selected from Rivers state purposively due to predominance of agricultural activities and 4 LGAs out of 8 LGAs was selected from Bayelsa state. In the third stage proportional random sampling was used to select 18 and 8 communities from the selected LGAs in Rivers and Bayelsa states respectively. In the fourth stage, it involves clustering into 2 main agricultural livelihood activities contributing to income (farming and fishing). Proportional random sampling was used in selecting the 251 farming households and 252 fishing households. In total of 503 household heads were interviewed and where the household head was not available the next available adult was interviewed.

The United Nations (2005 p. 44-45) sample size formula was used to determine the number of households to be selected for the study. Using confidence interval (Z) of 95%, 50% default value of prevalence of indicators (r), sample size of 430 households was required. However, account for missing values and outliers the sample size was increased to 503. The formula is stated below:

$$N = \frac{[(Z^2)(r)(1-r)(f)(k)]}{[(p)(n)(e^2)]} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 3.27$$

Where: N= sample size,

Z = confidence interval (95% level is 1.96),

r = estimate of key indicators being measured (default value is 0.5),

f = sample design effect (has a default value of 2),

k = multiplier accounting for non-response (1.1),

p= proportion of the total population accounted for by the target population (0.4),

n = mean of household size (5),

e = precision level (10% precision level equals 0.01r)

Table 3.5 Sample size distribution

State	Local Government Area (LGA)	Community	Number of households		Type of community
Rivers	Akuku-Toru	Abonema	20	20	Fishing
	Asari-Toru	Buguma	37	37	Fishing
	Degema	Degema	24	24	Fishing
	Okrika	Aboloma	12	30	Fishing
		Okrika	18		Fishing
	Eleme	Eteo	10	10	Farming
	Emohua	Ndele	20	20	Farming
	Etche	Umunkwe- ulakwo	20	20	Farming
	Gokana	Bidare	12	20	Farming
		Kpo	8		Farming
	Ikwerre	Isiokpo	10	10	Farming
	Khana	Kani	10	20	Farming
		Sugo	10		Farming
	Oyigbo	Oboma	10	10	Farming
	Ogu/Bolo	Bolo	6	13	Farming
		Ogu	7		Farming
	Tai	Kira	15	15	Farming
Total				**249**	
Bayelsa	Yenagoa	Akpide Biseni	39	119	Dual
		Ikibiri	50		
		Polaku	4		
		Zarama-nyambiri	26		
	Kolokuma/Opokuma	Kiama	34	64	
		Koroama	30		
	Sagbama	Ogobiri	40	40	
	Ogbia	Abobiri	26	31	
		Ogbia town	5		
Total				**254**	
Grand total				**503**	

Source: Field survey (2018)

3.4.3 Description of the study area

The study area is Niger Delta region. It is located on latitude 4° 25' N to 6° 00' N and longitudes 5° 00' E to 7° 5' E (Ogbonna et al., 2017). It is situated in the Atlantic Coast of southern Nigeria where River Niger divides into many branches (Uyigue and Agho, 2007). It is the second biggest delta in the world having a coastline covering around 450 kilometers which ends at the mouth of Imo River (Awosika, 1995). The region extends to over 20,000 square kilometers and is the biggest wetland in Africa and is one of the three largest and richest wetlands in the world (CLO, 2002; Ijayi, 2004). Around 2,370 square kilometers of the Niger Delta area is made up of rivers, creeks and estuaries and while stagnant swamp spans about 8600 square kilometers. It has the largest mangrove swamps in Africa which covers around 1900 square kilometers (Awosika, 1995). The region is found in the tropical rain forest zone having rich ecosystem that supports varieties of plant and animal species (World bank, 1995). The region is divided into four ecological zones namely coastal inland zone, mangrove swamp zone, freshwater zone and lowland rain forest zone (ANEEJ, 2004).

There have been a lot of controversies over which states make up the Niger Delta region. However, the Niger Delta region officially comprises of nine states namely Abia, Akwa Ibom, Bayelsa, Cross River, Delta, Edo, Imo, Ondo and River States. It has about 185 local government areas (LGAs) and over 40 ethnic groups in an estimated 3000 communities (Idemudia, 2009) (Omeri et al. 2014). The region has an estimated population of about 30 million (NPC, 2009) majority of which depend on fishing and farming as a means of livelihood. The region accounts for all the oil and gas exported from the country of which 80% of the revenue of Nigeria comes from (Obi, 2009). However, it is the least development region with poverty and unemployment level higher than the national average and lacking basic infrastructures such as electricity, healthcare facilities, roads,

tap water (NDDC, 2004). Figure 1 below shows the map of Nigeria depicting the states in the Niger Delta region

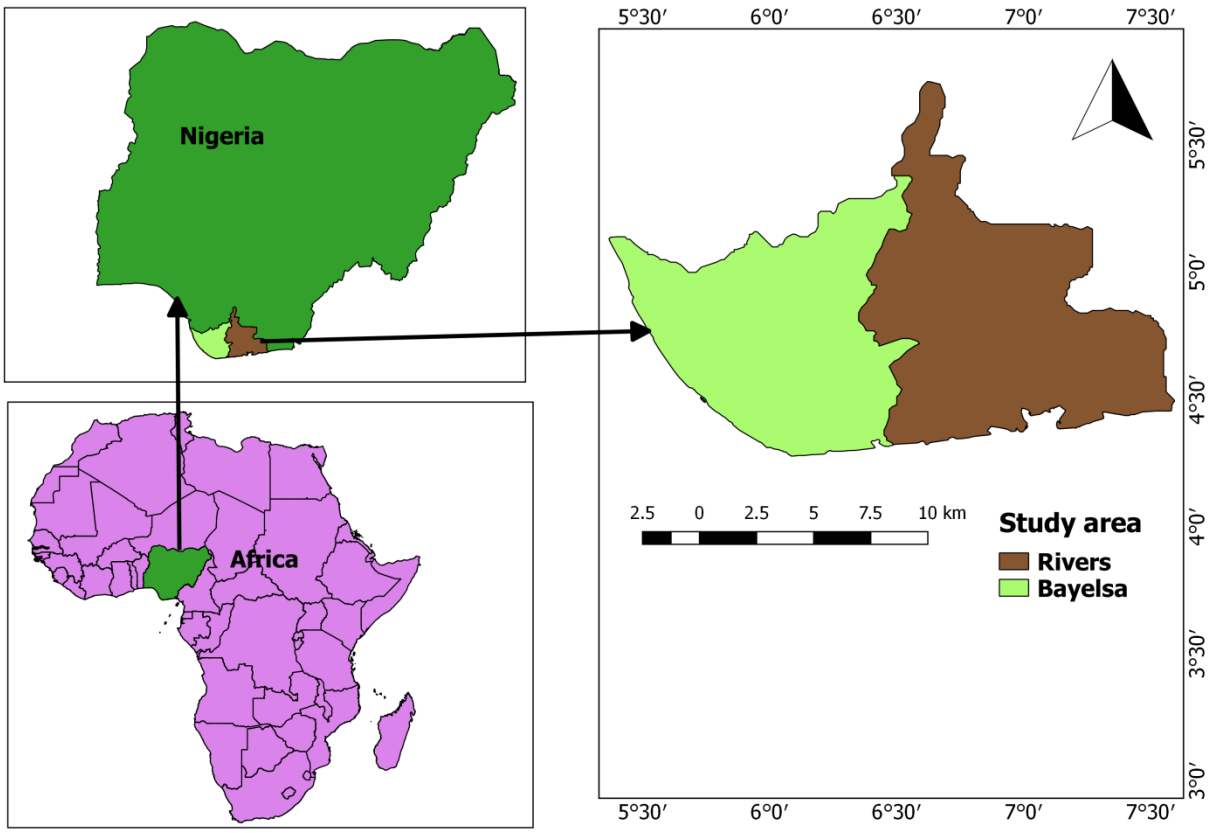


Figure 3. 3 Map of Nigeria showing the study area.

5.5 Scope and Limitation of the Study

The study was limited to only two states out of the 9 states that make up the Niger Delta region. This is due to the prevalence of the three stressors climate shocks, environmental degradation and conflict in these two states. As with any index approach, there is need for carefulness in interpreting

results as indicators and indices can conceal fundamental multidimensional realities driving vulnerabilities. Despite these limitations, the findings of this thesis provide a comprehensive view of the vulnerability and food security situation of agricultural households in the study area.

CHAPTER FOUR
RESULTS AND DISCUSSION

4.1 Introduction

This chapter presents and discusses the results of the study. The first section presents the socio-economic characteristics of the respondents. The vulnerability results are discussed in section two. Section three presents the adaptation strategies employed by the farming and fishing households and factors influencing their choice of adaptation strategies. The final section presents the effects of vulnerability on the food security status of farming and fishing households.

4.2 Socio-economic Characteristics of Respondents

The socio-economic characteristics considered in this study include: sex, age, level of education, household size, marital status, membership of association, access to health care and extension services, number of years of experience in farming/fishing and participation in off-farm work. A summary of the socioeconomic characteristics is shown in Table 4.1. Majority (62.4%) of the households sampled were headed by males. This may be explained by the patriarchal nature of the communities sampled. The strenuous nature of the fishing occupation could as well explain the dominance of male in the fishing households. The females are mainly involved in processing and marketing of the fish. Majority (77.3%) of the sampled household heads were married. A few (3%) of the sampled households head had no formal education, the remaining 96.6% had one form of formal education or other; the average years of schooling was 9 years. Generally, education enhances technology adoption, skill acquisition and reduces vulnerability of agricultural households. Majority of the sampled households had no access to extension services (94%), credit

Table 4.1 Socio-economic and demographic profile of farming and fishing households

	Full Sample		Farmers		Fishers		Mean	SD	Min.	Max
	Freq.	(%)	Freq.	(%)	Freq.	(%)				
Total number of respondents	503	100	251	49.9	252	50.1				
Sex										
Male	314	62.4	98	39.0	216	85.7				
Female	189	37.6	153	61.0	36	14.3				
Marital status										
Married	389	77.3	184	73.3	205	81.4				
Single	47	9.3	21	8.4	26	10.3				
Widowed	46	9.2	32	12.8	14	5.6				
Separated	13	2.6	9	3.6	4	1.6				
Divorced	8	1.6	5	1.9	3	1.2				
Level of education/years of schooling							9.1	4.5	0	18
None	17	3.4	9	3.6	8	3.2				
Primary	199	39.6	85	33.9	114	45.2				
Secondary	174	34.6	84	33.5	90	35.7				
Tertiary	91	18.1	56	22.3	35	13.9				
Adult education	22	4.4	17	6.8	5	1.9				
Access to extension service										
Yes	30	6.0	21	8.4	9	3.6				
No	473	94.0	230	91.6	243	96.4				
Membership of Association										
Yes	54	10.7	37	14.7	17	6.8				
No	449	89.3	214	85.3	235	93.2				
Access to credit										
Yes	62	12.3	37	14.7	25	9.9				
No	441	87.7	214	85.3	227	90.1				
Access to health care										
Yes	398	79.1	226	90.0	172	68.2				
No	105	20.9	25	10.0	80	31.8				
Off-farm work										

Petty trader	53	10.5	39	15.5	14	5.6				
Artisan	72	14.3	39	15.5	33	13.1				
Salaried employee	43	8.6	28	11.2	15	6.0				
Transport	27	5.4	10	4.0	17	6.8				
Food processor	45	9.0	37	14.7	8	3.2				
labourer	18	3.6	8	3.2	10	4.0				
Age (years)							47.8	12.6	19	90
Household size							7.4	2.6	1	14
Experience (years)							25.0	13.8	1	80
Farm size (ha)							0.3	0.5	0	3.6
Gross annual income (‘000₦)							698.8	632.6	15	3792
Distance to health care facility (km)							2.8	3.1	0.5	10
Distance to water source (km)							5.2	4.0	0.5	5

Source: Field Survey (2018)

NB: 1$= ₦ 380

(87.7%) and do not belong to any farmer/fisher-based association (89%). About 79% of the sampled population had access to health care and 51.3% of the sampled households were engaged in off-farm work. On the average the households sampled had heads aged 48 years, with household size of 7, farming or fishing experience of 25 years, farm size (for farmers) of 0.3 hectares and gross annual income of ₦698,955.8 ($1,839). It should be noted that $1 is equivalent to ₦380 at the time of survey. The average distance to health care facility and water sources were 2.8km and 5.2km respectively.

4.3 Vulnerability Level of Livelihood Groups to Climate Shocks, Environmental Degradation and Resource Conflict

4.3.1 The results on the composite vulnerability index.

The computed values for the various indicators used in computing the composite vulnerability index has been presented in Table 4.2 and Table 4.3. In the exposure component the farmers had higher exposure to climate shocks having an index of 0.60 while their fishing counterparts had an index of 0.45 all statistically significant at 1% significance level. This is observed from the higher value of the indicating variables shifts in temperature, rainfall, climate related losses and number of flooding reported by the farmers. The higher number of farmers reporting shifts in temperature and rainfall relative to fisher folks could be because any shift in temperature and rainfall seem to affect farming more than fishing. And this also explains why more farmers report losses resulting from climate shocks than the fishers, as well as higher number of floods. The floods affect farming and fishing differently. Fishing households seem to like the flood as it increases their catch and the variety of fish caught is more.

The resource conflict index was statistically significantly (1%) higher for farmers (0.35) than the fishers (0.22). The farmers were more involved in conflicts over land (0.18) than their fishing counterpart (0.17). The less involvement of the fishers in conflict over land and water resource could be linked to the fact than most of the fishers do not require land for farming; only a few (16.7%) of them are engaged in farming. Fishing households engage in off-farm activities such as trading, salaried employment and food processing to support income from fishing. Also, most of the water bodies where they fish are open to anyone who wants to fish. Hence, there is no struggle for fishing space. The result on land/water conflict index show higher values for farmers (0.40) than fishers as most of the farmers reported witnessing other people in the community being involved in conflict over land. The feeling of insecurity index for the fishers (0.25) was higher than the farmers (0.14) probably because of the volatility (in terms resource conflict) of some of the fishing communities visited (Degema, Buguma and Abonima). In the conflict related losses index, the farmers showed more vulnerability with a higher score of (0.68) than fishers which score (0.29). This is not surprising as the farmers reported being more involved in conflict relating to land than the fishers. The losses incurred by the farmers include destruction of their crops, properties, injury, money spent in treatment of injuries and even death in some cases.

The farming households had higher score (0.56) than the fishing households (0.51) on the environment degradation component, though this is statistically not different. The reason for the higher score was because more farmers reported higher incidences of land pollution (0.59) and pollution related losses (0.59) than fishers (0.29) and (0.49) respectively. Even though the incidences of land pollution reported by fishing households was low, they reported higher incidences of water pollution (74.2%) than the farming households (48.6%).

About 35.6% of farming households reportedly travel long distances of 5km and above to health care facility while 39.7% of fishing households reported travel long distance to health care facility. The average number of times the farming households were sick and unable to carry out their

Table 4.2 Computed values of livelihood vulnerability indices for farming and fishing households.

Major components	Sub-components	Indicators	Pooled Sample		Farmers		Fishers	
			Raw score	Standardized value	Raw score	Standardized value	Raw score	Standardized value
Exposure	Climate shocks			0.53		0.60		0.45
		Shifts in temperature	77.7	0.78	87.3	0.87	68.3	0.68
		Shifts in rainfall	63.6	0.94	74.1	0.74	53.2	0.53
		Climate related losses	56.5	0.57	67.3	0.67	45.6	0.46
		Average number of floods	0.87	0.12	0.90	0.13	0.85	0.12
	Resource conflict			0.29		0.35		0.22
		Involvement in conflict	17.5	0.18	18.3	0.18	16.7	0.17
		Reports on land/water conflict	29.6	0.30	40.2	0.40	19.0	0.19
		Feelings of insecurity	19.1	0.19	13.5	0.14	24.6	0.25
		Losses/death resulting from conflict	48.1	0.48	67.7	0.68	28.7	0.29
	Environmental degradation			0.53		0.56		0.51
		water bodies polluted	61.4	0.61	48.6	0.49	74.2	0.74
		land polluted	43.7	0.44	58.9	0.59	28.6	0.29
		Pollution related losses	54.1	0.54	59.4	0.59	48.8	0.49
Sensitivity	Health, food and water status			0.28		0.31		0.24
		Distance to healthcare facility	37.8	0.38	35.9	0.36	39.7	0.40

		Average number of days household head was ill.	1.21	0.08	1.23	0.08	1.2	0.08
		Dependence on farm for food	46.5	0.47	69.3	0.69	23.8	0.24
		Natural resource as main water source	18.3	0.18	11.6	0.12	25	0.25
	Physical and natural assets			0.27		0.11		0.43
		Index of house quality	0.34	0.21	0.17	0.34	0.34	0.21
		Land tenure	33.6	0.34	1.2	0.01	65.9	0.66
Adaptive capacity	Socio-demographic profile			0.75		0.70		0.80
		Adult workforce	83.5	0.84	81.7	0.82	85.3	0.85
		Presence of male headed household	62.4	0.62	39.0	0.39	85.7	0.86
		Education	55.3	0.55	59.4	0.59	51.2	0.51
		Experience	97.8	0.98	98.0	0.98	97.6	0.98
	Livelihood income strategies			0.28		0.33		0.23
		Remittance	30.2	0.30	37.8	0.38	22.6	0.23
		Access to credit	12.3	0.12	14.7	0.15	9.9	0.09
		Income sufficient to cover expenses	48.7	.49	53.8	0.54	43.7	0.44
		Diversification	1.60	0.20	1.7	0.23	1.5	0.17
	Social network			0.31		0.35		0.28

	Association membership	10.7	0.11	14.7	0.15	6.7	0.07
	Access to external assistance	23.5	0.23	28.4	0.28	18.7	0.19
	Access to information	49.3	0.49	49.0	0.49	49.6	0.50
	Local cooperation	41.6	0.42	46.6	0.47	36.5	0.37

Source: Field survey (2018)

*Maximum and minimum values of the indicators were 100 and 0 respectively except for average number of floods, average number of days household head was ill, index of house quality and diversification which had maximum values of 7, 15, 0.17 and 4 respectively and minimum values of 0, 0, 0.34 and 1 respectively.

Table 4.3 Indexed major and sub- components, overall composite vulnerability scores and test of means for farmers and fishermen

Major and sub-components	Number of indicators	Values of major and sub-components			T-test
		Pooled sample	Farmers	Fishers	
Exposure		0.45	0.50	0.39	5.37***
Climate shocks	4	0.53	0.60	0.45	6.41***
Resource conflict	4	0.29	0.35	0.22	4.56***
Environmental degradation	3	0.53	0.56	0.51	1.57
Sensitivity		0.28	0.21	0.34	-10.54***
Health, food and water status	4	0.28	0.31	0.24	3.92***
Physical and natural assets	2	0.27	0.11	0.43	-20.53***
Adaptive capacity		0.45	0.46	0.44	1.33
Socio-demographic profile	4	0.75	0.70	0.80	-5.98***
Livelihood income strategies	4	0.28	0.33	0.23	4.66***
Socio-political network	4	0.31	0.35	0.28	3.04***
Composite vulnerability index (CVI)		0.43	0.42	0.43	-1.31

Source: Field survey (2018)

livelihood activities were the same with the fishing households. Almost 69% of the farming households depend on farm as their main source of food while 23.8% of fishing households depend on farm as their main source of food. The greater percentage of the fishing household purchase their food. About 25% of the fishing households depend on only natural water source such as stream/rivers and lakes as their only source of water while only 11.6% of farming households depend on only natural water source for their water supply. A greater percent of them have other water source such as pipe borne water which could be private pump or community pump, boreholes and wells. The aggregate score for the sub-component health, food and water status is higher (0.31) for the farming households than the fishing households (0.24).

The physical and natural assets sub-component is comprised of two indicators house quality index and land tenure/access. The farming household and fishing household share a similar house quality index of 0.20 and 0.21 respectively. The maximum value of the index was 1 and the minimum

0.17. It should be noted that households with higher value of index were more vulnerable. Majority of the households live in cement houses with iron sheets used as roofing material and on the average had two adults sleeping in a room. Only a small percentage (1.2%) of the farming households reported not to have access to land for their farming while 65.9% of the fishing households reported not to have access to land for farming. Most of the lands owned by the farming households are privately owned with some of them renting. On the overall the physical and natural assets sub-component for the fishing households was higher (0.43) than that of the farming households (0.11). This means that the fishing households were more vulnerable with respect to the sensitivity sub-component compared to the farming households (statistically significant at 1%).

About 81.7% of the farming households had adult workforce comprising of ages between 15 years and 60 years that could engage in income generating activities while 85.3% of the fishing households had adult workforce. About 39% of the farming household heads were males while 85.7% of the fishing households head were males. This is not surprising looking at the tedious nature of the fishing business. About 59.4% of the farming household heads were educated at least up to secondary school while 51.2% of the fishing household heads were educated. Education is important as it enhances the adoption of improved technologies and skills that increases the overall productivity of the farming and fishing households. About 98% of the farming household heads had at least farming experience of 2 years while 97.6% of fishing households had at least fishing experience of 2 years. Overall, the farming households were more vulnerable on the socio-demographic profile component (0.70) than their fishing counterparts who had a score of 0.80. It should be noted that higher score means higher adaptive capacity which reduces vulnerability.

About 62.2% of farming households reported not to have received remittances from family members or friends living and working outside the community while 77.4% of the fishing households reported not to have received remittances. Majority of the farming (85.7%) and fishing (93.3%) households had no access to credit for their livelihood activities. About 53.8% of the farming households reported that their income was enough to cover important expenses such as food, water, shelter, education and health while 43.7% of the fishing households reported that their income covered important expenses. The farming households on the average engaged in more livelihood activities (1.7) than the fishing households (1.5). Overall, the fishing households were more vulnerable with a lower livelihood income strategies score of 0.23 than the farming households with a score of 0.33.

Majority of the farming (85.3%) and fishing households (93.3%) reported not belonging to any association. About 71.6% of the farming households and 81.3% of the fishing households received external support in difficult times. The percentage of households that reported to have access to information on climate are similar for the two groups 49% for farming households and 49.6% for fishing households. The medium through which they access this information are mostly (97%) through the radio. About 46.6% of the farming households reported local cooperation in the communities where they lived during difficult times while 36.5% of the fishing households reported local cooperation. On the socio-political network component, the fishing households are more vulnerable with a score of 0.28 than the farming households which scored 0.35. This is so because socio-political network reduces vulnerability.

The results of the sub-components are presented in the radar chart in Figure 4.1 shows that farming households were more vulnerable in relation to all the exposure components (climate shocks,

resource conflict and environmental degradation), one of the sensitivity components (health, food and water status) and one of the adaptive capacity components (socio-demographic profile). The fishing households were more vulnerable in relation to one of the sensitivity components (physical and natural assets) and two of the adaptive capacity components (livelihood income strategies and socio-political network). Overall the farming and fishing households share a similar vulnerability score of 0.42 and 0.43 respectively indicating moderate vulnerability to climate shocks, environmental degradation and resource conflicts.

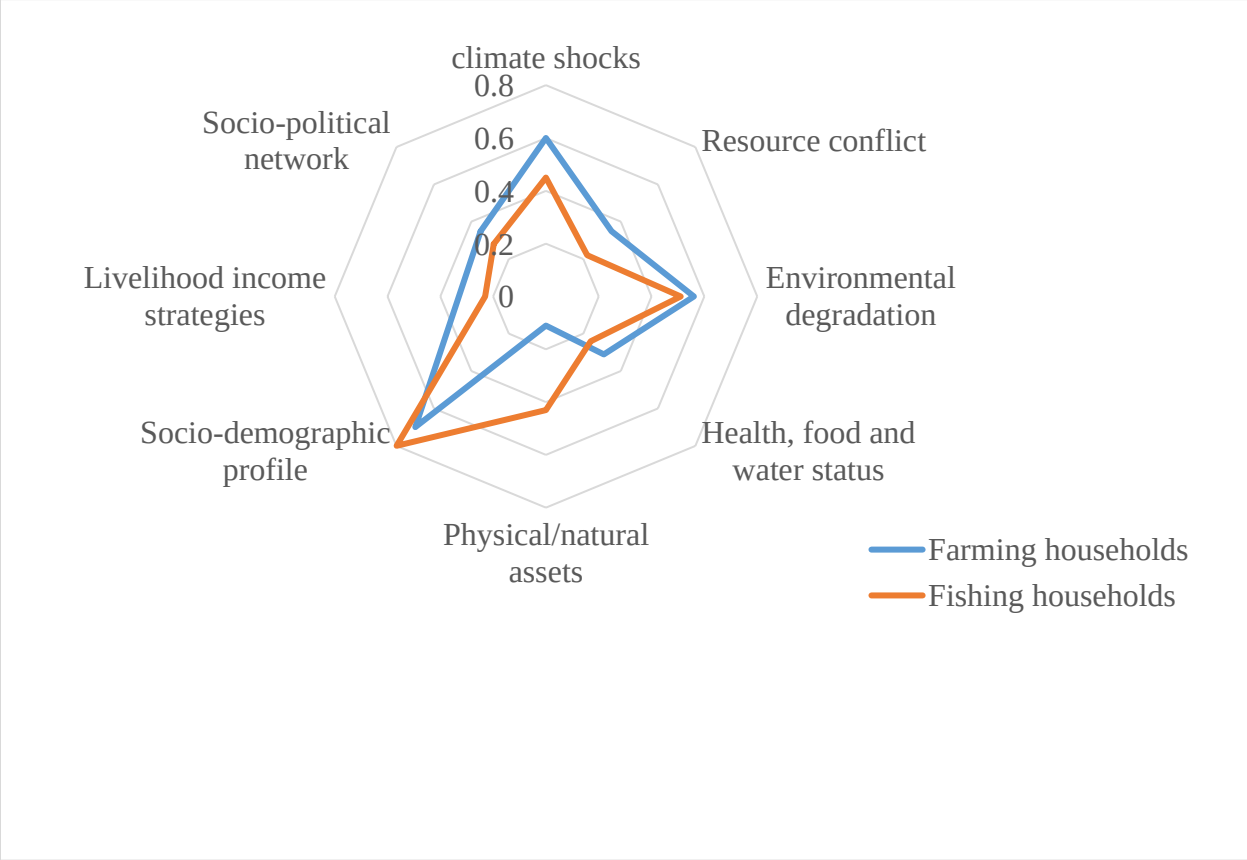


Figure 4. 1 Vulnerability radar chart of sub-components of composite vulnerability index for fishing and farming households

4.3.2 Discussion of vulnerability results

Climate shocks which is reflected in variability in rainfall and temperature, resource-use conflict in terms of water and land and environmental degradation defined in terms of water and land degradation are prevalent livelihood stresses in the Niger Delta region of Nigeria, often interacting together to alter the livelihood of natural resource dependent households. In this study the indicators used in computing the composite vulnerability index give us useful information as to the factors that contribute to the vulnerability of the farming and fishing households to climate shocks, environmental degradation and resource conflict. This in turn helps the policy makers to know which indicators to target in order to reduce vulnerability. For instance, variability in temperature and rainfall, climate and conflict related losses are key stressors that impact on livelihoods of, especially, farming households in the study. The fishing households were more vulnerable to environmental degradation of their water bodies being polluted, resulting in low fish catch. The farming households also reported that their lands were being polluted and are experiencing losses resulting from the pollution. Despite their vulnerability to these stresses they have high socio-demographic profile such as education, experience and adult workforce which builds into their adaptive capacity.

It should also be noted that although a higher percentage of farming households reported shifts in temperature, rainfall and absolute number of flooding it may not be the case since the farming and fishing households are both located in the same area. The data on shifts in temperature and rainfall are subject to recall bias since households that are more affected by these shifts are likely to report any shifts in temperature and rainfall than those less affected. A more appropriate method would have been to use rainfall and temperature data for the area but unfortunately the Bayelsa

metrological station is a new station and so do not have rainfall and temperature data that dates back to 1987 or even 1997, and using only climate information from Port-Harcourt meteorological station located in Rivers state and which is the closest station to Bayelsa state would not introduce any variability in data.

Even though the farming households reported most of the conflicts recorded, the fishing households felt more insecure than the farming households. The over dependence on farm for food by farming households could explain the reason why farmers reported experiencing climate related losses more than the fishing households.

Although both farming and fishing households scored low in the livelihood income strategies index, the fishing households were worst off. This is because majority of them dependent only on fishing with only 46% engaging in other activities such as artisan and transport. The farming households were more diversified (62.6%) engaging mainly in trading, artisan and food processing. The fishing household also received little remittances and credit for the fishing activity. All these translate to their reporting of not having enough income to cover important expenses. However, the fishing households had on the average a higher annual gross income of ₦786, 653 ($2,070) than the farming households which had an annual gross income of ₦ 610,908.5 ($1,608). So, their reporting not having enough income to cover important expenses could be because of the erratic nature of their catch. Some days they catch plenty of fish and at other days they catch little or nothing; and this means that their income was prone to some fluctuations.

The index of the social/political network was low with fishing households scoring the least. Only a small fraction of them belonged to any formal association (6.7%) and received external assistance during difficult times (18.7%). Social capital is important as it helps reduces vulnerability to

stresses as households can leverage on it in times of difficulty. Membership of association facilitates local bonding and access to credit and information. Their inability to organize themselves into groups could be part of what is contributing to their lack of access to credit which is generally reported in the study area.

Figure 4.2 shows the values for the major components and the overall composite vulnerability index (CVI) of the farming and fishing households. The figure shows that although the farming households were more exposed to the triple stressors the fishing households were more sensitive to the stressors specifically owing to their poor physical and natural asset base relative to the farming households and this made them more vulnerable. On the other hand, the farming households were less sensitive because relative to the fishing households they were better off in health, food and water status. However, the two groups have almost similar adaptive capacity, 0.46 and 0.44 for farming and fishing households respectively. Overall, both groups have almost the same vulnerability score, 0.42 and 0.43 for farming and fishing households respectively. There is no statistical difference in the adaptive capacity and vulnerability of farming and fishing households (refer to Table 4.3 for t-test).

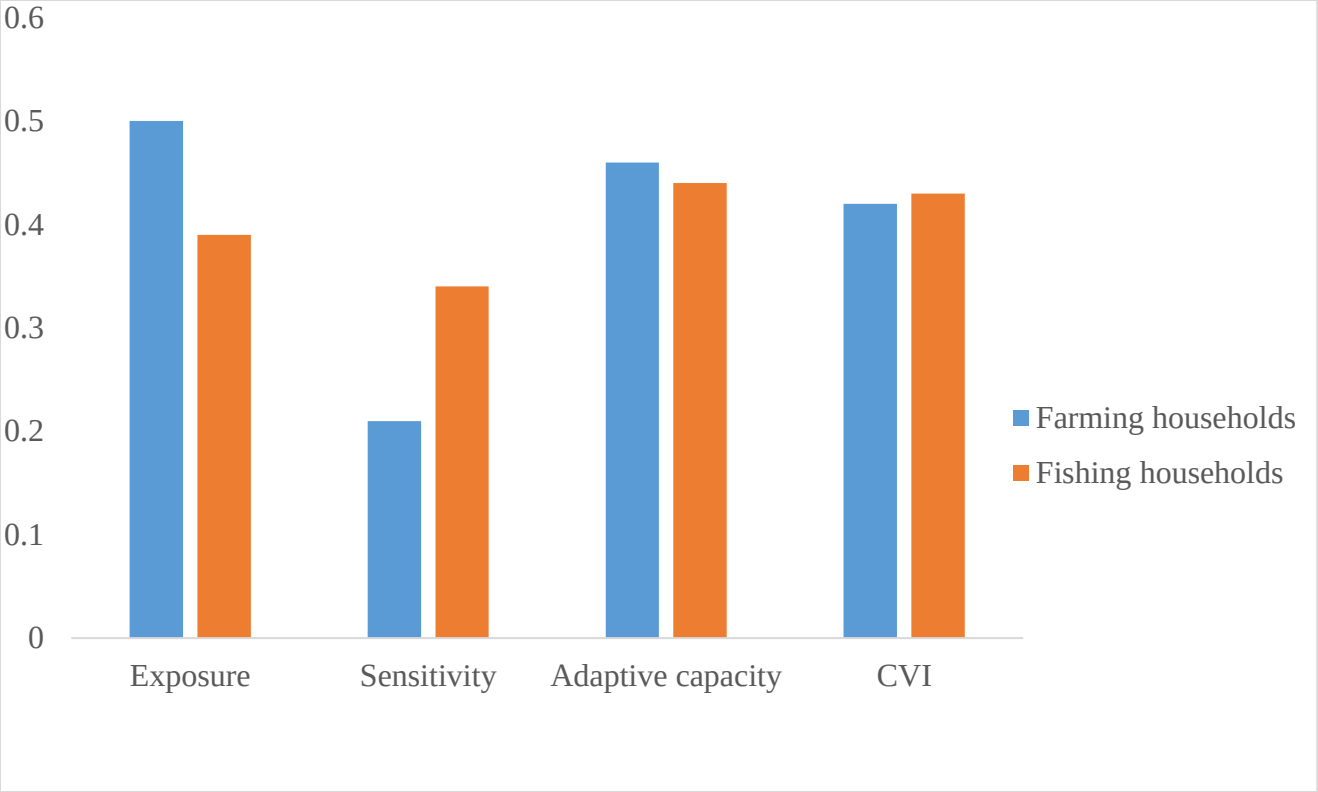


Figure 4. 2 Indexed major components and overall composite vulnerability scores for farming and fishing households in Rivers and Bayelsa states

The vulnerability level for the farming and fishing households have been presented in the Table 4.4. The Table shows that majority (81.9%) of the surveyed households fell in the category of the moderately vulnerable with only few (2%) of them in the highly vulnerable group. For the farming household none was found in the highly vulnerable category while 4% of the fishing household fell into the highly vulnerable category. 84.5% and 79.3% of the farming and fishing households respectively fell into the moderately vulnerable category while the remaining 15.5% and 16.7% of the farming and fishing households respectively fell into the category of the low vulnerability.

Table 4.4 Vulnerability levels of farming and fishing households

Level of vulnerability	Full sample		Farming households		Fishing households	
	Frequency	Percent	Frequency	Percent	Frequency	Percent
Low vulnerability	81	16.1	39	15.5	42	16.7
Moderate vulnerability	412	81.9	212	84.5	200	79.3
High vulnerability	10	2.0	0	0	10	4.0

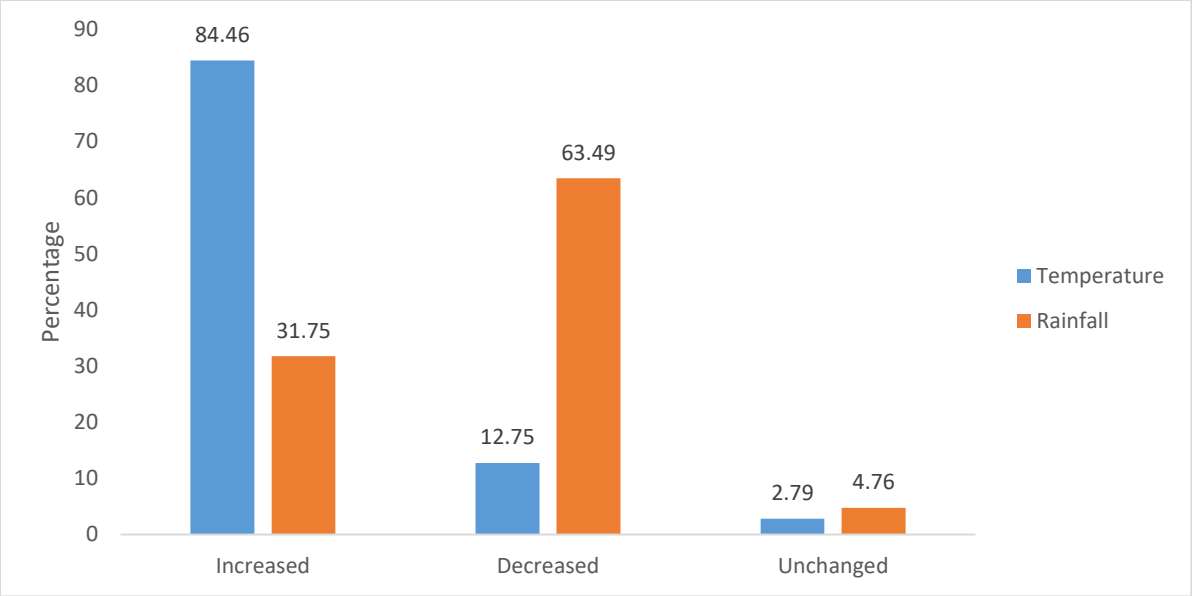
Source: Field survey (2018)

4.4 Adaptations Strategies Employed by Households to cope with the Influence of Climate Shocks and Environmental Degradation

This section summarizes the farming and fishing households' perception of climate shocks and their adaptation strategies employed in response to the situation. During the survey, the sampled households were asked questions regarding their observation of the patterns of temperature and rainfall over the last 20years. For those who perceive that there has been a change, a follow up question was asked on the adjustments they have made to adapt to climate shocks and environmental degradation. The results of the perception of changes in climate variables is first presented. This is followed by the adaptation strategies they are using and factors influencing their choice of the adaptation strategies.

4.4.1 Local perception of long-term temperature and rainfall changes

The results show that majority (84.46%) of the surveyed households perceived that the temperature has increased over the last 20years, 12.75% perceived that it has decreased while the remaining 2.79% did not perceive any change. On the other hand, majority (63.49%) of the respondents perceived that precipitation has decreased, 31.75% perceived that there has been an increase in rainfall while the remaining 4.76% have not observed any change (Figure 4.3).



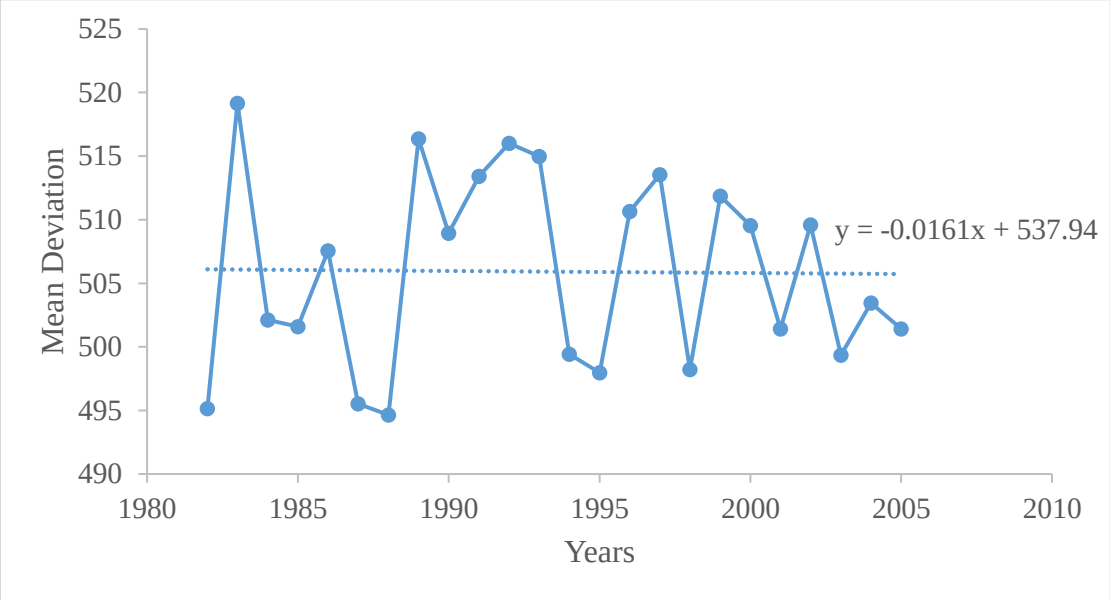
Source: Field survey (2018)

Figure 4. 3 Local perception of long-term temperature and rainfall changes

In order to validate the local perception of the long-term change in temperature and rainfall, the annual temperature and rainfall data for the region for the period between 1982 and 2005 were analysed. The rainfall data showed a large negative deviation compared to their long term means (dotted lines) for most years particularly between 1982-1988 and 1994-2005 indicating high rainfall variability (Figure 4.4). The rainfall data revealed that the annual rainfall decreased by 0.16mm every decade. This result corroborates the local perception of observed decrease in rainfall.

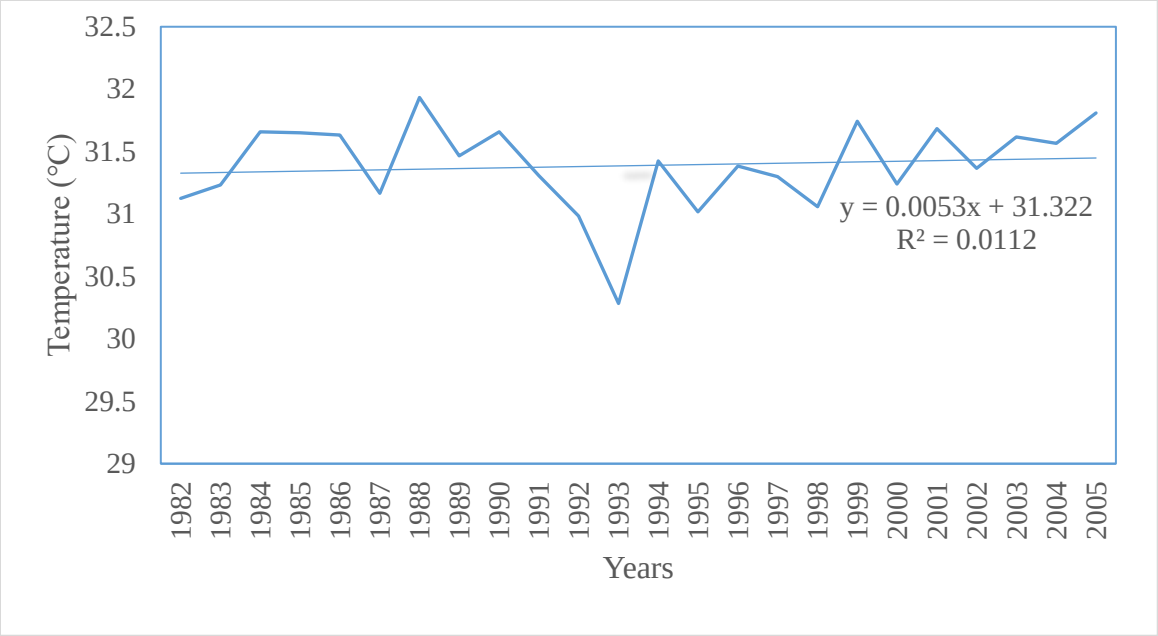
As expected, the temperature data showed less dramatic variability over time with overall warming being noticeable particularly later in the temporal span (Figure 4.5). The period between 1993 and 1998 had lower temperature than the annual mean maximum temperature of 31.3℃. The results further showed that the mean annual maximum temperature increased by 0.05℃ every decade.

The annual mean minimum temperature (Figure 4.6) shows a more dramatic variability over time than the annual maximum temperature and is increasing at a faster rate of 0.07℃ per decade. This evidently shows that the nights are warming over time. From the analysis of the temporal data it can be inferred that the local perception of climate variability agreed with the historical data on temperature and rainfall.



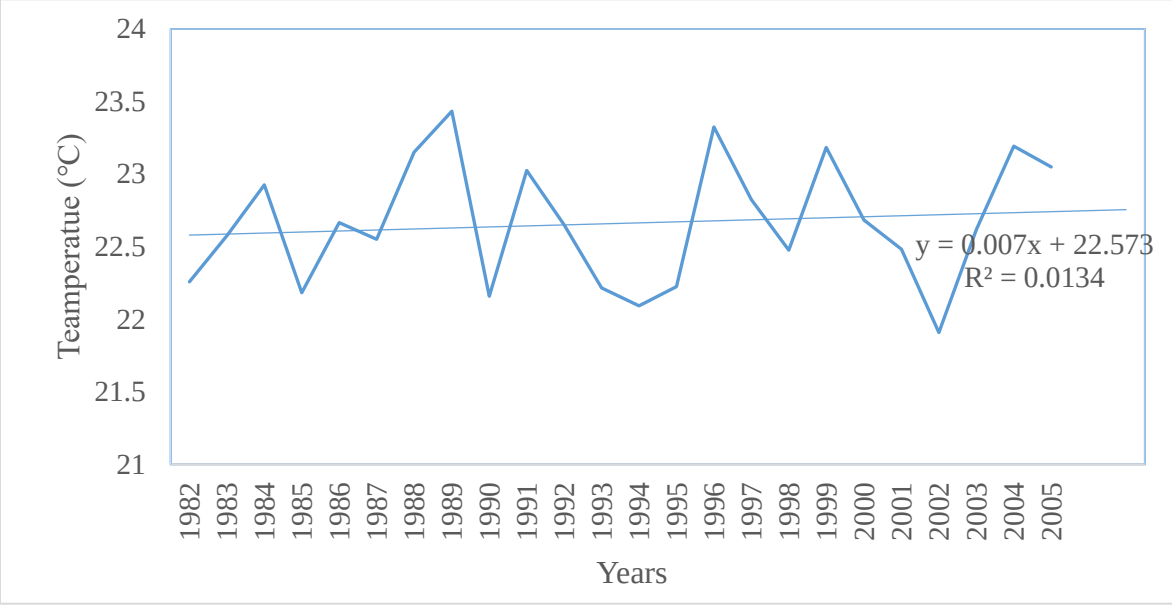
Source: NIMET

Figure 4. 4 Mean deviation of annual rainfall in the study area between 1982 and 2005



Source: NIMET

Figure 4. 5 Interannual variability in maximum temperature in the study area between 1982 and 2005.



Source: NIMET

Figure 4. 6 Interannual variability in minimum temperature in the study area between 1982 and 2005.

4.4.2 Farming households adaptation strategies to climate shocks and environmental degradation

The adaptation strategies the farming households employed were grouped into three (3) categories for computational ease. They include soil and water management, crop management, livelihood diversification and the 'no adaptation' option (Table 4.5). In this study the following adaptation strategies (cover crops, deep tillage, hedging, mulching, ridge cultivation and run-off harvesting) was grouped into the soil and water management component (SWM). Crop rotation, crop diversification, agroforestry, changing of planting and harvesting date, use of improved and drought resistant varieties were grouped under crop management component (CM). Engagement in off-farm and non-farm activity was grouped under livelihood diversification component (LD). Majority (78.5%) of the surveyed farming households used livelihood diversification as an adaptation option. This is followed by crop management (77.7%) and soil and water management options (64.5%).

Table 4.5 Adaptation strategies employed by farming households in the study area

Adaptation Options	Frequency	Percentage (%)
Soil and water management (SWM)	162	64.54
Cover crops	106	42.23
Deep tillage	130	51.79
Hedging	58	23.11
Mulching	33	13.15
Ridge cultivation	69	27.49
Run-off harvesting	12	4.78
Crop management (CM)	195	77.69
Crop rotation	118	47.01
Crop diversification	143	56.97
Agroforestry	12	4.78
Changing of planting and harvesting date	168	66.93
Improved and drought resistant varieties	157	62.55
Livelihood diversification (LD)	197	78.49

Source: Field Survey (2018)

4.4.3 Fishing households adaptation strategies to climate shocks and environmental degradation

The adaptation strategies the fishing households employed were categorized into two: intensification and livelihood diversification for the purpose of computational ease (Table 4.6). Use of improved gears, extension of working hours, varying fishing locations and fishing over large expanse were grouped as intensification. Engagement in off-fishing and non-fishing activities were grouped as livelihood diversification. The 'no adaptation' option was included in the computation of factors influencing choice of adaptation strategies. Majority (83.61%) of the surveyed fishing households used livelihood diversification as an adaptation option. This is followed by use of improved gears (80.33%) and varying fishing locations (67.21%) while the least used strategy was fishing over large expanse (40.98%).

Table 4.6 Adaptations strategies employed by fishing households

Adaptation strategies	Frequency	Percentage (%)
Intensifying fishing efforts		
Using improved fishing gear	49	80.33
Extending working hours	36	59.02
Varying fishing location	41	67.21
Fishing over large expanse	25	40.98
Livelihood diversification	51	83.61

Source: Field survey (2018)

4.5 Factors Affecting Choice of Adaptation Strategies employed by Farming and Fishing Households

4.5.1 Factors affecting the farming households choice of adaptation strategies

The decision to choose a certain adaptation strategy is based on a number of socio-demographic, economic, institutional and biophysical factors which is estimated using the multinomial logit

model. The summary statistics of variables used in the multinomial logit model is presented in Table 4.7.

Table 4.7 1Summary statistics of variables used in multinomial logit model

Variables	Description	Mean	Standard deviation
Dependent variable			
Adaptation strategies:	This is a categorical variable which takes the value 0 if no adaptation strategy is being		
No adaptation	employed, 1=soil and water management	0.10	0.02
SWM	practices (SWM), 2=crop management practices	0.11	0.02
CM	(CM) and 4=livelihood diversification (LD)	0.41	0.03
LD		0.37	0.03
Explanatory variables			
Age	Age of household head (years)	47.48	13.48
Gender	Gender of household head (1=male; 0=female)	0.39	0.03
Farming experience	Farming experience of household head (years)	25.19	14.74
Household size	Number of household members	7.41	2.74
Education	Formal education of household head (years)	9.61	4.64
Access to credit	Access to credit services (1=yes, 0=no)	0.15	0.02
Social network	Membership in local organization (1=yes, 0=no)	0.15	0.02
Extension	Access to extension services (1=yes, 0=no)	0.08	0.02
Access to climate information	Access to information on climate change (1=yes, 0=no)	0.49	0.03
Farm size	Size of land cultivated (hectare)	0.63	0.54
Household income	Total household annual income (‘000₦)	610.5	529.2
Perception of shift in temperature	Perception of change in temperature (1=yes, 0=no)	0.87	0.02
Perception of shift in rainfall	Perception of change in rainfall (1=yes, 0=no)	0.74	0.03
Location	State (1=Bayelsa 0=Rivers)		
Bayelsa		0.50	0.03
Rivers		0.50	0.03

Source: Field Survey (2018)
NB: Base categories for comparison: Adaptation strategies (no adaptation), location (Rivers)

The results of the multinomial logit model are presented in Table 4.8. The results indicate that age of household head positively and significantly affected the probability of adopting soil and water management practices as an adaption strategy at probability level of 0.05. The magnitude of this

effect as can be seen in Table 4.9 is 0.003. This means as age of household head is increased by one year the probability of adopting soil and water management practices increases by 0.28%. A plausible explanation to this result is that older farmers are more experienced and more likely to experience changes in climate and therefore, adopt adaptation strategies to cope with the change. Previous studies that reported that age positively affected the adoption of adaptation strategies to climate change include Adimassu & Kessler (2016); Opiyo et al., (2016) and Alemayehu & Bewket (2017).

The result shows that gender of household head positively and significantly ($p<0.1$) influenced the adoption of soil and water management practices. This means that the adoption of soil and water management practices was higher among male headed households than female headed households. The marginal effect results show that male headed households had 13% chances of adopting soil and water management practices than their female counterpart. This is probably because male headed households have better access to resources and information. Previous studies that corroborate this findings include Asfaw & Admassie (2004) and Deressa et al., (2014). On the other hand, gender was found to negatively and significantly ($p<0.1$) influenced the adoption of livelihood diversification as an adaptation strategy. This means that female headed households adopted this strategy more than the male headed households. The marginal effect of the variable is -0.1841. This means that being a female headed households increases the chances of adopting livelihood diversification as an adaptation strategy by 18%. This result is in agreement with the findings of Amare & Simane (2017) who found that female headed households diversified more.

Household size was found to positively and significantly ($p<0.01$) influence the adoption of crop management practices and livelihood diversification (though not significant) as an adaptation

strategy but it has a negative influence on adoption of soil and water management practices although not significant. As household size increases by one the probability that the household will adopt crop management practices increases by 8.9%. This is probably because activities involved in crop management are capital intensive and so only large households' size who have household members engaged in other income generating activities which generate extra income to invest in this adaptation option. Also, it is understandable that large household will like to engage their workforce in different income generating activities and hence are more likely to diversify. This result is in agreement with the findings of Tizale (2007).

Table 4.8 Multinomial regression results for determinants of adaptation strategies by farming households

Explanatory variables	Soil and water management	Crop management	Livelihood diversification
	Coefficient	Coefficient	Coefficient
Age	0.061**	0.015	0.019
Gender	1.164*	-0.326	-0.889*
Household size	-0.048	0.353***	0.002
Education	0.188***	0.142**	0.036
Access to credit	-0.226	1.672	1.532
Social network	-0.583	0.619	0.985
Extension	0.148	-0.849	-1.983**
Access to climate information	0.689	-0.168	0.422
Farm size	-0.433	0.867	1.517**
Perception of shift in temperature	-0.507	-0.177	-0.355
Perception of shift in rainfall	0.074	0.271	-0.661
Constant	-4.695**	-3.684	-0.013
Diagnostics			
Number of observations	251		
LR $\chi^2(33)$	128.64		
Prob > chi2	0.0000		
Log likelihood	-240.00978		
Pseudo R^2	0.2113		

Source: Field survey (2018)

Note: Base category: no adaptation; ***, ** and * indicate significance at 1%, 5% and 10% respectively.

Table 4.9 Marginal effects from the multinomial logit model

Explanatory variables	Soil and water management	Crop management	Livelihood diversification
	Coefficient	Coefficient	Coefficient
Age	0.0028**	-0.0016	0.0004
Gender	0.1270***	0.0232	-0.1841
Household size	-0.0135**	0.0886***	-0.0611***
Education	0.0063*	0.0231**	-0.0214
Access to credit	-0.0665***	0.1125	0.0360
Social network	-0.5592**	-0.0276	0.1313
Extension	0.1131	0.0366	-0.2722***
Access to climate information	0.0364	-0.1363*	0.1116
Farm size	-0.0910**	-0.0419	0.2177***
Perception of shift in temperature	-0.0179	0.0360	-0.0389
Perception of shift in rainfall	0.0151	0.1813**	-0.2111

Source: Field survey (2018)
Note: ***, ** and * indicate significance at 1%, 5% and 10% respectively.

This study shows the significant and positive effect of education on farming households' decision to adopt soil and water management and crop management practices as an adaptation strategy to climate shocks and environmental degradation at 1 and 5% significance levels respectively. This is expected as education provides more understanding as to the impacts of climate change and environmental degradation as well as adaptation methods to be adopted to be able to cope with these impacts. The marginal effects as can be seen in Table 4.9 shows that an increase in education by 1 year increases the probability that households will adopt soil and water management and crop management practices by 0.63% and 2.31% respectively. This result is in agreement with previous studies like Alauddin & Sarker (2014); Alam et al., (2016) and Khanal et al., (2018) which report the positive influence of education on adaptation.

Access to extension have a significant ($p<0.05$) and negative effect on the adoption of livelihood diversification as an adaptation strategy. A plausible explanation could be that households with access to extension are equipped with information on other adaptation strategies that they could choose from. Another plausible explanation could be the weakness of the extension delivery

system typically in most African countries as pointed out by Oladele and Sakagami (2004) which include poor financial decentralization, inadequate use of alternative extension methods, high bureaucratic setting and inadequate cooperation and coordination with other agencies. This result is contrary to the findings of Alemayehu & Bewket (2017) who reported positive influence of extension service on adoption of soil and water conservation as an adaptation strategy. On the other hand, access to extension have a positive but not significant influence on the adoption of soil and water management practices. This is probably because the extension services provide information on this practice and its effectiveness in coping with the impact of climate shocks and environmental degradation. The result shows that an increase in access to extension increases the probability to adopt the soil and water management practice by farming households by 11.3%. This result support the findings of Alemayehu & Bewket (2017) that showed that access to extension increases the chances of adopting soil and water conservation practices as an adaptation strategy.

Farm size was found to positively and significantly ($p<0.05$) influence farming household choice of livelihood diversification as an adaptation strategy as well as positively influence the adoption of crop management practices. This means that households with larger farm size were more likely to diversify more probably to generate additional income for adaptation and expand production. A unit increase in farm size increases the chances of adoption of livelihood diversification as an adaptation strategy by 22% as depicted in Table 4.9. This result contradicts the findings of Deressa et al., (2011); Bazezew et al., (2013) and Gebreyesus (2016) that reported that farm size negatively affects the probability of using livelihood diversification as an adaptation measure. At the same time farm size was found to negatively influence the adoption of soil and water management practices. A unit increase in farm size by a hectare will result in decrease in probability of adopting

soil and water management practice by 9.1%. This is probably because farming households with large farm size are less worried about the impact of climate shocks and willing to take the risk.

In conclusion the results showed that farmers perception on shifts in temperature and rainfall was not significant in influencing their choice of adaptation strategies. Their choice of adaptation strategies was rather influenced by other socio-demographic, institutional and farm characteristics. So, efforts should be concentrated on these factors to facilitate adaptation.

4.5.2 Factors influencing the choice of adaptation strategies of fishing households

The decision to choose a certain adaptation strategy is based on a number of socio-demographic, economic, institutional and biophysical factors. The summary statistics of variables used in the multinomial logit model is presented in Table 4.10.

The results of the multinomial logit model are presented in Table 4.11 and the marginal effects in Table 4.12. The results indicate that education of household head positively and significantly affected the probability of adopting intensification of fishing efforts and livelihood diversification as an adaption strategy at 1% and 5% significance levels respectively. This means as years of education of household head is increased by one year the probability of adopting intensification increases by 1.5% and livelihood diversification by 0.9%. This agrees with previous studies such as Alam et al., 2016 and Deressa et al., 2009 that reported that education positively influences adaptation choices.

Access to climate information was found to have significant negative influence on the choice of intensification as an adaptation strategy by fishing households at 5% significance level. This result

is contrary to some studies (Bryan et al., (2009) and Adimassu & Kessler (2016) which have found access to climate information to positively influence the adoption of adaptation.

Table 4.10 Summary statistics of variables used in multinomial logit model

Variables	Description	Mean	Standard deviation
Dependent variable			
Adaptation strategies:	This is a categorical variable which takes the value 0 if no adaptation strategy is		
No adaptation	being employed, 1=intensification of	0.76	0.03
I	fishing efforts (I), 2= livelihood	0.16	0.02
LD	diversification (LD)	0.08	0.02
Explanatory variables			
Age	Age of household head	48.02	11.68
Gender	Gender of household head (1=male; 0=female)	0.86	0.02
Fishing experience	Fishing experience of household head	24.75	12.86
Household size	Number of household members	7.41	2.74
Education	Formal education of household head (years)	8.54	4.29
Access to credit	Access to credit services (1=yes, 0=no)	0.10	0.02
Social network	Membership in local organization (1=yes, 0=no)	0.07	0.02
Extension	Access to extension services (1=yes, 0=no)	0.04	0.02
Access to climate information	Access to information on climate change (1=yes, 0=no)	0.49	0.03
Household income	Total household annual income (‘000₦)	1,031	815.4
Perception of shift in temperature	Perception of change in temperature (1=yes, 0=no)	0.68	0.03
Perception of shift in rainfall	Perception of change in rainfall (1=yes, 0=no)	0.53	0.03
Location	State (1=Bayelsa 0=Rivers)		
Bayelsa		0.50	0.03
Rivers		0.50	0.03

Source: Field Survey (2018). Note: Base categories for comparison: Adaptation strategies (no adaptation), location (Rivers), 1 USD = ₦380

As expected, the results in the study showed that household income positively and significantly influences the probability of adopting intensification as an adaptation strategy at 5% significance

Table 4.11 Multinomial regression results for determinants of adaptation strategies by fishing households in the study area

Explanatory variables	Intensification	Livelihood diversification
	Coefficient	Coefficient
Age	0.0300	0.0188
Gender	0.5289	0.1391
Fishing experience	-0.0385	0.0183
Household size	-0.1037	-0.0321
Education	0.3670***	0.1963***
Access to credit	0.6220	0.4159
Social network	-0.5184	-0.6995
Extension	1.0767	2.4239**
Access to climate information	-1.6644***	-0.8858
Household income	6.83e-07*	7.38e-07**
Perception of shift in temperature	-0.8593	-0.9797
Perception of shift in rainfall	2.3457***	1.8665**
location	-2.7383***	-0.0987
Constant	-5.5811***	-4.5704**
Diagnostics		
Number of observations	252	
LR $\chi^2(26)$	144.03	
Prob > chi2	0.0000	
Log likelihood	-106.04623	
Pseudo R^2	0.4044	

Source: Field survey (2018). Base category: no adaptation; ***, ** and * indicate significance at 1%, 5% and 10% respectively.

Table 4.12 Marginal effects from the multinomial logit model

Explanatory variables	Intensification	Livelihood diversification
	Coefficient	Coefficient
Age	0.00127	-0.00106
Gender	0.01806	0.00601
Fishing experience	-0.00161	0.00105
Household size	-0.00415	-0.00143
Education	0.01449***	0.00942**
Access to credit	0.03027	0.02284
Social network	-0.01647	-0.02774
Extension	0.03408	0.30863
Access to climate information	-0.07031**	-0.04220
Household income	2.61e-08	3.71e-08**
Perception of shift in temperature	-0.03718	-0.05796
Perception of shift in rainfall	0.09674**	0.09239**
location	-0.13849***	0.00308

Source: Field survey (2018). Note: ***, ** and * indicate significance at 1%, 5% and 10% respectively.

level. This means that as income increases, the probability of intensifying fishing efforts by using improved fishing gears, fishing more hours, changing location such as moving to larger waters and fishing over large expanse increases.

4.6 Food Security Status of Farming and Fishing Households

Table 4.13 presents the main food sources of households in the study area. For the farming households, their main food source (69.3%) came from their own production while the fishing households' main food source (76.2%) came from purchases. They sold the fish caught and use the money to purchase food items they require. This is so as majority of them do not own a farm. Only about 16.7% of the fishing households are engaged in farming.

Table 4.13 Main foods sources of households

Main food source	Farming households	Fishing households
Own production	174 (69.3)	60 (23.8)
Purchases	77 (30.7)	192 (76.2)
Total	251	252

Source: Field survey (2018). Note: Figures in parenthesis represent column percentages

The food security status of households is presented in Table 4.14. For the farming households, 30.3% and 24.7% fell into the category of food secured and mildly food insecure respectively while 19.9% and 25% fell into the category of moderately food insecure and severely food insecure respectively. On the other hand, for the fishing households 25.4% and 31.8% belong to the category of food secured and mildly food insecure respectively while 21.0% and 21.8% belong to the category of moderately food insecure and severely food insecure respectively. In summary about 56% of the sampled households are food secure while the remaining 44% are food insecure.

Table 4.15 presents a cross tabulation of households by vulnerability levels and food security levels. As expected, majority of the households with low vulnerability 50.6% and 33.3% fell into the food secure and mildly food insecure category respectively. Only 4.9% fell into the category of the severely food insecure. On the other hand, majority (70%) of the households with high vulnerability levels fell into the category of the severely food insecure. For households with moderate vulnerability levels, the distribution between the various food security categories are similar.

Table 4.14 Food security levels of farming and fishing households in the study area

	Pooled sample	Farming households	Fishing households
Food secure	140 (27.83)	76 (30.28)	64 (25.40)
Mildly food insecure	142 (28.23)	62 (24.70)	80 (31.75)
Moderately food insecure	103 (20.48)	50 (19.92)	53 (21.03)
Severely food insecure	118 (23.46)	63 (25.10)	55 (21.83)
Total	503 (100)	251 (100)	252 (100)

Source: Field survey (2018). Note: Figures in parenthesis represent column percentages

Table 4.15 Cross tabulation of Farming and Fishing households by vulnerability level and food security status

	Low vulnerability	Moderate vulnerability	High vulnerability	Total
Food secure	41 (50.6)	97 (23.5)	2 (20)	140
Mildly food insecure	27 (33.3)	115 (27.9)	0	142
Moderately food insecure	9 (11.1)	93 (22.6)	1 (10)	103
Severely food insecure	4 (4.9)	107 (26)	7 (70)	118
Total	81	412	10	503

Source: Field survey (2018). Figures in parenthesis represent column percentages

4.7 The Effect of Vulnerability to the Three Stressors on Food Security Status of Farming and Fishing Households

The dependent variable in the econometric model is an ordered variable that has been grouped into four categories namely food secure, mildly food insecure, moderately food insecure and severely food insecure. The methodology section gives a detailed explanation of how the food security variable was constructed and grouped. In Table 4.16 is shown the summary statistics of the explanatory variables used in the econometric model.

Table 4.16 Summary statistics of variables in the ordered logit model

Variable	Definition	Mean (S.E)
Dependent variable		
FISlevel	0=food secure household	0.28 (0.02)
	1=mildly food insecure	0.28 (0.02)
	2=moderately food insecure	0.21 (0.18)
	3=severely food insecure	0.24 (0.19)
Explanatory variables		
VIn	Vulnerability indices	0.43 (0.10)
Y_log	Logarithm of household annual income	13.07 (0.95)
Mstat	0 = single (omitted base group)	0.09 (0.01)
	1= married	0.77 (0.02)
	2= others	0.13 (0.02)
Saving	=1 if household saves, 0 otherwise	0.56 (0.02)
Non_farm_wk	=1 if household is engaged in non -farm work, 0 otherwise	0.38 (0.02)
Dep_ratio	Dependency ratio	3.27 (1.60)
Store_food	=1 if household store food, 0 otherwise	0.59 (0.02)
Receive_help	=1 if household receive help from family and friends during difficult times, 0 otherwise	0.46 (0.02)
Farmsize	Total farm size cultivated (hectares)	0.31 (0.49)
Age	Age of household head (years)	47.75 (12.60)
HHsize	Household size	7.42 (2.55)
State	0=Rivers (omitted base group); 1=Bayelsa	0.51 (0.02)
Livelihood group	0=Farming households (omitted base group); 1=Fishing households	0.50 (0.02)

Source: Field survey (2008)

The results of the influence of vulnerability of households to climate shocks, environmental degradation and conflict on their food security are presented in Table 4.17. In ordered logit model the sign of the coefficient is interpreted and it indicates the likelihood of belonging to a higher or lower category of food insecurity. The magnitude of the coefficients is not usually interpreted instead the marginal effects are interpreted. Hence, the marginal effects in Table 4.18 will be discussed. In interpreting the marginal effects, the sign and magnitude of the coefficient are used and this is given for each category of food insecurity. The significance level of the variable is important. Hence, a coefficient with a positive sign in a category means that an increase in that variable will increase the likelihood of belonging to that category while a negative sign decreases the likelihood of belonging to that category. Hence, in this study a significant positive coefficient can be interpreted to mean that a unit increase in the explanatory variable increases the probability of the household falling in the category of the food insecure while a significant negative coefficient means that a unit increase in the explanatory variable decreases the probability that the household will fall into the category of the food insecure.

The results of the ordered logit model in Table 4.17 indicates that variables such as vulnerability, dependency ratio, livelihood group increases the probability of being in the higher categories of food insecurity while household annual income, household size, receive help, farm size and participation in non-farm income increases the probability of being food secure.

The results of marginal effects associated with the estimated model is presented in Table 4.18. The coefficient of the vulnerability indices is significant at 1% in all the category. This indicate that as the vulnerability of households increases it decreases the probability of households belonging to the food secure and mildly food insecure category and increases the probability of belonging to

the moderately food insecure and severely food insecure category. It should be noted that vulnerability indices range from 0-1, a value of 1 means that the household is highly vulnerable while the food security is a dummy variable with 4 categories (0-3) where 3 is the highly food insecure category. Hence, vulnerability score and food security score move in the same direction. This conforms to a priori expectation since vulnerability to climate shocks and environmental degradation negatively affects productivity and this in turn impacts negatively on household food security.

Table 4.17 Estimated Coefficient of Ordered Logit Model

Variable	Coefficient	Std. Error	P-value
Vulnerability indices	5.400	0.993	0.000***
Household annual income	-0.284	0.111	0.011**
Marital status			
Married	0.464	0.323	0.151
Others	0.399	0.407	0.327
Age	0.003	0.008	0.745
Household size	-0.144	0.053	0.007***
Dependency ratio	0.188	0.082	0.022**
Store food	0.022	0.181	0.905
Receive help	-0.402	0.184	0.029**
Farm size	-0.914	0.275	0.001***
Saving	0.004	0.175	0.980
Non-farm work	-0.061	0.203	0.000***
State			
Bayelsa	-0.032	0.192	0.867
Livelihood group			
Fishing households	-0.671	0.247	0.007***
Cut 1	-3.0828	1.6157	
Cut 2	-1.5823	1.6154	
Cut 3	-0.3904	1.6133	
No of observations	503		
LR chi2 (12)	163.51		
Prob>chi2	0.0000		
Pseudo R^2	0.1180		
Log likelihood	-611.32485		

Source: Field survey (2018). Note: ***, ** and * indicate significance at 1%, 5% and 10% respectively.

The coefficient of household annual income is significant at 1%. The result show that an increase in household annual income increases the probability of households belonging to food secure and mildly food insecure category but decreases the chances of belonging to moderately food insecure and severely food insecure category. This is expected as an increase in income increases food consumption expenditure and access to quality food and more diversified food consumption pattern. Also, it enables them to invest in inputs which can be used to increase production thereby ensuring food security. This result conforms with the findings of (Arene & Anyaeji, 2010; Kuwornu et al., 2013 and Cordero-Ahiman et al., 2017).

Table 4.18 Marginal Effects associated with Ordered Logit Model

	Food secure	Mildly food insecure	Moderately food insecure	Severely food insecure
Vulnerability scores	-0.849***	-0.196***	0.236***	0.809***
Household annual income	0.045**	0.010**	-0.012**	-0.043***
Marital status				
Married	-0.077	-0.011**	0.023	0.065
Others	-0.067	-0.009	0.021	0.055
Age	-0.000	-0.000	0.000	0.000
Household size	0.023***	0.005**	-0.006***	-0.022***
Dependency ratio	-0.030**	-0.007**	0.008**	0.028**
Store food	-0.003	-0.001	0.001	0.003
Receive help	0.063**	0.015**	-0.018**	-0.060**
Farm size	0.144***	0.033***	-0.040***	-0.137***
Saving	-0.001	-0.000	0.000	0.001
Non-farm work	0.184***	0.032***	-0.065***	-0.151***
State				
Bayelsa	0.005	0.001	-0.001	0.005
Livelihood group				
Fishing household	0.105***	0.022***	-0.028***	-0.100***

Source: Field survey (2018). Note: ***, ** and * indicate significance at 1%, 5% and 10% respectively.

An increase in household size increases the probability of households belonging to the food secure and mildly food insecure category and decreases the probability of being moderately food insecure and severely food insecure. The plausible explanation to this result is that a large household size

where most of the members are gainfully employed leads to higher income which could be used to increase both quantity and quality of food and invest in production. Thereby leading to improved food security. Moreover, larger households are less vulnerable to shocks resulting from death or loss of job of bread winner (Lipton, 1983). This result agrees with the findings of (Woldehanna & Behrman, 2013; Maitra & Rao, 2015 and Ogundari, 2017).

As expected, an increase in the dependency ration decreases the chances of belonging to the food secure and mildly food insecure category and increases the changes of belonging to the moderately food insecure and severely food insecure category. This variable is significant at 5%. An explanation to this result could be that an increase in the proportion of households not employed (the aged and children) exerts pressure on the household resources and thereby increases food insecurity. This conforms with previous studies such as (Ojogho, 2010; Kuwornu et al., 2013; and Mutisya, Ngware, Kabiru, & Kandala, 2016).

Households who receive help from family and friends are more likely to fall into the food secure and mildly food insecure category and less likely to belong to the category of the moderately food insecure. This is expected as studies have shown that social capital form part of the adaptive capacity and are important assets that households draw upon draw upon during difficult times (Thomas & Twyman, 2007 and Baird & Gray, 2014). Hence, they play significant roles in assisting people recover from shocks.

An increase in farm size increases the probability of households being food secure and mildly food insecure and decreases the chances of being moderately food insecure and severely food insecure. This conforms to a prior expectation that large farm size increases food security. It is

believed that large scale farmers tend to be more efficient in the use of resources. This results agrees with the findings of (Bogale & Shimelis, 2009 and Asogwa & Umeh, 2012).

The coefficient of the non-farm work is significant at 1%. Participation in non-farm work increases the chances of households being food secure or mildly food insecure and decreases the chances of being moderately food insecure and severely food insecure. This is possible as participation in non-farm work enables households to earn extra income which could be used to purchase enough and quality food as well as invest in their production activities to boost production. This result agrees with previous studies such as (Babatunde & Qaim, 2010; Victor Owusu, Abdulai, & Abdul-Rahman, 2011; Zereyesus et al., 2017; Kuwornu et al., 2018).

The coefficient of livelihood group was found to be significant at 1%. It means that belonging to a fishing household increases the chances of being food secure and mildly food insecure and decreases the probability of being moderately food insecure and severely food insecure.

4.8 Correlation between Food Insecurity and Vulnerability Index

The correlation matrix between food insecurity index and major components of livelihood vulnerability index is presented in Table 4.19. The result show that the two major components of vulnerability index that significantly ($p<0.05$) affect food insecurity were exposure and adaptive capacity. The positive relationship between exposure and food insecurity index (0.2079) implies that the more exposed households are the more food insecure the household. This is because exposure to stressors increases households vulnerability. On the other hand, the adaptive capacity has a negative relationship (-0.3473) with food insecurity implying that households which greater adaptive capacity has more probability of being food secured. This is expected as adaptive capacity

has been found to reduce vulnerability of households. This result resonates with the findings of Sam et al., (2018) which found that adaptive capacity plays an important role in attaining food security.

Table 4.19 Correlation Matrix between Food Insecurity index and Major Components of Livelihood Vulnerability Index

	Food insecurity index	Exposure	Sensitivity	Adaptive capacity
Exposure	0.2079**	1.0000		
Sensitivity	0.0762	-0.1194**	1.0000	
Adaptive capacity	-0.3473**	0.2018**	-0.1995**	1.0000

Source: Field survey (2018). Note: ** indicate significance at 5%

In appendix III, the results of the correlation matrix between food insecurity index and the sub components and indicators that make up exposure and adaptive capacity suggests that the indicators of exposure such as: involvement in conflict related to land, feelings of insecurity and losses resulting from conflict were found to significantly ($p<0.05$) affect food insecurity. For the adaptive capacity factors such as remittances, income, diversification, membership of association, access to external support and local cooperation were found to be significant ($p<0.05$) in reducing food insecurity. This result corroborates the findings of Islam, Sallu, Hubacek, & Paavola, (2014) which show that financial capital, social capital and diversification were important indicators of adaptive capacity which reduce vulnerability.

CHAPTER FIVE
SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

This chapter presents the summary and conclusion of the findings from the study. Based on the findings recommendations are made to guide policy makers and other stakeholders on how to reduce vulnerability of agricultural households and enhance food security and adaptation. Suggestions are made for future research in the area.

5.2 Summary of the Study

An array of stressors shape vulnerabilities in developing world context. There is an overwhelming evidence to suggest that climate shocks, environmental degradation and resource conflict undermine food security and livelihood well-being in areas where people are dependent on land and water resources. The main aim of this study is to assess the vulnerability of two livelihood groups (farmers and fishermen) in Niger Delta to the triple stressors of climate shocks, environmental degradation and resource conflict. Specifically, the study sought to determine vulnerability levels of the two livelihood groups to the triple stressors; identify adaptation strategies employed by the two livelihood groups and factors influencing the choice of adaptation strategies; estimate the food security levels and the effect of vulnerability to the triple stressors on food security status of the two livelihood groups.

The study employed a multistage sampling technique to select 503 (252 fishing households and 251 farming households) households for the study. The first stage involved a purpose selection of two states, followed by a purposive selection of 13 local government areas (LGAs) from Rivers

State and 4 LGAs from Bayelsa State. The third stage involved a proportional random selection of 18 communities (13 farming and 5 fishing communities) from Rivers State and 8 communities (involved in both farming and fishing) from Bayelsa state. The final stage involved a random selection of households from the selected communities. In all 503 households were surveyed using the sample size estimation procedure proposed by United Nation (2005). The data analysis was done using the STATA software package.

The vulnerability of households to the triple stressors was assessed using ratio analysis (composite vulnerability index). Adaptation strategies employed by the two livelihood groups were identified using descriptive statistics and multinomial logit model used to ascertain factors influencing the choice of adaptation strategies. The food security levels of the two livelihood groups was determined using food insecurity experience scale (FIES). The ordered logit model was employed to assess the effect of vulnerability to the triple stressors on food security status of the two livelihood groups.

The results of the study showed that majority (62.4%) of the sampled households were headed by male. Most (77.3%) of the household heads were married and had one form of formal education (96.6%) with the average years of schooling being 9years. Majority (94%), (87.7%) and (89.3%) of the sampled households had no access to extension services, credit and not belonging to any association respectively. A good number (79%) of them had access to health care. 51.3% of the sampled households are engaged in off-farm work. On the average the households sampled had heads aged 48years, household size of 7, farming or fishing experience of 25years, farm size of 0.3ha and gross annual income of ₦698955.8. The average distance to health care facility and water source were 2.8km and 5.2km respectively.

Majority of the farming (84.5%) and fishing (79.3) households were found to be moderately vulnerable although there is no statistically significant difference in their vulnerability levels. On the overall both groups have the vulnerability score of 0.42 and 0.43 for farming and fishing households respectively. The farming households were more exposed (statistically significant at 1%) to the triple stressors of climate shocks (0.60), resource conflict (0.35) and environmental degradation (0.56). Though the fishing households was at 1% statistically significantly better off (0.24) than the farming households (0.31) in health, food and water sub-component, the fishing households (0.43) had poor physical and asset base relative to the farming households (0.11) which made the fishing households statistically significantly more sensitive to the triple stressors. The adaptive capacity of the farming household (0.46) was higher than that of fishing households (0.44), though this was not statistically different.

Majority (84.46%) of the surveyed households perceive that the temperature has increased over the last 20years, while majority (63.49%) of the respondents perceived that precipitation has decreased. The rainfall data revealed that the annual rainfall decreased by 0.16mm every decade While the temperature data showed that the mean annual maximum and minimum temperature increased by 0.05℃ and 0.07℃ respectively every decade. This result corroborates the local perception of observed decrease in rainfall and increase in temperature.

A summary of the adaptation strategies used by households to cope with the climate shocks and environmental degradation shows that majority (78.5%) of the surveyed farming households used livelihood diversification as an adaptation option. This is followed by crop management (77.7%) and soil and water management options (64.5%). On the other hand, majority (83.61%) of the surveyed fishing households used livelihood diversification as an adaptation option. This is

followed by use of improved gears (80.33%) and varying fishing locations (67.21%) while the least used strategy was fishing over large expanse (40.98%). The use of improved gears, varying fishing location and fishing over large expanse were grouped into intensification component for easy computation.

Factors influencing the choice of adaptation strategies for the farming households were age, gender (male headed household), household size, education, extension and farm size. Age, gender and education increases the probability of adoption of soil and water management option as an adaptation strategy. Household size and education increases the probability of adoption crop management practices as an adaptation strategy. While farm size increases the probability of adoption of livelihood diversification as an adaptation option gender and extension decreases the probability of adoption of livelihood diversification as an adaptation strategy. On the other hand, factors influencing the choice of adaptation strategies for the fishing households were education, access to climate information, extension, household income, perception of shift in rainfall and location. While education, perception of shift in rainfall and household income increases the probability of adoption of intensification as an adaptation strategy, access to climate information and being located in Rivers state decreases the probability of adoption of intensification. Education, extension, household income and perception of shift in rainfall all increases the probability of adoption of livelihood diversification as an adaption strategy.

56% of the sampled households were food secure. As expected, majority of the households with low vulnerability 50.6% and 33.3% fell into the food secure and mildly food insecure category respectively. On the other hand, majority (70%) of the households with high vulnerability levels fell into the category of the severely food insecure.

The results of the ordered logit model indicate that variables such as vulnerability to the triple stressors, dependency ratio, and livelihood group (whether a fishing or farming household) increases the probability of being in the higher categories of food insecurity while household annual income, household size, receive help, farm size and participation in non-farm work decreases the probability of being food insecure. The fishing households were found to be more food secure that the farming households.

5.3 Conclusions of the Study

The study has investigated the vulnerability of the farming and fishing households to the triple stressors of climate shocks, environmental degradation and resource conflict and its implication for food security of the two livelihood groups. The results of our study suggest that whilst both groups were similarly vulnerable several factors influence the vulnerability of the two livelihood groups. The most important exposure element was climate shocks and environmental degradation, while the key factors determining sensitivity were access to health care, dependence on natural resource as main water source and land tenure. Both livelihood groups share similar vulnerability to the triple stressors and are moderately vulnerable.

Livelihood diversification was a common adaptation strategy for both livelihood group. Empowering both livelihood groups through education, training and farmer/fisher-based organization can enable them leverage on assets at their disposal to facilitate their adaptation strategies.

Households which are vulnerable are relatively food insecure. The triple stressors of climate shock, environmental degradation and conflict impact negatively on the food security of farming and

fishing households. Although, the two livelihood groups are impacted by the three stressors, they both command different resources that makes fishing households more food secure than farming households.

5.4 Recommendations of the Study

To improve food security status of the two livelihood groups, it is important that policy makers and other stakeholders pursue policies and target programmes aimed at reducing vulnerability to the triple stressors. Such efforts must be multifaceted in order to simultaneously tackle exposure, sensitivity and adaptive capacity. Early warning systems should be put in place to reduce exposure to climate shocks. Government and relevant stakeholders should ensure effective monitoring of the activities of multi-national oil companies so that they adhere to best practices in order to curtail the menace of oil spillage and gas flaring that degrade the environment.

Though some are already adopting adaptation strategies to cope with these stressors, public and private sectors can promote these adaptation efforts by strengthening both formal and informal education and skills training and providing credit facilities since education and household income play a significant role in the adoption of adaptation strategies. Government should also restructure extension services to improve access. They can also provide them with incentives such as mobility to improve service delivery. This is important as the study result show that only a few had access to extension. Meanwhile extension was an important factor in the adoption of livelihood diversification.

However, to reduce food insecurity attention should be given to other factors apart from vulnerability that affect food insecurity. Hence, there is an urgent need to improve fishing

households' access to land for farming to diversify income sources to reduce food insecurity. Also, provide basic infrastructures such as health facilities and water and promote non-farm and non-fishing activities. This could be achieved by providing livelihood diversification opportunities such as establishing small and medium scale enterprises in the study area to provide extra employment opportunities thereby improving their income and food security situation. This is important as livelihood diversification was identified as an important adaptation strategy employed by the two livelihood groups.

5.6 Suggestions for Future Research

Replication of this study in the same location over time might provide information about how the vulnerabilities of households in the study area change as new adaptation practices are initiated and existing ones promoted and intensified. Future work might include refinement of the indicators or components to highlight regional context in order to capture how factors operating beyond the household level shape vulnerabilities of agricultural households. Future research may also want to look at the trade-offs between the various adaptation strategies in order to be able to identify the most suitable means for households to adapt.

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APPENDIX I QUESTIONNAIRE

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CLIMATE SHOCKS, ENVIRONMENTAL DEGRADATION AND RESOURCE CONFLICT: IMPLICATIONS FOR AGRICULTURAL LIVELIHOODS AND FOOD SECURITY IN NIGER DELTA REGION OF NIGERIA

FISHERS' VERSION OF THE QUESTIONNAIRE

Good day, Mr/Mrs/Miss,
You have been selected by chance from all fishermen in the area to participate in the study undertaken by Onyenekwe Sylvia Chinasa for her PhD research. The purpose of this interview is to obtain current information about your fishery activities, vulnerability to climate shocks, environmental degradation and resource conflict, adaptation strategies to these stressors and impact of these stressors on your food security status. The survey is voluntary and information gathered will be confidential and will be only served for this academic purpose. Your support and contribution would be very much appreciated. For further inquiries, please contact her at sconyenekwe@st.ug.edu.gh or Tel: +2348036545790/+233541712437.

GENERAL INFORMATION

1. Questionnaire No. …… 2. Enumerator Name/No……..

3. State …… 4. Local Govt. Area: ……

5. Village/community: …….. 6. Respondent's Name/No……

SECTION A: RESPONDENTS' HOUSEHOLD CHARACTERISTICS (SOCIO-DEMOGRAPHIC PROFILE)

A1. Name of household head ……
A2. Marital Status:
1= Married 2 = Widowed 3 = Single 4= Separated 5 = Divorced
A3. Age of household head ……..years
A4. Sex of household head.
0 = Male 1 = Female
A5. What is your residential status?
1. Indigene/Native 2. Migrant
A6. How long have you lived in this community?.....years
A7. What is your religious affiliation? 0= None 1= Christian 2= Muslim 3= Traditional 4= Others (mention)…..
A8. What is your ethnicity?
1. Ijaw 2. Ikwerre 3. Kalabari 4. Okrika 5. Ogoni 6. Itsekiri 7. Isoko 8. Ukwuani 9. Opobo 10. Eleme 11. Others
A9. What is your main occupation?
1 = Farming
2 = Fishing
3 = Pastoralist
4 = Hired labourer on farm
5 = Trading (including kiosk)
6 = Self-employed artisan/Skilled Craftman (such as carpentry, tailoring, bricklaying, etc.)
7 = Salaried employee
8 = Transport (using bike, boats, cars, lorries)
9 = Food processor (garri, chips, food vendors etc)
10 = natural resource collector
11 = others (specify)

A10. How many years have you worked in this primary occupation?…….years

A11. What is your secondary occupation? (Other activities engaged in besides the one above)

1 = Farmer
2 = Fisher
3 = Pastoralist
4 = Hired labourer on farm
5 = Trader (including kiosk)
6 = Self-employed artisan/Skilled Craftman (such as carpentry, tailoring, bricklaying, etc.)
7 = Salaried employee
8 = Transport (using bike, boats, cars, lorries)
9 = Food processor (garri, chips, food vendors etc)
10 = natural resource collector
11 = others (specify)

A12. How many years have you worked in this secondary occupation?……years

A13. What is your highest level of education?

0= None
1. Uncompleted primary
2. Primary completed
3. JSS
4. Secondary/SSS
5 = Tertiary
6 = Adult education
7 = Non-formal education
8 = others (specify)

A14. Number of year spent to attain this level of education? ……

A15.What is the size of your household and how many were available for fishing during 2017? (***Should include respondent***)

Category of household members	A15aNumber
Adults (60 years & above)	
Male adults (eighteen years to 59years)	
Female adults (eighteen years to 59years)	
Children between 6 years and 18 years	
Children under 6 years	
Total household size	

A16. How many of your household members went fishing per day during 2017? …….

A17. How many days and duration did household member(s) spend fishing in a week? ……days …….. hours

A18. How many months were you and your household involved in fishing last year?.....

A19. Does your household use fishing vessel fitted with an outboard motor? 1= Yes 0= No
A20. Does your household use fishing vessel fitted with electric/light fishing devices? 1= Yes 0= No
A21. Specify number of fishing seasons in the community.

0 = no clear seasonality 1= One season 2 = Two seasons 3= Three seasons

A21a. Which are the HIGH season months?

Jan	Feb	Mar	April	May	June	July	Aug	Sept	Oct	Nov	Dec

A21b. Which months are the LOW season months?

Jan	Feb	Mar	April	May	June	July	Aug	Sept	Oct	Nov	Dec

A21c. Which months is there almost no fishing?

Jan	Feb	Mar	April	May	June	July	Aug	Sept	Oct	Nov	Dec

A22. What were the fish species you obtained/caught in 2017?

Fish produce*	**J19a. Fishing crew size**	**J19b. Total number of trip**	**J19c. Realized catch/trip**			**J19d. Past (5-10years) catch/trip**		
			Quantity	**Units** 1= bags; 2=bucket; 3= bowl; 4= Kg; 5 = others (specify)	**Price/unit (₦)**	**Quantity**	**Units** 1= bags; 2=bucket; 3= bowl; 4= Kg; 5 = others (specify	**Price/ unit (₦)**

**1. Tilapia; 2. Chrysichtys; 3. Clupeids; 3. Prawns/Shrimps; 4. Clams 5. Others*

A23. What changes have you observed in your catch over the last five years?

1=1-25% increase 2=26-100% increase 3=1-25% decrease 4=26-100% decrease 5=Natural fluctuation 6=no change

A24. What are the reasons for the changes in your household's catch over the last five years?

1= Household has more fishing gear now 2= Household has fewer or older fishing gear now 3= we spend more time fishing now 4= we spend less time fishing now 5=there are too many fishers now 6=there are too many fewer fishers now 7=the number of fishers have not changed but they all have more fishing gear now 8=The fish stock is depleted 9= The fish stock is increased 10=Water bodies are being polluted 11=Water bodies are not being polluted 12=Climate change 13=Natural fluctuation 14=Poor management of the natural resource 15=overfishing 17=Destructive fishing practices 16= Others (specify)……..

A25. Are you engaged in farming? 1= Yes 0= No
A26. Do you have access road to your farm? 1= Yes 0= No
A27. What is the walking distance from your farm to the nearest vehicular access road? .....km .....mins
A29. Do you meet your household food needs from your farming activities? 1= Yes 0= No
A30. Provide information on your output last season.

Type of crop	J17a. Area under cultivation		J17b. Output from 2017 season				
Please use codes below	Area	Units 1= acres; 2= ha; 3= poles	Quantity harvested	Units 1= bags; 2=bucket 3= bowl; 4= Kg 5 = others (specify)	Quantity sold	Units 1= bags; 2= bucket 3= bowl; 4= Kg 5 = others (specify)	Unit Price (₦)

1. Maize; 2.Cassava; 3.Plantain; 4.Cocoyam; 5.Yam; 6.Groundnut; 7.Beans 8.Vegetables; 9.others (specify)

A31. Please indicate also the types of livestock raised and realized income last year below:

Livestock Raised*	J18a. Number of animals sold	J18b. Price/unit (₦)

**1. Cattle; 2. Sheep; 3. Goats; 4. Pigs; 5. Poultry birds 6. Others*

SECTION B: LIVELIHOOD INCOME STRATEGIES/SOCIAL/POLITICAL NETWORKS

B1. Does any member of the household collect something from the bush and forest to sell? 1= Yes 0= No

B2. Do you have any member of your household who have moved out of the community and is living/working outside?
1= Yes 0= No

B3. Where did he/she move to?

1. Neighboring community 2.other local government areas 3.other states within the country 3. Outside the country

B4. What are the reasons for relocating?

1. To look for work
2. marriage/family reasons
3. Threat of violence/physically forced to leave
4. Political reasons
5. Famine
6. Disease
7. Property destroyed/occupied
8. Community disputes: land
9. Community disputes: water
10. Community disputes: ethnic
11. Lack of land

B5. Have you received remittances (in kind or cash) from family members, friends and relations living outside in the last 1year? 1= Yes 0= No

B6. What type of help did you receive from relatives and friends? 1. Cash 2. Food supply 3.clothing 4.others (specify)……..

B7. Do you receive help from family, friends and relatives living within the village during difficult times?
1=Yes 0=No

B8. Did you lend money to relatives or friends during difficult times? 1= Yes 0= No

B9. Do you have access/apply for credit/loans (from any source including non-formal institutions) in the last 5 years

1= Yes 0= No

B9a. If NO, why did you not apply for credit? (Provide possible responses)

1. Don't need money from the Financial Institution (FI)
2. Don't have access to a FI— too far
3. No collateral
4. Cannot meet loan repayment scheduling

5. Relatives/Friends, etc. always help me financially
6. Complicated loan processing procedure
7. Never made any attempt
8. Don't know how to access loan from FI
9. No savings at FI to access loans
10. Others (specify)

B10. Do you save with any financial institution? 1= Yes 0= No

B11. How will you rate your household income considering your expenses?

1. Usually not enough to cover important household expenses

2. Just enough to cover important household expenses

3. Usually have some left over after important household expenses have been met

(NB: Important household expenses include food, medicine, clothes, education, shelter, utility bills)

B12. Are you a member of any fishers/fish farmers' organization or any social group/association/cooperative organization in your community? 1=Yes 0=No
B12a. If yes how many do you belong to …….
B12b. What major benefits do you derive from the group?
1. Credit 2. Information 3. Training 4. Marketing of produce 5. Others (specify)……
B13. Is your household/village able to access external support during difficult times such as flooding, conflict?
1=Yes 0=No
B13a. If yes, who provides the support?
1. Government 2. NGOs 3. Private organization 4. Politicians' 5. Philanthropists 6. Others (specify)……..
B13b. What kind of support do they provide?
1. Monetary assistance 2. Materials assistance 3. Training assistance 4. Networking assistance 5. Others (specify)……..
B14. Do you have any organization that manage disaster in your community or near community? 1=Yes 0=No
B14a. How far is your home from the disaster office? .....km……..mins
B15. Do you have any locally based/external advocacy organization working in your community? 1=Yes 0=No

B15a. Do they come to your aid during difficult times such as flooding and conflict? 1=Yes 0=No

B16.Do groups/village folks cooperate more during difficult times such as flooding, water scarcity/conflict
1=Yes 0=No
B17. Do you have access to information on climate, security and livelihood? 1=Yes 0=No

B17a. How do you access such information?

1 Radio 2. TV 3. Social groups/association 4. Fellow farmers/fishermen 5. Extension workers 6. NGOs 7. Social media 8. Phone 9. Local information board/announcement 10. Villager's meeting 11. Printed materials 12. Others (Specify)……

B18. Have you been contacted by any extension officer in the last 1 year? 1= Yes 0= No
B18a. How often did you have contact with extension officer?..... Times.
B19. Do you have access road to your regular fishing site? 1= Yes 0= No
B19a. What is the walking distance from the fishing site to the nearest vehicular access road? .....km .....mins
B20. Do you have access to any market? 1= Yes 0= No
B20a. Are you able to buy and sell in the market? 1= Yes 0= No
B20b. How far is the nearest market?.....km/……mins?
B21. Do you have access to any health care facility? 1= Yes 0= No
B21a. Are you able to afford the health care services? 1= Yes 0= No
B21b. If yes what form of health service?
1. Clinic 2. Hospital 3. Pharmacy shop. 4. Herbal centre 5. Others (specify)……..
B21c. How far is the nearest health care facility? ……..km/ ……mins

B21d. Does anybody in your family get ill very often or chronically ill? 1= Yes 0= No
B21e. Many times in last year were you sick and unable to carry out your fishing activity?.....
B22. What is your primary source of water? a. streams/rivers b. private well c. pipe borne water
B22a. How far is this water point?……..km/……..mins.
B22b. Is this water available every day? 1= Yes 0= No
B22c. Do you drink the water collected from this source directly without first treating/boiling it? 1= Yes 0= No
B22d. If yes, do members of your household report of ill health upon drinking it untreated? 1= Yes 0= No
B23. Is the stream/rivers the only water point/source to your household? 1= Yes 0= No
B23a. If yes how long have your household been using water from the streams/rivers ……years
B24. Do you have private well or pipe borne water? 1= Yes 0= No
B25. Is scarcity of water a concern to you in this village? 1= Yes 0= No
B26. What problems does your household face in accessing water.
……
……
B27. Is pollution of water bodies a concern for you in this village? 1= Yes 0= No
B27a. What is the nature of water pollution?

i. industrial chemical waste ii. Chemical runoff from agricultural field iii. Trash or garbage iv. Oil spills v. others (mention)……..

B27b. What problems does your household face as a result of water pollution
……
……
B28. Is land pollution/degradation a concern for you in this village? 1= Yes 0= No
B28a. What is the nature of land pollution/degradation?

i. industrial chemical waste ii. Trash or garbage iii. Oil spills v. others (Mention)……..

B28b. What problems does your household face as a result of land pollution/degradation
……
……
B29. Does your household own/can access land i.e rent land legally for agricultural purposes? 1= Yes 0= No
B29a. If yes what is the tenure system of the land you are using?

1. Family land 2. Community land 3. Freehold 4. Rented 5. others

B30. Do you have access to irrigation facility? 1= Yes 0= No
B31. Do you have good drainage system? 1= Yes 0= No
B32. Do you depend only on the water bodies for your livelihood? 1= Yes 0= No

B33. Indicate the extent of your agreement on the following statements:
B33a. Fishery is a viable livelihood for the future for your household

1=strongly agree 3=do not agree 5=can't tell
2=agree 4= strongly disagree

B33b. I would advice and encourage my children to become fishers in future
1=Yes 0=No
B33c. If you get another job outside fishery sector would you want to stop fishing?
1=Yes 0=No
B33d. If yes, why would you want to stop fishing?
1=the income is not enough/not rewarding
2=Unreliable enterprise
3=Prices are not encouraging
4=the water bodies are polluted affecting its productivity
5=the catch is greatly reduced
B33e. If no, why would you **not** want to stop fishery?
1=the income is enough/rewarding
2=It is a very reliable enterprise
3=Favourable price
4=Easy access to market
5=Family enterprise
6 = I don't have other options
B33f. Were there members of the household who were fishing in the past but have stopped?
1=Yes 0=No
B33g. If yes what was the reasons for stopping?

1= too old 2=Sickness/handicapped 3= Left the household and found another job 4=Migrate to fish somewhere else 5= Found a better paid job nearby 6=Fishing was a temporary job 7=continue school 8=the catch were not high enough

B33h. How would you rate your current living conditions?

1=Very Good 3=Fair 5=Very Poor
2=Good 4=Poor

SECTION C: HOUSEHOLD INCOME SOURCES AND EXPENDITURE

C1. How many livelihood (income generating) activities are you (household head) engaged in? .....

C2. How many members of your household apart from you (household head) are earning income……

C3. Please provide information on the income sources of your household over the past 12months (i.e. from anybody who works and earn income for the household).

C3a. Fishing Income Sources	**C3b. Amount (₦)**	**C3c. Income flow** *1=Daily 2=Weekly 3=Monthly 4=Quarterly 5=Yearly*	**C3d. Farm Income Sources**	**C3e. Amount (₦)**	**C3f. Income flow** *1=Daily 2=Weekly 3=Monthly 4=Quarterly 5=Yearly*	**C3g. Non-Farm Income Sources**	**C3h. Amount (₦)**	**C3i. Income flow** *1=Daily 2=Weekly 3=Monthly 4=Quarterly 5=Yearly*
1.Fresh fish sales			1.Food crops sales:			1.Salary/Non-Farm wage income		
2. Processed fish sales			2.Cash Crops:			2.Informal business/petty trading		
3. Fish bi-products sales (shells, gut entrails etc.)			3.Natural resources (Hunting/gathering/charcoal/minerals)			3. Artisan (Handicraft, Mason, construction work, etc)		
4.Value of fish given out as gift			4.Livestock			4. Transport business		
5.Fish consumed by household			5.Farm wages			5. Remittances		
6. Fishing wages			6. Others			6. Dividends/ Interest on Financial investments		
						7. Others (pension, rent, agro-processing)		
Total			**Total**			**Total**		

C4. Why do you choose to engage in these different income generating activities?
(a) Diversification purposes (b) Environmental sustainability (c) Availability of skills (d) Cultural reasons (e) Availability of capital (g) others (mention)……

C5. Indicate your expenditures

Item	C5a. Most regular Period of expenditure *1=Daily* *2=Weekly* *3=Monthly* *4=Quarterly* *5=Yearly*	C5b. Expenditure per period (₦)
1. Food purchase		
2. Water		
3. Clothes		
4. Sanitation – waste disposal		
5. Education for children (mainly uniform, books, school fees & transport)		
6. Health		
7. Electricity		
8. Rent		
9. Public Transport (exclude education related expenses)		
10. Funerals/social events including weddings		
11. Firewood/Charcoal		
12. Kerosene		
13. Gas		
14. Petrol		
15. Diesel		
16. Vehicle/bike maintenance		
17. Recharge cards		
18. Personal care goods (soap, cosmetics, razor, T-roll)		
19. Remittance		
20. Church offerings and donations		
21. Gifts/charity		
22. Others (specify)		

SECTION D: ASSETS OF THE HOUSEHOLD [INCLUDE ITEMS ONLY IF THEY ARE IN WORKING CONDITION]

D1. What type of house do you have or live in?

1. Mud house 2. Thatch house 3. Container 4. Wooden house 5. Cement house

D2. What kind of material was used to construct the walls of the house?

1. non-cemented material/mud 2. Corrugated tin 3. Cement and brick casting/concrete

D3. What kind of material was used to construct the roof of the house?

1. leaves/straw 2. Corrugated tin 3. Concrete 4. Bricks

D4. What kind of material was used to construct the floor of the house?

1. Dirt 2. Brick/wood with non-cemented material 3. Concrete

D5. Do you have good sanitary toilet where you live? 1= Yes 0= No

D6. How many adults sleeps in a room?.....

D7. Please indicate which of these assets you own and their numbers:

Fishing Assets

Asset	D7a. Number/ quantity owned	D7b. Unit value (₦)
1. Fishing net (mosquito net)		
2. (Beach) Seine		
3. Gillnet		
4. Cast net		
5. Fishing trap		
6. Long/hand line		
7. Plank boat		
8. Outboard engine		
9. Others (list below)		

D8. Other assets (non-fishing assets) ***Indicate zero if respondent does not own item***

Assets	D8a. Indicate number or size of assets where applicable.
1. Motor car	
2. Motor bike	
3. Bicycle	
4. Tractor	
5. Furniture	
6. Sewing machine	
7. Sawing machine (for timber)	
8. Solar/electricity	
9. Refrigerator/Freezer	
10. Radio	
11. Television /Video recorder	
12. Satellite Dish	
13. Computer	
14. DVD player	
15. Electric Iron	
16. Electric Fan	
17. Mobile Telephone	
18. Washing machine	
19. Generator	
20. Electric/Gas Stove	
21. Microwave	
22. Air conditioner	
23. Spraying Machine	
24. Irrigation equipment (e.g irrigation pipes)	
25. Water pump	
26. House/building	
27. Land for farming	
28. Account with financial institution	
29. Shares in a company/Treasury bill	
30. Jewellery	
31. Cloth: Damask, Lace etc.	

32. Cattle	
33. Sheep/Goats	
34. Chickens	
35. Non-farm business enterprise (e.g. a store)	
36. Donkeys	
37. Corn Mill	
38. Other (specify.....)	

SECTION E: CLIMATE SHOCKS

E1. Have you noticed any long term changes (>=20years) in temperature? 1= Yes 0= No

E1a. If yes please indicate the changes you observed on temperature **multiple responses**

1. Increase of average temperature [ ] 2. Decrease of average temperature [ ] 3. Increase of the minimum level compare to the last 2 decades [ ] 4. Decrease of the minimum level compare to the last 2 decades [ ] 5. Increase of the maximum level compare to the last 2 decades [ ] 6. Decrease of the maximum level compare to the last 2 decades

E2. Have you noticed any long term changes (i.e. >=20years) in rainfall? 1= Yes 0= No

E2a. If yes Please indicate the changes you observed on rain **multiple responses**

1. Increase of the variability of the rain [ ] 2. Decrease of the variability of the rain [ ] 3. Late rain [ ] 4. Early rain [ ] 5. Increase of the intensity of rain [ ] 6. Decrease of the intensity of rain [ ] 7. Increase of average rainfall [ ] 8. Decrease of average rainfall [ ] 9. Increase of minimum rainfall [ ] 10. Decrease of the minimum rainfall [ ] 11. Increase of maximum rainfall [ ] 12. Decrease of maximum rainfall [ ]

E3. Have these changes had any effect on your livelihood in terms of losses incurred in the past (5-10years)

1= Yes 0= No

E3a. If yes indicate the extent to which climate variability is responsible for reduced income in your household

i. 1-25% ii. 26-50% iii. 51-75% iv. 76-100%

E4. Have you experienced flooding, drought or any natural disaster in the past (5-10years) 1= Yes 0= No

E4a. How many times have you experienced a. flooding……..b. drought…….

E5. Did you receive any warning about the aforementioned disaster before it happened? 1= Yes 0= No

E6. Was any one in your household injured during those events? 1= Yes 0= No

E7. Did any member in your household die during those events? 1= Yes 0= No

E8. Were you displaced from your home during these events? 1= Yes 0= No

E8a. If yes where did you go to?

1. Friends' 2. Relations 3. Neighbors 4. Refugee camp 5. Others (specify)……..

E9. Have this event had any effect on your livelihood in terms of losses incurred in the past (5-10years)

1= Yes 0= No

E9a. If yes indicate the extent to which flooding is responsible for reduced income in your household

1. 1-25% 2. 26-50% 3. 51-75% 4. 76-100%

E10. Please indicate your level of agreement about the following statement

Issue	Level of agreement
The weather is changing	
The change in weather will induce increase of temperature and decrease of rainfall	
The change in weather will increase the variability of precipitation	
The change in weather will reduce the availability of water	
The change in weather will increase coastal erosion	
The change in weather will increase the likelihood of drought and flood	
The change in weather will affect fish catch	
Climate change is affecting fishery productivity	

1. Strongly disagree 2 disagree 3. Neither agree nor disagree 4. Agree 5. Strongly agree

SECTION F: CONFLICT

F1. Have you been aggressive about water resource i.e having the urge to grab or control public water?

1= Yes 0= No

F2. Are you aware of any conflict over water resource that has turned violent in your area?

1= Yes 0= No

F3. Who are the persons involved in this conflict?

i. Small scale fishers vs commercial fishers ii. Professional fishers vs sports fishers ii fishers vs farmers iii fishers vs pastoralists iv. Fishers vs fishery enforcement and regulatory agencies v. fishers vs companies such as oil, sewage disposal, electricity etc. vi. Community vs community vii. Others (mention)……

F4. What are the reasons for these conflicts?

-	Strongly agree	Agree	Disagree	Strongly disagree	Don't know
1. Influx of new people into fishing					
2. Influx of migrants fishers from other communities					
3. Too many people chasing fewer fish					
4. Destructive fishing practices					
5. Use of light luring and modern fishing gears by large scale fishers					
6. Conflict between users of different fishing technology					
7. Conflict over right and access to designated zones					

8. Construction by farmers o irrigation dams on floodplains					
9. Use of water from the river for farm irrigation					
10. Water contamination by agricultural toxins/chemical and animal manure					
11. Disrespectful treatment by enforcement agencies					
12. Inappropriate apprehension of gear and fish by enforcement agencies					
13. Imposing fines.					
14. Polluting effluent discharge and oil spills from industries					
15. If government agencies did their job properly, there would be very few conflicts fisheries					
16. Influence of powerful influentials in fishing is the major cause of fisheries conflicts					

F5. Are there laws prohibiting certain groups of fishers from fishing in some waters.

1= Yes 0= No

F5a. If yes mention the laws.

……

……....

F6. Have you been forced to stop fishing in some parts of rivers/waters surrounding neighouring village?

F7. Have your community been involved in conflict with another community over ownership of some area based on residency or ancestral occupation? 1= Yes 0= No

F8. Have you migrated to other fishing ground outside your territory to fish and did you have conflict with local fishers there? 1= Yes 0= No

F9. The conflict did it involve i. physical violence [ ] ii fishing gears seized [ ] iii. Arrest by border security force [ ] iv. Others (mention)……. **Multiple responses**

F10. Do you feel secure in your village i.e safe from threats of conflict and violence? 1= Yes 0= No

F11. How safe do you feel in your neighbourhood or local area?

	Strongly agree	Agree	Disagree	Strongly disagree	Don't know
1. I feel safe when walking alone in the neighbourhood during the day.					
2. I feel safe when walking alone in the neighbourhood during the night.					
3. I feel safe from crime and violence when I am alone at home.					
4. I avoid using certain ways and do not go to certain areas that I think are dangerous.					
5. My neighbourhood is peaceful overall.					
6. My neighbourhood is marked by the repeated occurrence of violence.					
7. The level of violence has increased a lot compared to two years ago.					

8. It is very likely that in the next 12 months I will become a victim of violence.					
9. I never hear weapons being fired in my neighbourhood.					
10. The police are doing a good job.					

F12. Have you suffered any of the following due to water conflict? **Multiple responses**

i. Injury [ ] ii. Loss of family members or relatives [ ] iii. Loss of friends [ ] iv. Loss of neighbor or kinsman [ ] v. others (Mention)……

F13. How can these conflicts be resolved?

	Strongly agree	Agree	Disagree	Strongly disagree	Don't know
1. Meetings and workshops by all stakeholders to resolve issues through dialogue and negotiations					
2. Strengthening the capacity of local/informal institutions as conflict mediators					
3. Awareness raising in all fishing communities against illegal fishing practices					
4. Effective enforcement of fishery regulations					
5. Cooperation between communities/states to resolve transboundary conflict					
6. Dealing with issues of corruption in the fishery sub-sector.					
7. Others (Mention)					

F14. What are the necessary conditions that can foster conflict?

1. Understanding of existing policy and regulations by all parties 1=Yes 0=No
2. Organizing community and government to work together in resource management. 1=Yes 0=No
3. Better understanding of one another's needs. 1=Yes 0=No

F15. Which entities are saddled with the responsibility of resolving conflict?

	Strongly agree	Agree	Disagree	Strongly disagree	Don't know
1. Government play the most significant role in management of conflicts.					
2. The NGOs can support communities in managing conflicts					
3. Fishers and their leaders should take the initiative to resolve conflicts					
4. Local elites can play an important role in conflict resolution					
5. Everyone has a social responsibility to help to resolve conflicts					

SECTION G: ENVIRONMENTAL DEGRADATION

G1. Which of the following environmental problems do you experience? **Multiple responses**

1. Urban waste water pollution [ ]
2. Urban solid waste water pollution [ ]
3. Oil spillage [ ]
4. Water pollution due to agriculture [ ]
5. Deforestation in the water shed [ ]
6. Sedimentation and irrigation [ ]

G2. What are the effects of these environmental problems on your livelihood in terms of losses incurred in the past (5-10years). **Multiple responses**

1. Fish deaths/low fish catch [ ]
2. Diminished population of native species [ ]
3. Loss of soil fertility [ ]
4. Loss of vegetation cover/scarcity of forages/grasses for livestock [ ]
5. Biodiversity depletion [ ]
6. Reduction in income [ ]
7. Reduction in productivity of land [ ]

G3. Have there been any changes in the benefit you derive from the river/stream in recent years (i.e 5-10years) as a result of pollution? 1. Yes 2. No

G4. Indicate the extent to which pollution of the water bodies is responsible for reduced income in your household

1. 1-25% 2. 26-50% 3. 51-75% 4. 76-100%

G5. Have there been any changes in the benefit you derive from the agricultural land in recent years (i.e 5-10years) as a result of pollution? 1. Yes 2. No

Indicate the extent to which pollution of the land is responsible for reduced income in your household

1. 1-25% 2. 26-50% 3. 51-75% 4. 76-100%

SECTION H: ADAPTATION STRATEGIES

H1. Have you made any adjustments to cope with changes in climate and land/water degradation? 1= Yes 0= No

H2. If yes what are the adjustments you have made and against what risks?

Application: 1. Yes 0. No

Risks: 1. Floods 2. Droughts 3. High temperature 4. Low temperature 5. Variability of rain fall 6. Decrease of rain fall 7. Increase of rain fall 8. Late rain 9. Early rain 10. Environmental degradation

Strategies	**I2a. application**	**Ib. Against which Risk**
Using improved and more sophisticated fishing gears		
Extending working hours		
Varying fishing location		
Diversification beyond fishery		
Fishing over large expanse		
Prayers		
Others (Specify)		

H3. What are the challenges to adaptation?

i. Inadequate information on modern adaptation techniques ii. lack of financial capital iii. Lack of modern equipment.

SECTION J: FOOD SECURITY

J1. In the past 4 weeks, were you worried your household would run out of food because of lack of money or other resources?

0 = No (Skip to J2) 1 = Yes

J1a. How often did this happen in the past 4 weeks?

0 = rarely (1–2 times) 1 = Sometimes (3–10 times) 2 = Often (more than 10 times)

J2. In the past 4 weeks were you or any member of your household unable to eat healthy and nutritional food because of lack of money or other resources?

0 = No (Skip to J3) 1 = Yes

J2a. How often did this happen in the past 4 weeks

0 = rarely (1–2 times) 1 = Sometimes (3–10 times) 2 = Often (more than 10 times)

J3. In the past four weeks did you or any member of your household have to eat only few kinds of food because of lack of money or other kinds of resources?

0 = No (Skip to J4) 1 = Yes

J3a. How often did this happen in the past 4 weeks

0 = rarely (1–2 times) 1 = Sometimes (3–10 times) 2 = Often (more than 10 times)

J4. In the past 4 weeks did you or any member of your household eat less than they should eat because of lack of money or other resources?

0 = No (Skip to J5) 1 = Yes

J4a. How often did this happen in the past 4 weeks

0 = rarely (1–2 times) 1 = Sometimes (3–10 times) 2 = Often (more than 10 times)

J5. In the past 4 weeks did your household ran out of food because of lack of money or other resources?

0 = No (Skip to J6) 1 = Yes

J5a. How often did this happen in the past 4 weeks

0 = rarely (1–2 times) 1 = Sometimes (3–10 times) 2 = Often (more than 10 times)

J6. In the past 4 weeks did you or any member of your household ever have to skip a meal because there was not enough money or other resources to get food?

J7. In the past 4 weeks did you or any household member go to sleep at night hungry because there was not enough food or other resources?

0 = No (Skip to J8) 1 = Yes

J7a. How often did this happen in the past 4 weeks

0 = rarely (1–2 times)
1 = Sometimes (3–10 times)
2 = Often (more than 10 times)

J8. In the past 4 weeks, did you or any household member go a whole day and night without eating anything at all because there was not enough food and lack of money or other resources?
0 = No (Skip to J9) 1 = Yes

J8a. How often did this happen in the past 4 weeks

0 = rarely (1–2 times)
1 = Sometimes (3–10 times)
2 = Often (more than 10 times)

J9. Does your household normally experience severe food shortages (famine)?
0= No (Skip to J10) 1= Yes

J9a. If yes, during which months (2017) did the household experience severe food shortages? Please tick major month

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec

J9b Why was there difficulty in satisfying food needs in 2017? [Multiple answers allowed]

1. An Income earning member of the household died
2. An Income earning member of the household left
3. Additional members joined the household
4. An income earning member of household lost his/her job
5. An income earning member of household could no longer work because of illness
6. Remittances no longer received
7. Reduction in remittances received
8. Poor harvest of food crops due to pest/disease
9. Poor harvest of food crops due to climatic conditions, e.g. drought
10. Problem with storage of food
11. Sold most of product right after harvest and did not get a good price
12. Food prices became too high
13. Reduced access to land
14. Other ……..

J10. Do you store food for use during period of shortage? 1= Yes 0= No
J11. How many months does this stored food take you and your household?.....months
J12. Where do you get most of your food? a. Own farm b. Purchases c. Barter with fish d. gift e. others (specify)..

FARMERS' VERSION OF THE QUESTIONNAIRE

Good day, Mr/Mrs/Miss,
You have been selected by chance from all fishermen in the area to participate in the study undertaken by Onyenekwe Sylvia Chinasa for her PhD research. The purpose of this interview is to obtain current information about your fishery activities, vulnerability to climate shocks, environmental degradation and resource conflict, adaptation strategies to these stressors and impact of these stressors on your food security status. The survey is voluntary and information gathered will be confidential and will be only served for this academic purpose. Your support and contribution would be very much appreciated. For further inquiries, please contact her at sconyenekwe@st.ug.edu.gh or Tel: +2348036545790/+233541712437.

GENERAL INFORMATION

1. Questionnaire No. …… 2. Enumerator Name/No……..

3. State …… 4. Local Govt. Area: ……

5. Village/community: …….. 6. Respondent's Name/No……

SECTION A: RESPONDENTS' HOUSEHOLD CHARACTERISTICS (SOCIO-DEMOGRAPHIC PROFILE)

A1. Name of household head ……
A2. Marital Status:
1= Married 2 = Widowed 3 = Single 4= Separated 5 = Divorced
A3. Age of respondent ……..years
A4. Sex of respondent.
0 = Male 1 = Female
A5. What is the residential status of respondent?
1. Indigene/Native 2. Migrant
A6. How long have you lived in this community?.....years
A7. What is your religious affiliation? 0. None; 1. Christian; 2. Muslim; 3. Traditional; 4. Other (Specify)……..
A8. What is your ethnicity?
1. Ijaw 2. Ikwerre 3. Kalabari 4. Okrika 5. Ogoni 6. Itsekiri 7. Isoko 8. Ukwuani 9. Opobo 10. Eleme 11. Others
A9. What is your main occupation?
1 = Farmer
2 = Fisher
3 = Pastoralist
4 = Hired labourer on farm
5 = Trader (including kiosk)
6 = Self-employed artisan/Skilled Craftsman (such as carpentry, tailoring, bricklaying, etc.)
7 = Salaried employee
8 = Transport (using bike, boats, cars, lorries)
9 = Food processor (garri, chips, food vendors etc)
10 = others (specify)
A10. How many years have you worked in this primary occupation?…….years

A11. What is your secondary occupation? (Other activities engaged in besides the one above)
1 = Farmer
2 = Fisher
3 = Pastoralist
4 = Hired labourer on farm
5 = Trader (including kiosk)
6 = Self-employed artisan/Skilled Craftsman (such as carpentry, tailoring, bricklaying, etc.)
7 = Salaried employee
8 = Transport (using bike, boats, cars, lorries)
9 = Food processor (garri, chips, food vendors etc)
10 = others (specify)

A12. How many years have you worked in this secondary occupation?……years

A13. What is your highest level of education?

0. None
1. Uncompleted primary
2. Primary completed
3. Secondary/JSS
4. Secondary/SSS
5 = Tertiary
6 = Adult education
7 = Non-formal education
8 = others (specify):

A14. Number of years spent to attain this level of education? ……

A15.What is the size of your household and how many are available for work regularly? (***Should include respondent***)

Category of household members	A15a. Number
Adults (60 years & above)	
Male adults (eighteen years to 59years)	
Female adults (eighteen years to 59years)	
Children between 6 years and 18 years	
Children under 6 years	
Total household size	

A16. How many of your household members were involved in farming during the last season? …….

A17. How many days and duration did household member(s) spend farming in a week? ……days …….. hours

A18. How many members of your household apart from you (household head) are earning income……..

A19**.** Indicate the number of farm holdings (plots) you own

	A19a	A19b	A19c	A19d	A19e	A19f
farm holding (plot #)	Location name of the farm/plot [hint: This is how the respondent refers to the plot will be used for identification of the specific plot throughout the survey]	Type of landholding **(see Code below)** 1. Freehold/owned 2. Family land 3. Rented 4. Community 5. Sharecropping 6. Others	If rented land, state rent per year (Naira)	State size of farm (#)	Farm/plot size code (see below): 1. Poles 2. Acres 3. Hectares (HA)	Soil fertility level [4.0 = very fertile; 3.0 = moderately fertile; 2.0 = low fertility 1.0 = not fertile]
Plot 1						
Plot 2						
Plot 3						
Plot 4						

A20. Which of these crops do you grow? **Multiple responses**

1. Maize [ ] 2. Cassava [ ] 3.Plantain [ ] 4. Cocoyam [ ] 5. Yam [ ] 6. Beans [ ] 7. Groundnut [ ] 8. Vegetables [ ] 9. Others (specify)…….

A21. Which one is your main crop? ? 1. Maize [ ] 2. Cassava [ ] 3.Plantain [ ] 4. Cocoyam [ ] 5. Yam [ ] 6. Beans [ ] 7. Groundnut [ ] 8. Vegetables [ ] 9. Others (specify)

A22. For how many years have you being cultivating it? .....years

A23. What is your objective for growing this crop? 1. Food [ ] 2. Sell [ ] 3. Both [ ]

A24. What proportions of the crops grown is/are used for consumption and sale? Proportion for consumption ……% Proportion for sale ……..%

A25. Do you meet your household food needs from your farming activities? 1= Yes 0= No

A26. Provide information on your output last season

Type of crop	A26a. Area under cultivation		A26b. Output from 2017 season				
Please use codes below	Area	Units 1= poles 2= acres 3= ha	Quantity harvested	Units 1= bags; 2=bucket 3= bowl; 4= Kg 5 = others (specify)	Quantity sold	Units 1= bags; 2= bucket 3= bowl; 4= Kg 5 = others (specify)	Unit Price (₦)

1. Maize 2. Cassava 3.Plantain 4. Cocoyam 5. Yam 6. Beans 7. Groundnut 8. Vegetables 9. Others (specify)

A27. What changes have you observed in your output over the last five years?

1=1-25% increase 2=26-100% increase 3=1-25% decrease 4=26-100% decrease 5=Natural fluctuation 6=no change

A28. What are the reasons for the changes in your output over the last five years?

1=the soil is degraded/polluted 2=the fertility of the soil is reduced 3=climate change 4=natural fluctuation 5= destructive farming practices 6=others (specify)…….

A29. Please indicate also the types of livestock raised and realized income last year below:

Livestock Raised*	**J18a. Number of animals sold**	**J18b. Price/unit (₦)**

**1. Cattle; 2. Sheep; 3. Goats; 4. Pigs; 5. Poultry birds 6. Others*

SECTION B: LIVELIHOOD INCOME STRATEGIES/SOCIAL/POLITICAL NETWORKS

B1. Does any member of the household collect something from the bush and forest to sell? 1= Yes 0= No

B2. Do you have any member of your household who have moved out of the community and is living/working outside? 1= Yes 0= No

B3. Where did he/she move to?

2. Neighboring community 2.other local government areas 3.other states within the country 3. Outside the country

B4. What are the reasons for relocating?

12. To look for work
13. marriage/family reasons
14. Threat of violence/physically forced to leave
15. Political reasons
16. Famine
17. Disease
18. Property destroyed/occupied
19. Community disputes: land
20. Community disputes: water
21. Community disputes: ethnic

B5. Have you received remittances (in kind or cash) from family members, friends and relations living outside in the last 1year? 1= Yes 0= No

B6. What type of help did you receive from relatives and friends? 1. Cash 2. Food supply 3.clothing 4.others (specify)……..

B7. Do you receive help from family, friends and relatives living within the village during difficult times?
1=Yes 0=No

B8. Did you lend money to relatives or friends during difficult times? 1= Yes 0= No

B9. Do you have access/apply for credit/loans (from any source including non-formal institutions) 1= Yes 0= No

B9a. If NO, why did you not apply for credit? (Provide possible responses)

11. Don't need money from the FI
12. Don't have access to a Financial Institution (FI)—Financial Institution too far
13. No collateral
14. Cannot meet loan repayment scheduling
15. Relatives/Friends, etc. always help me financially
16. Complicated loan processing procedure
17. Never made any attempt
18. Don't know how to access loan from FI
19. No savings at FI to access loans
20. Others (specify)

B10. Do you save with any financial institution? 1= Yes 0= No

B11. How will you rate your household income considering your expenses?

1. Usually not enough to cover important household expenses
2. Just enough to cover important household expenses
3. Usually have some left over after important household expenses have been met

(NB: Important household expenses include food, medicine, clothes, education, shelter, utility bills)

B12. Are you a member of any farmer organization or any social group/association/cooperative organization in your community? 1=Yes 0=No

B12a. If yes how many do you belong to …….

B12b. What major benefits do you derive from the group?

2. Credit 2. Information 3. Training 4. Marketing of produce 5. Others (specify)……

B13. Is your household/village able to access external support during difficult times? 1=Yes 0=No

B13a. If yes, who provides the support?

2. Government 2. NGOs 3. Private organization 4. Politicians' 5. Philanthropists 6. Others (specify)……..

B13b. What kind of support do they provide?

1. Monetary assistance 2. Materials assistance 3. Training assistance 4. Networking assistance 5. Others (specify)……..

B14. Do you have any organization that manage disaster in your community or near community? 1=Yes 0=No
B14a. How far is your home from the disaster office? .....km……..mins
B15. Do you have any locally based/external advocacy organization working in your community? 1=Yes 0=No

B15a. Do they come to your aid during difficult times such as flooding and conflict? 1=Yes 0=No

B16. Do groups/village folks cooperate more during difficult times such as flooding, water scarcity/conflict
1=Yes 0=No
B17. Do you have access to information on climate, security and livelihood? 1=Yes 0=No

B17a. How do you access such information?

1 Radio 2. TV 3. Social groups/association 4. Fellow farmers/fishermen 5. Extension workers 6. NGOs 7. Social media 8. Phone 9. Local information board/announcement 10. Villager's meeting 11. Printed materials 12. Others (Specify)……

B18. Have you been contacted by any extension officer in the last 1 year? 1= Yes 0= No
B18a. How often did you have contact with extension officer (number of times in the farming season)..... Times.
B19. Do you have access road to your farm? 1= Yes 0= No
B19a. What is the walking distance from your farm to the nearest vehicular access road? .....km .....mins
B20. Do you have access to any market? 1= Yes 0= No
B20a. Are you able to buy and sell in the market? 1= Yes 0= No
B20b. How far is the nearest market?.....km/……mins?
B21. Do you have access to any health care facility? 1. Yes 0= No
B21a. Are you able to afford the health care services? 1= Yes 0= No
B21b. If yes what form of health service?
1. Clinic 2. Hospital 3. Pharmacy shop. 4. Herbal centre 5. Others (specify)……..
B21c. How far is the nearest health care facility? ……..km/ ……mins
B21d. Does anybody in your family get ill very often or chronically ill? 1= Yes 0= No
B21e. Many times in last year were you sick and unable to carry out your farming activity?.....
B22. What is your primary source of water? a. streams/rivers b. private well c. pipe borne water
B22a. How far is this water point?……..km/……..mins.
B22b. Is this water available every day? 1= Yes 0= No
B22c. Do you drink the water collected from this source directly without first treating/boiling it? 1= Yes 0= No
B22d. If yes, do members of your household report of ill health upon drinking it untreated? 1= Yes 0= No
B23. Is the stream/rivers the only water point/source to your household? 1. Yes 0= No
B23a. If yes how long have your household been using water from the streams/rivers ……years
B24. Do you have private well or pipe borne water? 1. Yes 0= No
B25. Is scarcity of water a concern to you in this village? 1. Yes 0= No
B26. What problems does your household face in accessing water.
……
……
B27. Is pollution of water bodies a concern for you in this village? 1. Yes 0= No
B27a. What is the nature of water pollution?
ii. industrial chemical waste ii. Chemical runoff from agricultural field iii. Trash or garbage iv. Oil spills v. others (mention)……..
B27b. What problems does your household face as a result of water pollution
……
……
……
B28. Is land pollution/degradation a concern for you in this village? 1= Yes 0= No
B28a. What is the nature of land pollution/degradation?
ii. industrial chemical waste ii. Trash or garbage iii. Oil spills v. others (Mention)……..
B28b. What problems does your household face as a result of land pollution/degradation

……
……

B29. Do you have access to irrigation facility? 1= Yes 0= No

B30. Do you have good drainage system? 1= Yes 0= No

B31. Do you depend only on the land for your livelihood? 1= Yes 0= No

B32. Indicate the extent of your agreement on the following statements:

B32a. Farming is a viable livelihood for the future for your household

1=strongly agree 3=do not agree 5=can't tell
2=agree 4= strongly disagree

B32b. I would advice and encourage my children to become farmers in future
1=Yes 0=No

B32c. If you get another job outside farming would you want to stop farming?
1=Yes 0=No

B32d. If yes, why would you want to stop farming?
1=the income is not enough/not rewarding
2=Unreliable enterprise
3=Prices are not encouraging
4=the land are polluted/degraded affecting its productivity

B32e. If no, why would you **not** want to stop farming?
1=the income is enough/rewarding
2=It is a very reliable enterprise
3=Favourable price
4= Family enterprise
5= I don't have other options

B32f. Were there members of the household who were farming in the past but have stopped?
1=Yes 0=No

B32g. If yes what was the reasons for stopping?
1= too old 2=Sickness/handicapped 3= Left the household and found another job 4=Migrate to farm somewhere else 5= Found a better paid job nearby 6=Farming was a temporary job 7=continue school

B32h. How would you rate your current living conditions?

1=Very Good 3=Fair 5=Very Poor
2=Good 4=Poor

SECTION C: HOUSEHOLD INCOME SOURCES AND EXPENDITURE

C1. How many livelihood (income generating) activities are you (household head) engaged in? .....

C2. Please provide information on the income sources of your household over the past 12months (i.e. from anybody who works and earn income for the household).

C2a. Farm Income Sources	**C2b. Amount (₦)**	**C2c. Income flow** *1=Daily 2=Weekly 3=Monthly 4=Quarterly 5=Yearly*	**C2d. Non-Farm Income Sources**	**C2e. Amount (₦)**	**C2f. Income flow** *1=Daily 2=Weekly 3=Monthly 4=Quarterly 5=Yearly*
1.Food crops sales:			1.Salary/Non-Farm wage income		
2.Cash Crops:			2.Informal business/petty trading		

3.Natural resources (Hunting/gathering/ charcoal/minerals)			3. Artisan (Handicraft, Mason, construction work, etc)		
4.Livestock			4. Transport business		
5.Farm wages			5. Remittances		
6. Others			6. Dividends/ Interest on Financial investments		
			7. Others (pension, rent, agro-processing)		
Total			**Total**		

C3. Why do you choose to engage in these different income generating activities?
(a) Diversification purposes (b) Environmental sustainability (c) Availability of skills (d) Cultural reasons (e) Availability of capital (g) others (mention)……
C4. Indicate your expenditures

Item	C4a. Most regular Period of expenditure *1=Daily 2=Weekly 3=Monthly 4=Quarterly 5=Yearly*	C4b. Expenditure per period (₦)
23. Food purchase		
24. Water		
25. Clothes		
26. Sanitation – waste disposal		
27. Education for children (mainly uniform, books, school fees &transport)		
28. Health		
29. Electricity		
30. Rent		
31. Public Transport (exclude education related expenses)		
32. Funerals/social events including weddings		
33. Firewood/Charcoal		
34. Kerosene		
35. Gas		
36. Petrol		
37. Diesel		
38. Vehicle/bike maintenance		
39. Recharge cards		
40. Personal care goods (soap, cosmetics, razor, T-roll)		
41. Remittance		
42. Church offerings and donations		
43. Gifts/charity		
44. Others (specify)		

SECTION D: ASSETS OF THE HOUSEHOLD [INCLUDE ITEMS ONLY IF THEY ARE IN WORKING CONDITION]

D1. What type of house do you have or live in?

1. Mud house 2. Thatch house 3. Container 4. Wooden house 5. Cement house

D2. What kind of material was used to construct the walls of the house?

1. non-cemented material/mud 2. Corrugated tin 3. Cement and brick casting/concrete

D3. What kind of material was used to construct the roof of the house?

1. leaves/straw 2. Corrugated tin 3. Concrete 4. Bricks

D4. What kind of material was used to construct the floor of the house?

2. Dirt 2. Brick/wood with non-cemented material 3. Concrete

D5. Do you have good sanitary toilet where you live? 1= Yes 0= No

D6. How many adults sleeps in a room?.....

D7. Please indicate which of these assets you own and their numbers (indicate zero if respondent does not own item)

Assets	D7a. Indicate number or size of assets where applicable.
39. Motor car	
40. Motor bike	
41. Bicycle	
42. Tractor	
43. Furniture	
44. Sewing machine	
45. Sawing machine (for timber)	
46. Solar/electricity	
47. Refrigerator/Freezer	
48. Radio	
49. Television /Video recorder	
50. Satellite Dish	
51. Computer	
52. DVD player	
53. Electric Iron	
54. Electric Fan	
55. Mobile Telephone	
56. Washing machine	
57. Generator	
58. Electric/Gas Stove	
59. Microwave	
60. Air conditioner	
61. Spraying Machine	
62. Irrigation equipment (e.g irrigation pipes)	
63. Water pump	
64. House/building	
65. Land for farming	
66. Account with financial institution	

67. Shares in a company/Treasury bill	
68. Jewellery	
69. Cloth: Damask, Lace etc.	
70. Cattle	
71. Sheep/Goats	
72. Chickens	
73. Non-farm business enterprise (e.g. a store)	
74. Donkeys	
75. Corn Mill	
76. Other (specify.....)	

SECTION E: CLIMATE SHOCKS

E1. Have you noticed any long term changes (>=20years) in temperature? 1= Yes 0= No

E1a. If yes please indicate the changes you observed on temperature **multiple responses**

1. Increase of average temperature [ ] 2. Decrease of average temperature [ ] 3. Increase of the minimum level compare to the last 2 decades [ ] 4. Decrease of the minimum level compare to the last 2 decades [ ] 5. Increase of the maximum level compare to the last 2 decades [ ] 6. Decrease of the maximum level compare to the last 2 decades

E2. Have you noticed any long term changes (i.e. >=20years) in rainfall? 1= Yes 0= No

E2a. If yes please indicate the changes you observed on rain **multiple responses**

1. Increase of the variability of the rain [ ] 2. Decrease of the variability of the rain [ ] 3. Late rain [ ] 4. Early rain [ ] 5. Increase of the intensity of rain [ ] 6. Decrease of the intensity of rain [ ] 7. Increase of average rainfall [ ] 8. Decrease of average rainfall [ ] 9. Increase of minimum rainfall [ ] 10. Decrease of the minimum rainfall [ ] 11. Increase of maximum rainfall [ ] 12. Decrease of maximum rainfall [ ]

E3. Have this changes had any effect on your livelihood in terms of losses incurred in the past (5-10years)

1= Yes 0= No

E3a. If yes indicate the extent to which climate variability is responsible for reduced income in your household

ii. 1-25% ii. 26-50% iii. 51-75% iv. 76-100%

E4. Have you experienced flooding, drought or any natural disaster in the past (5-10years) 1= Yes 0= No

E4a. How many times have you experienced a. flooding……..b. drought…….

E5. Did you receive any warning about the aforementioned disaster before it happened? 1= Yes 0= No

E6. Was any one in your household injured during those events? 1= Yes 0= No

E7. Did any member in your household die during those events? 1= Yes 0= No

E8. Were you displaced from your home during this events? 1= Yes 0= No

E8a. If yes where did you go to?

1. Friends' 2. Relations 3. Neighbors 4. Refugee camp e. others (specify)……..

E9. Have this event had any effect on your livelihood in terms of losses incurred in the past (5-10years)

1= Yes 0= No

E9a. If yes indicate the extent to which flooding is responsible for reduced income in your household

5. 1-25% 6. 26-50% 7. 51-75% 8. 76-100%

E10. Please indicate your level of agreement about the following statement

Issue	Level of agreement
The weather is changing	
The change in weather will induce increase of temperature and decrease of rainfall	
The change in weather will increased the variability of precipitation	
The change in weather will reduce the availability of water	
The change in weather will increase land erosion	
The change in weather will increase the likelihood of drought and flood	
The change in weather will affect agricultural production	
Climate change is affecting agricultural production	

2. Strongly disagree 2 disagree 3. Neither agree nor disagree 4. Agree 5. Strongly agree

SECTION F: CONFLICT

F1. Have you been aggressive about land conditions or having the urge to grab land?

1= Yes 0= No

F2. Are you aware of any land conflict that has turned violent in your area?

1= Yes 0= No

F3. Who are the persons involved in this conflict?

ii. Farmers ii. Pastoralists iii. government iv oil companies v. Others (mention)……

F4. What are the reasons for these conflicts?

……

……

F5. Have you suffered any of the following due to land conflict? **Multiple responses**

1. Injury [ ] ii. Loss of family members or relatives [ ] iii. Loss of friends [ ] iv. Loss of neighbor or kinsman [ ] v. others (Mention)……

F6. Do you feel secure in your village i.e safe from threats of conflict and violence? 1= Yes 0= No

F7. How safe do you feel in your neighbourhood or local area?

	Strongly agree	Agree	Disagree	Strongly disagree	Don't know
11. I feel safe when walking alone in the neighbourhood during the day.					

12. I feel safe when walking alone in the neighbourhood during the night.					
13. I feel safe from crime and violence when I am alone at home.					
14. I avoid using certain ways and do not go to certain areas that I think are dangerous.					
15. My neighbourhood is peaceful overall.					
16. My neighbourhood is marked by the repeated occurrence of violence.					
17. The level of violence has increased a lot compared to two years ago.					
18. It is very likely that in the next 12 months I will become a victim of violence.					
19. I never hear weapons being fired in my neighbourhood.					
20. The police are doing a good job.					

F8. How can these conflicts be resolved?

	Strongly agree	Agree	Disagree	Strongly disagree	Don't know
8. Meetings and workshops by all stakeholders to resolve issues through dialogue and negotiations					
9. Strengthening the capacity of local/informal institutions as conflict mediators					
10. Cooperation between communities/states to resolve conflict					
11. Dealing with issues of corruption					
12. Others (Mention)……					

F9. Which entities are saddled with the responsibility of resolving conflict?

	Strongly agree	Agree	Disagree	Strongly disagree	Don't know
6. Government play the most significant role in management of conflicts.					
7. The NGOs can support communities in managing conflicts					
8. Local elites can play an important role in conflict resolution					
9. Everyone has a social responsibility to help to resolve conflicts					

SECTION G: ENVIRONMENTAL DEGRADATION

G1. Which of the following environmental problems do you experience? **Multiple responses**

7. Urban solid waste pollution [ ]
8. Oil spillage [ ]

9. Deforestation [ ] 10. Others (specify) [ ]

G2. Have there been any changes in the benefit you derive from the agricultural land in recent years (i.e 5-10years) as a result of these environmental problems? 1= Yes 0= No

G3. What are the effects of these environmental problems on your livelihood in terms of losses incurred in the past (5-10years). **Multiple responses**

8. Loss of soil fertility [ ]
9. Loss of vegetation cover
10. scarcity of forages/grasses for livestock [ ]
11. Biodiversity depletion [ ]
12. Reduction in income [ ]
13. Reduction in productivity of land [ ]

G4. Indicate the extent to which pollution of land is responsible for reduced income in your household

2. 1-25% 2. 26-50% 3. 51-75% 4. 76-100%

G5. What is the distance of your house/farm to oil exploration site……km…….min

SECTION H: ADAPTATION STRATEGIES

H1. Have you made any adjustments to cope with changes in climate and land degradation? 1= Yes 0= No

H2. If yes what are the adjustments you have made and against what risks?

strategies	**H2a. Measures**	**H2b. application**	**H2c. Against which Risk**
Agricultural soil and water management	Cover crops		
	Deep tillage		
	Hedges		
	Mulching		
	Ridge cultivation		
	Irrigation		
	Runoff harve sting		
Crop and livestock management	Crop rotation		
	Mixed cropping		
	Agroforestry		
	Keep livestock		
	grow vegetables in off season		
Improved varieties	High yield variety		
	Shorter cycle variety		
	Mixed local and improved varieties		
	Variety resistant to drought		

Change planting time	Earlier planting		
	Late planting		
Planting trees	planting trees/shading		
Diversification beyond farm	selling of agric. Products		
	Processing of agric. Products		
	Artisan/handcraft		
	Artisan/handcraft		
	Natural resource (fish, wood, charcoal, minerals)		
	Resource rent income		
	salaried/professional employment		
	Wage work (labourer)		
	Traditional medicine/healing		
Temporary migration	Migration within state		
	Migration outside state		
	Migration abroad		
Others	use of insurance		
	Prayers		
	Others (specify)		

Application: 1. Yes 0. No

Risks: 1. Floods 2. Droughts 3. High temperature 4. Low temperature 5. Variability of rain fall 6. Decrease of rain fall 7. Increase of rain fall 8. Late rain 9. Early rain

H3. What are the challenges to adaptation?

i. Lack of information on weather forecast ii. Inadequate supply of improved varieties iii. Limited access to water for irrigation iv. Inadequate information on modern adaptation techniques v. lack of financial capital vi. Lack of modern equipment.

SECTION J: FOOD SECURITY

J1. In the past 4 weeks, were you worried your household would run out of food because of lack of money or other resources?

0 = No (Skip to J2) 1 = Yes

J1a. How often did this happen in the past 4 weeks?

0 = rarely (1–2 times) 1 = Sometimes (3–10 times) 2 = Often (more than 10 times)

J2. In the past 4 weeks were you or any member of your household unable to eat healthy and nutritional food because of lack of money or other resources?

0 = No (Skip to J3) 1 = Yes

J2a. How often did this happen in the past 4 weeks

0 = rarely (1–2 times) 1 = Sometimes (3–10 times) 2 = Often (more than 10 times)

J3. In the past four weeks did you or any member of your household have to eat only few kinds of food because of lack of money or other kinds of resources?

0 = No (Skip to J4) 1 = Yes

J3a. How often did this happen in the past 4 weeks

0 = rarely (1–2 times) 1 = Sometimes (3–10 times) 2 = Often (more than 10 times)

J4. In the past 4 weeks did you or any member of your household eat less than they should eat because of lack of money or other resources?

0 = No (Skip to J5) 1 = Yes

J4a. How often did this happen in the past 4 weeks

0 = rarely (1–2 times) 1 = Sometimes (3–10 times) 2 = Often (more than 10 times)

J5. In the past 4 weeks did your household ran out of food because of lack of money or other resources?

0 = No (Skip to J6) 1 = Yes

J5a. How often did this happen in the past 4 weeks

0 = rarely (1–2 times) 1 = Sometimes (3–10 times) 2 = Often (more than 10 times)

J6. In the past 4 weeks did you or any member of your household ever have to skip a meal because there was not enough money or other resources to get food?

0 = No (Skip to J7) 1 = Yes

J6a. How often did this happen in the past 4 weeks

0 = rarely (1–2 times) 1 = Sometimes (3–10 times) 2 = Often (more than 10 times)

J7. In the past 4 weeks did you or any household member go to sleep at night hungry because there was not enough food or other resources?

0 = No (Skip to J8) 1 = Yes

J7a. How often did this happen in the past 4 weeks

0 = rarely (1–2 times)
1 = Sometimes (3–10 times)
2 = Often (more than 10 times)

J8. In the past 4 weeks, did you or any household member go a whole day and night without eating anything at all because there was not enough food and lack of money or other resources?
0 = No (Skip to J9) 1 = Yes

J8a. How often did this happen in the past 4 weeks

0 = rarely (1–2 times)
1 = Sometimes (3–10 times)
2 = Often (more than 10 times)

J9. Does your household normally experience severe food shortages (famine)?
0= No (Skip to J10) 1= Yes

J9a. If yes, during which months (2017) did the household experience severe food shortages? Please tick major month

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec

J9b Why was there difficulty in satisfying food needs in 2017? [Multiple answers allowed]

15. An Income earning member of the household died
16. An Income earning member of the household left
17. Additional members joined the household
18. An income earning member of household lost his/her job
19. An income earning member of household could no longer work because of illness
20. Remittances no longer received
21. Reduction in remittances received
22. Poor harvest of food crops due to pest/disease
23. Poor harvest of food crops due to climatic conditions, e.g. drought
24. Problem with storage of food
25. Sold most of product right after harvest and did not get a good price
26. Food prices became too high
27. Reduced access to land
28. Other ……...

J10. Do you store food for use during period of shortage? 1= Yes 0= No
J11. How many months does this stored food take you and your household?.....months
J12. Where do you get most of your food? a. Own farm b. Purchases c. Barter with fish d. gift e. others (specify)...
J16. Do you meet your household food needs from your farming activities? 1= Yes 0= No

APPENDIX II REGRESSION RESULTS

Computer generated multinomial logit results

```
  ___  ____  ____  ____  ____ (R)
 /__    /   ____/   /   ____/
___/   /   /___/   /   /___/   14.0   Copyright 1985-2015 StataCorp LP
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Notes:
      1.  Unicode is supported; see help unicode_advice.
      2.  Maximum number of variables is set to 5000; see help set_maxvar.

. use "C:\Users\user\Desktop\recoverd\dropbox\Thesis Analysis\Data mangt\multinomial_logit_model.dta"

.  mlogit adaptation_option1 Age Sex hh_sizetot yrs_sch access_credit memb_asso extension_visit information_access farm
> siz_ha  shift_temp shift_rain, baseoutcome(0)

Iteration 0:   log likelihood = -304.32805
Iteration 1:   log likelihood = -244.68738
Iteration 2:   log likelihood = -240.24743
Iteration 3:   log likelihood = -240.01088
Iteration 4:   log likelihood = -240.00978
Iteration 5:   log likelihood = -240.00978

Multinomial logistic regression                 Number of obs     =        251
                                                LR chi2(33)       =     128.64
                                                Prob > chi2       =     0.0000
Log likelihood = -240.00978                     Pseudo R2         =     0.2113
```

adaptation_option1	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
0	(base outcome)					
1						
Age	.0613598	.0244023	2.51	0.012	.0135323	.1091874
Sex	1.164238	.6115838	1.90	0.057	-.0344438	2.362921
hh_sizetot	-.0479048	.1204939	-0.40	0.691	-.2840685	.1882589
yrs_sch	.1881672	.0728806	2.58	0.010	.0453238	.3310106
access_credit	-.226312	1.341337	-0.17	0.866	-2.855285	2.402661
memb_asso	-.5828293	1.171134	-0.50	0.619	-2.878209	1.712551
extension_visit	.1483105	.8108612	0.18	0.855	-1.440948	1.737569
information_access	.6886804	.613944	1.12	0.262	-.5146277	1.891989
farmsiz_ha	-.4330227	1.006958	-0.43	0.667	-2.406625	1.540579
shift_temp	-.5074679	1.046407	-0.48	0.628	-2.558389	1.543453
shift_rain	.0736677	.8147344	0.09	0.928	-1.523182	1.670518
_cons	-4.695264	1.872451	-2.51	0.012	-8.3652	-1.025328
2						
Age	.0148109	.0207016	0.72	0.474	-.0257636	.0553853
Sex	-.325838	.5061391	-0.64	0.520	-1.317852	.6661764
hh_sizetot	.3525095	.0975484	3.61	0.000	.1613182	.5437007
yrs_sch	.1418634	.0621627	2.28	0.022	.0200267	.2637001
access_credit	1.672433	1.120124	1.49	0.135	-.5229695	3.867835
memb_asso	.6188511	.9325866	0.66	0.507	-1.208985	2.446687
extension_visit	-.8488027	.7443313	-1.14	0.254	-2.307665	.6100598
information_access	-.1676258	.494424	-0.34	0.735	-1.136679	.8014275
farmsiz_ha	.8673206	.7686816	1.13	0.259	-.6392676	2.373909
shift_temp	-.1771479	.8977064	-0.20	0.844	-1.93662	1.582324
shift_rain	.271025	.6792698	0.40	0.690	-1.060319	1.602369
_cons	-3.683702	1.581494	-2.33	0.020	-6.783374	-.5840301
3						
Age	.0194062	.0202137	0.96	0.337	-.020212	.0590244
Sex	-.8890192	.5110002	-1.74	0.082	-1.890561	.1125228
hh_sizetot	.0017462	.0980755	0.02	0.986	-.1904782	.1939707
yrs_sch	.0363107	.0622406	0.58	0.560	-.0856785	.1583
access_credit	1.532223	1.136072	1.35	0.177	-.6944371	3.758883
memb_asso	.9853152	.9185636	1.07	0.283	-.8150364	2.785667
extension_visit	-1.982793	.8515254	-2.33	0.020	-3.651752	-.3138341
information_access	.4222054	.4924185	0.86	0.391	-.5429171	1.387328
farmsiz_ha	1.51684	.7677754	1.98	0.048	.0120282	3.021653
shift_temp	-.3547752	.8422737	-0.42	0.674	-2.005601	1.296051
shift_rain	-.6614015	.6394509	-1.03	0.301	-1.914702	.5918993
_cons	-.0132385	1.491961	-0.01	0.993	-2.937428	2.910951

```
. mfx, predict (pr outcome (0))

Marginal effects after mlogit
      y  = Pr(adaptation_option1==0) (predict, pr outcome (0))
         =  .08842098
```

variable	dy/dx	Std. Err.	z	P>|z|	[	95% C.I.	]	X
Age	-.0016213	.00155	-1.05	0.295	-.004654	.001411		47.4781
Sex*	.0338727	.03991	0.85	0.396	-.04434	.112086		.390438
hh_siz~t	-.0139938	.00717	-1.95	0.051	-.028039	.000052		7.40637
yrs_sch	-.0080589	.0046	-1.75	0.080	-.017081	.000963		9.60956
acces~it*	-.0819471	.0367	-2.23	0.026	-.153874	-.01002		.14741
memb_a~o*	-.0478274	.04577	-1.04	0.296	-.137539	.041884		.14741
extens~t*	.1225786	.10146	1.21	0.227	-.076281	.321438		.083665
inform~s*	-.011758	.03646	-0.32	0.747	-.083222	.059706		.49004
farmsi~a	-.0848153	.05553	-1.53	0.127	-.193642	.024012		.626029
shift_~p*	.020801	.0554	0.38	0.707	-.087791	.129393		.87251
shift_~n*	.0146845	.04544	0.32	0.747	-.074378	.103747		.741036

(*) dy/dx is for discrete change of dummy variable from 0 to 1

```
.
.  mfx, predict (pr outcome (1))

Marginal effects after mlogit
      y  = Pr(adaptation_option1==1) (predict, pr outcome (1))
         =  .06532716
```

variable	dy/dx	Std. Err.	z	P>|z|	[	95% C.I.	]	X
Age	.0028106	.00115	2.45	0.014	.00056	.005061		47.4781
Sex*	.1270268	.04433	2.87	0.004	.040134	.21392		.390438
hh_siz~t	-.0134684	.00583	-2.31	0.021	-.024894	-.002043		7.40637
yrs_sch	.0063383	.00333	1.90	0.057	-.000189	.012865		9.60956
acces~it*	-.0665278	.02468	-2.70	0.007	-.114909	-.018146		.14741
memb_a~o*	-.0559244	.02807	-1.99	0.046	-.110943	-.000906		.14741
extens~t*	.1130972	.09237	1.22	0.221	-.067946	.294141		.083665
inform~s*	.0364243	.03015	1.21	0.227	-.02266	.095508		.49004
farmsi~a	-.0909513	.04175	-2.18	0.029	-.172772	-.009131		.626029
shift_~p*	-.0178706	.05505	-0.32	0.745	-.125773	.090032		.87251
shift_~n*	.0151331	.03329	0.45	0.649	-.050105	.080371		.741036

(*) dy/dx is for discrete change of dummy variable from 0 to 1

```
. mfx, predict (pr outcome (2))

Marginal effects after mlogit
      y  = Pr(adaptation_option1==2) (predict, pr outcome (2))
         =  .45590545
```

variable	dy/dx	Std. Err.	z	P>|z|	[95% C.I.]		X
Age	-.0016071	.00324	-0.50	0.620	-.007955	.004741	47.4781
Sex*	.0232058	.08109	0.29	0.775	-.135731	.182143	.390438
hh_siz~t	.088558	.01614	5.49	0.000	.056922	.120194	7.40637
yrs_sch	.0231239	.00924	2.50	0.012	.005006	.041242	9.60956
acces~it*	.1124823	.11957	0.94	0.347	-.121874	.346839	.14741
memb_a~o*	-.0275753	.11883	-0.23	0.816	-.260468	.205318	.14741
extens~t*	.0365492	.14851	0.25	0.806	-.254529	.327627	.083665
inform~s*	-.1362853	.07618	-1.79	0.074	-.285604	.013034	.49004
farmsi~a	-.041898	.07573	-0.55	0.580	-.190332	.106536	.626029
shift_~p*	.0359805	.1289	0.28	0.780	-.216662	.288623	.87251
shift_~n*	.181267	.09213	1.97	0.049	.000692	.361842	.741036

(*) dy/dx is for discrete change of dummy variable from 0 to 1

```
.
. mfx, predict (pr outcome (3))

Marginal effects after mlogit
      y  = Pr(adaptation_option1==3) (predict, pr outcome (3))
         =  .39034642
```

variable	dy/dx	Std. Err.	z	P>|z|	[95% C.I.]		X
Age	.0004178	.00307	0.14	0.892	-.005591	.006426	47.4781
Sex*	-.1841054	.07391	-2.49	0.013	-.32897	-.03924	.390438
hh_siz~t	-.0610958	.01547	-3.95	0.000	-.091409	-.030783	7.40637
yrs_sch	-.0214034	.00898	-2.38	0.017	-.039	-.003807	9.60956
acces~it*	.0359926	.12009	0.30	0.764	-.199376	.271361	.14741
memb_a~o*	.1313271	.11851	1.11	0.268	-.100949	.363603	.14741
extens~t*	-.2722249	.09675	-2.81	0.005	-.461857	-.082593	.083665
inform~s*	.111619	.07428	1.50	0.133	-.033974	.257212	.49004
farmsi~a	.2176646	.07372	2.95	0.003	.073177	.362152	.626029
shift_~p*	-.0389108	.11999	-0.32	0.746	-.274092	.19627	.87251
shift_~n*	-.2110847	.09164	-2.30	0.021	-.390691	-.031479	.741036

(*) dy/dx is for discrete change of dummy variable from 0 to 1

```
. mlogit adapation_option Age Sex yrs_pri_occup hh_sizetot yrs_sch access_credit memb_asso extension_visit information_
> access GrossR_Y shift_temp shift_rain State, baseoutcome(0)

Iteration 0:   log likelihood = -178.06081
Iteration 1:   log likelihood = -125.70154
Iteration 2:   log likelihood = -112.90183
Iteration 3:   log likelihood = -106.88123
Iteration 4:   log likelihood = -106.05653
Iteration 5:   log likelihood = -106.04624
Iteration 6:   log likelihood = -106.04623

Multinomial logistic regression                 Number of obs     =        252
                                                LR chi2(26)       =     144.03
                                                Prob > chi2       =     0.0000
Log likelihood = -106.04623                     Pseudo R2         =     0.4044
```

adapation_option	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
no_adaptn	(base outcome)					
intensification						
Age	.0299991	.0334169	0.90	0.369	-.0354967	.095495
Sex	.528944	.9090788	0.58	0.561	-1.252818	2.310706
yrs_pri_occup	-.0384784	.0294573	-1.31	0.191	-.0962136	.0192569
hh_sizetot	-.1036659	.1255851	-0.83	0.409	-.3498081	.1424763
yrs_sch	.3667612	.0715482	5.13	0.000	.2265293	.5069931
access_credit	.6215824	.8405115	0.74	0.460	-1.02579	2.268955
memb_asso	-.5184188	1.255555	-0.41	0.680	-2.979261	1.942423
extension_visit	1.076694	1.407353	0.77	0.444	-1.681667	3.835055
information_access	-1.664374	.5482898	-3.04	0.002	-2.739002	-.5897456
GrossR_Y	6.83e-07	3.91e-07	1.75	0.081	-8.31e-08	1.45e-06
shift_temp	-.859266	.6685689	-1.29	0.199	-2.169637	.4511049
shift_rain	2.345705	.6729864	3.49	0.000	1.026676	3.664734
State	-2.738263	.8359409	-3.28	0.001	-4.376678	-1.099849
_cons	-5.581073	2.059895	-2.71	0.007	-9.618393	-1.543753
diversification						
Age	-.0188391	.0343069	-0.55	0.583	-.0860793	.0484011
Sex	.1391985	.7749845	0.18	0.857	-1.379743	1.65814
yrs_pri_occup	.0183262	.0322825	0.57	0.570	-.0449463	.0815987
hh_sizetot	-.0320885	.1321218	-0.24	0.808	-.2910424	.2268655
yrs_sch	.1962851	.0712721	2.75	0.006	.0565943	.3359758
access_credit	.4158764	.9519813	0.44	0.662	-1.449973	2.281725
memb_asso	-.6995773	1.048018	-0.67	0.504	-2.753655	1.3545
extension_visit	2.423896	.9492497	2.55	0.011	.5634013	4.284392
information_access	-.8857982	.5773029	-1.53	0.125	-2.017291	.2456948
GrossR_Y	7.38e-07	2.97e-07	2.48	0.013	1.55e-07	1.32e-06
shift_temp	-.9797272	.7579142	-1.29	0.196	-2.465212	.5057573
shift_rain	1.86652	.74561	2.50	0.012	.4051511	3.327889
State	-.0987199	.708712	-0.14	0.889	-1.48777	1.29033
_cons	-4.57044	1.986305	-2.30	0.021	-8.463526	-.677353

```
. mfx, predict (pr outcome (0))

Marginal effects after mlogit
      y  = Pr(adapation_option==no_adaptn) (predict, pr outcome (0))
         =  .90193319
```

variable	dy/dx	Std. Err.	z	P>|z|	[	95% C.I.	]	X
Age	-.0002089	.00234	-0.09	0.929	-.004802	.004384		48.0198
Sex*	-.0240639	.04814	-0.50	0.617	-.118414	.070286		.857143
yrs_pr~p	.0005602	.00213	0.26	0.793	-.003622	.004742		24.75
hh_siz~t	.0055866	.00881	0.63	0.526	-.011687	.02286		7.42857
yrs_sch	-.0239071	.00643	-3.72	0.000	-.036514	-.0113		8.53571
acces~it*	-.0531153	.08698	-0.61	0.541	-.223588	.117358		.099206
memb_a~o*	.0442094	.05092	0.87	0.385	-.055588	.144007		.06746
extens~t*	-.3427072	.21383	-1.60	0.109	-.761814	.0764		.035714
inform~s*	.1125114	.04486	2.51	0.012	.024596	.200427		.496032
GrossR_Y	-6.32e-08	.00000	-2.58	0.010	-1.1e-07	-1.5e-08		1.0e+06
shift_~p*	.0951384	.06606	1.44	0.150	-.034346	.224623		.68254
shift_~n*	-.18913	.05448	-3.47	0.001	-.295913	-.082347		.531746
State*	.1354068	.0632	2.14	0.032	.011538	.259276		.503968

(*) dy/dx is for discrete change of dummy variable from 0 to 1

```
.
.  mfx, predict (pr outcome (1))

Marginal effects after mlogit
      y  = Pr(adapation_option==intensification) (predict, pr outcome (1))
         =  .04257169
```

variable	dy/dx	Std. Err.	z	P>|z|	[	95% C.I.	]	X
Age	.0012673	.00145	0.87	0.383	-.001578	.004112		48.0198
Sex*	.0180545	.02668	0.68	0.499	-.034236	.070345		.857143
yrs_pr~p	-.0016117	.00126	-1.28	0.200	-.004076	.000852		24.75
hh_siz~t	-.0041495	.00514	-0.81	0.419	-.014224	.005925		7.42857
yrs_sch	.0144852	.00515	2.82	0.005	.004401	.02457		8.53571
acces~it*	.0302744	.0524	0.58	0.563	-.072436	.132985		.099206
memb_a~o*	-.0164735	.0355	-0.46	0.643	-.086054	.053107		.06746
extens~t*	.0340774	.09006	0.38	0.705	-.142434	.210589		.035714
inform~s*	-.070314	.03193	-2.20	0.028	-.132889	-.007739		.496032
GrossR_Y	2.61e-08	.00000	1.60	0.109	-5.8e-09	5.8e-08		1.0e+06
shift_~p*	-.0371799	.03627	-1.03	0.305	-.108265	.033905		.68254
shift_~n*	.0967432	.03878	2.49	0.013	.020726	.17276		.531746
State*	-.1384858	.05247	-2.64	0.008	-.241317	-.035655		.503968

(*) dy/dx is for discrete change of dummy variable from 0 to 1

```
.
.  mfx, predict (pr outcome (2))

Marginal effects after mlogit
      y  = Pr(adapation_option==diversification) (predict, pr outcome (2))
         =  .05549512
```

variable	dy/dx	Std. Err.	z	P>|z|	[	95% C.I.	]	X
Age	-.0010583	.00175	-0.61	0.544	-.00448	.002363		48.0198
Sex*	.0060094	.03737	0.16	0.872	-.067233	.079252		.857143
yrs_pr~p	.0010515	.00164	0.64	0.522	-.00217	.004273		24.75
hh_siz~t	-.001437	.00686	-0.21	0.834	-.01489	.012016		7.42857
yrs_sch	.0094219	.00409	2.31	0.021	.001414	.01743		8.53571
acces~it*	.0228409	.06439	0.35	0.723	-.10337	.149051		.099206
memb_a~o*	-.0277359	.03247	-0.85	0.393	-.091382	.03591		.06746
extens~t*	.3086297	.19878	1.55	0.121	-.080964	.698224		.035714
inform~s*	-.0421974	.03159	-1.34	0.182	-.104122	.019727		.496032
GrossR_Y	3.71e-08	.00000	2.18	0.029	3.8e-09	7.0e-08		1.0e+06
shift_~p*	-.0579586	.05431	-1.07	0.286	-.164407	.04849		.68254
shift_~n*	.0923868	.04148	2.23	0.026	.011078	.173695		.531746
State*	.003079	.03529	0.09	0.930	-.066092	.07225		.503968

(*) dy/dx is for discrete change of dummy variable from 0 to 1

Computer generated ordered logit results

```
. ologit FIES_dummy VIn Y_log ib0.Mstat i.saving i.non_farm_wk dep_ratio store_food recieve_help farmsiz_ha Age hh_size
> tot ib0.State ib1.type_respondent

Iteration 0:   log likelihood =  -693.0816
Iteration 1:   log likelihood = -613.01284
Iteration 2:   log likelihood = -611.32783
Iteration 3:   log likelihood = -611.32485
Iteration 4:   log likelihood = -611.32485

Ordered logistic regression                     Number of obs     =        503
                                                LR chi2(14)       =     163.51
                                                Prob > chi2       =     0.0000
Log likelihood = -611.32485                     Pseudo R2         =     0.1180
```

FIES_dummy	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
VIn	5.400062	.9927267	5.44	0.000	3.454353	7.34577
Y_log	-.2839586	.1114997	-2.55	0.011	-.5024941	-.0654232
Mstat						
married	.4640043	.3228136	1.44	0.151	-.1686987	1.096707
others	.3991508	.4070921	0.98	0.327	-.398735	1.197037
saving						
yes	.00443	.1754019	0.03	0.980	-.3393515	.3482115
1.non_farm_wk	-1.060945	.203002	-5.23	0.000	-1.458822	-.6630687
dep_ratio	.187695	.0818122	2.29	0.022	.027346	.348044
store_food	.0215383	.1807566	0.12	0.905	-.3327381	.3758147
recieve_help	-.4018216	.1836229	-2.19	0.029	-.761716	-.0419273
farmsiz_ha	-.9143729	.2747696	-3.33	0.001	-1.452911	-.3758343
Age	.002621	.0080442	0.33	0.745	-.0131452	.0183873
hh_sizetot	-.1438041	.0529441	-2.72	0.007	-.2475726	-.0400356
State						
Bayalsa	-.0322084	.1924156	-0.17	0.867	-.4093361	.3449192
type_respondent						
fisherman	-.6714279	.2470474	-2.72	0.007	-1.155632	-.187224
/cut1	-3.754196	1.578404			-6.847811	-.6605806
/cut2	-2.253694	1.576956			-5.344471	.8370823
/cut3	-1.061793	1.57362			-4.146031	2.022445

```
. margins, dydx(*)

Average marginal effects                        Number of obs     =        503
Model VCE    : OIM

dy/dx w.r.t. : VIn Y_log 1.Mstat 2.Mstat 1.saving 1.non_farm_wk dep_ratio store_food recieve_help farmsiz_ha Age
               hh_sizetot 1.State 2.type_respondent
1._predict   : Pr(FIES_dummy==1), predict(pr outcome(1))
2._predict   : Pr(FIES_dummy==2), predict(pr outcome(2))
3._predict   : Pr(FIES_dummy==3), predict(pr outcome(3))
4._predict   : Pr(FIES_dummy==4), predict(pr outcome(4))
```

		Delta-method				
	dy/dx	Std. Err.	z	P>|z|	[95% Conf.	Interval]
VIn						
_predict						
1	-.8491779	.1521587	-5.58	0.000	-1.147403	-.5509523
2	-.1959384	.0451836	-4.34	0.000	-.2844967	-.1073802
3	.2356678	.0534757	4.41	0.000	.1308574	.3404781
4	.8094485	.1416671	5.71	0.000	.531786	1.087111
Y_log						
_predict						
1	.0446535	.0174507	2.56	0.011	.0104507	.0788562
2	.0103033	.0043144	2.39	0.017	.0018473	.0187593
3	-.0123924	.0051868	-2.39	0.017	-.0225583	-.0022266
4	-.0425643	.0165252	-2.58	0.010	-.0749531	-.0101755
1.Mstat						
_predict						
1	-.0768837	.0558956	-1.38	0.169	-.1864369	.0326696
2	-.0112535	.0049378	-2.28	0.023	-.0209314	-.0015756
3	.0233846	.0184458	1.27	0.205	-.0127685	.0595378
4	.0647525	.0415274	1.56	0.119	-.0166396	.1461447
2.Mstat						
_predict						
1	-.0667479	.0687904	-0.97	0.332	-.2015746	.0680789
2	-.008851	.0091558	-0.97	0.334	-.0267961	.0090941
3	.0206297	.0217823	0.95	0.344	-.0220629	.0633223
4	.0549692	.0551046	1.00	0.319	-.0530339	.1629723
1.saving						
_predict						
1	-.0006966	.0275794	-0.03	0.980	-.0547513	.0533581
2	-.0001607	.006359	-0.03	0.980	-.012624	.0123026
3	.0001932	.0076494	0.03	0.980	-.0147993	.0151858
4	.000664	.026289	0.03	0.980	-.0508614	.0521895
1.non_farm_wk						
_predict						
1	.183595	.0366719	5.01	0.000	.1117195	.2554706
2	.0322694	.0096523	3.34	0.001	.0133511	.0511876
3	-.0649201	.0161639	-4.02	0.000	-.0966007	-.0332395
4	-.1509443	.0275511	-5.48	0.000	-.2049434	-.0969451

dep_ratio						
_predict						
1	-.0295157	.0127607	-2.31	0.021	-.0545262	-.0045051
2	-.0068104	.0031331	-2.17	0.030	-.0129512	-.0006697
3	.0081913	.0036668	2.23	0.025	.0010044	.0153782
4	.0281348	.0122004	2.31	0.021	.0042224	.0520471
store_food						
_predict						
1	-.003387	.028422	-0.12	0.905	-.0590931	.0523191
2	-.0007815	.0065631	-0.12	0.905	-.0136449	.0120819
3	.00094	.0078828	0.12	0.905	-.0145101	.01639
4	.0032285	.0271021	0.12	0.905	-.0498907	.0563477
recieve_help						
_predict						
1	.0631878	.0287156	2.20	0.028	.0069063	.1194693
2	.0145799	.0070244	2.08	0.038	.0008124	.0283474
3	-.0175362	.0082411	-2.13	0.033	-.0336884	-.001384
4	-.0602315	.0274443	-2.19	0.028	-.1140214	-.0064417
farmsiz_ha						
_predict						
1	.1437882	.0422195	3.41	0.001	.0610394	.226537
2	.0331775	.0116257	2.85	0.004	.0103916	.0559635
3	-.0399048	.0127621	-3.13	0.002	-.0649181	-.0148915
4	-.137061	.0409939	-3.34	0.001	-.2174076	-.0567144
Age						
_predict						
1	-.0004122	.0012644	-0.33	0.744	-.0028904	.0020661
2	-.0000951	.0002929	-0.32	0.745	-.0006692	.000479
3	.0001144	.0003514	0.33	0.745	-.0005743	.0008031
4	.0003929	.0012059	0.33	0.745	-.0019706	.0027563
hh_sizetot						
_predict						
1	.0226137	.0082051	2.76	0.006	.0065319	.0386954
2	.0052179	.0021211	2.46	0.014	.0010605	.0093752
3	-.0062759	.0023977	-2.62	0.009	-.0109754	-.0015764
4	-.0215557	.0079108	-2.72	0.006	-.0370606	-.0060508
1.State						
_predict						
1	.005056	.0301696	0.17	0.867	-.0540754	.0641874
2	.0011786	.007079	0.17	0.868	-.012696	.0150532
3	-.0013986	.0083278	-0.17	0.867	-.0177208	.0149237
4	-.004836	.0289206	-0.17	0.867	-.0615193	.0518473
2.type_respondent						
_predict						
1	.1048843	.0374147	2.80	0.005	.0315528	.1782157
2	.0223396	.0087242	2.56	0.010	.0052405	.0394387
3	-.0276485	.009791	-2.82	0.005	-.0468386	-.0084585
4	-.0995753	.0363323	-2.74	0.006	-.1707852	-.0283654

Note: dy/dx for factor levels is the discrete change from the base level.

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APPENDIX III CORRELATION MATRIX BETWEEN FOOD SECURITY AND VULNERBILITY INDEX

```
. pwcorr FIES E SEN AC, star (5)
```

	FIES	E	SEN	AC
FIES	1.0000			
E	0.2079*	1.0000		
SEN	0.0689	-0.1506*	1.0000	
AC	-0.3428*	0.1993*	-0.1775*	1.0000

```
. pwcorr FIES CS RC ED SD LI SN, star (5)
```

	FIES	CS	RC	ED	SD	LI	SN
FIES	1.0000						
CS	0.0196	1.0000					
RC	0.2812*	0.2802*	1.0000				
ED	0.1618*	0.4203*	0.3445*	1.0000			
SD	0.0768	0.0791	0.1979*	0.1792*	1.0000		
LI	-0.3767*	0.2274*	-0.0399	0.0923*	-0.0103	1.0000	
SN	-0.3561*	0.1854*	-0.1198*	0.1496*	0.0469	0.5281*	1.0000

```
. pwcorr FIES agresive_land violent_conflict feel_insecure loss_conflict_dummy remittance access_credit
>  dummyincome_exp diversityn memb_asso ext_support information_access cooperation, star (5)
```

	FIES	agresi~d	viole~ct	feel_i~e	loss_c~y	remi~nce	acces~it
FIES	1.0000						
agresive_l~d	0.2205*	1.0000					
violent_co~t	0.1061*	0.4691*	1.0000				
feel_insec~e	0.2150*	0.3223*	0.1281*	1.0000			
loss_confl~y	0.2423*	0.2897*	0.4210*	0.2006*	1.0000		
remittance	-0.0990*	0.0538	0.1546*	-0.0779	0.1054*	1.0000	
access_cre~t	0.0749	0.1139*	0.1276*	0.0487	0.1715*	0.2206*	1.0000
dummyincom~p	-0.5110*	-0.1347*	0.0124	-0.2708*	-0.1264*	0.1927*	-0.0145
diversityn	-0.2840*	-0.0830	0.0037	-0.2448*	-0.1112*	0.1735*	-0.0478
memb_asso	-0.1343*	0.0770	0.0704	-0.0213	0.0517	0.1566*	0.1630*
ext_support	-0.3160*	0.0044	0.1854*	-0.1734*	-0.0072	0.2360*	0.1778*
informatio~s	0.0366	0.0047	-0.2108*	0.1328*	-0.3327*	-0.0966*	0.0386
cooperation	-0.3019*	-0.1122*	0.1157*	-0.2452*	-0.1014*	0.1711*	0.0029

	dummyi~p	diver~yn	memb_a~o	ext_su~t	inform~s	cooper~n
dummyincom~p	1.0000					
diversityn	0.3363*	1.0000				
memb_asso	0.0604	0.0930*	1.0000			
ext_support	0.4179*	0.3006*	-0.0101	1.0000		
informatio~s	-0.0425	-0.0971*	-0.0186	-0.1613*	1.0000	
cooperation	0.4940*	0.4365*	0.0464	0.4948*	-0.1002*	1.0000

```
.
```