Empowering Women as Key Leaders in Promoting Community-Based Climate Change Adaptation and Disaster Risks Reduction Initiatives in Niger Delta Region

Preliminary Research Report

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Executive Summary

Introduction

This is a preliminary report, as at October 2019, based on the summary of some of the key findings of the research component of the project. Further analysis and disaggregation of the data collected which are available in CPED data base has commenced. Team members are working on the various aspects of the collected data which hopefully will in the first instance guide the implementation of the pilot program during the remaining period of the implementation of the project. Furthermore, Team members will publish various aspects of the key findings of the research component in peer reviewed journals.

Background

In spite of the global concern and the obvious vulnerability of the Niger Delta region to climate change given its long coast line and related industrial activities, empirical investigations of climate variability and long term change, particularly households' vulnerability and their adaptation strategies, have not been given sufficient attention in the literature.

This study analyzed vulnerability and adaptation from two broad perspectives: (1) a gender perspective and (2) an agro-ecosystem perspective

It focused on three different ecological localities in Delta State within the Niger Delta region namely; the *Mangrove Swamp*, the *Freshwater Swamp* and the *Forest Lowland*.

The study is focused on filling the gaps in empirical data and information on how vulnerable households, particularly farming and fishing households are impacted by climate change and variability and how they adapt to these variations in climate.

The overall objective of the research project is to contribute to socially-equitable development in Niger Delta region by promoting women-led, community-based initiatives on climate change adaptation and disaster risk reduction. The project is organized into five work packages with the specific objectives as indicated below.

The project has five specific objectives organized into four work packages: Knowledge development (objective 1), Pilot activities (objective 2), Capacity building (objective 3), and Knowledge translation (objectives 4 & 5) as follows:

1. Increase understanding of the varied impacts of, responses to, and adaptations to climate change in rural communities to enable identification of effective and affordable community-based approaches;

2. Improve climate-change adaptation and disaster-risk reduction strategies in rural communities by testing and validating the most effective and affordable women-led, community-based initiatives;

3. Scale out validated community-based initiatives by strengthening local capacities to generate the necessary conditions to adapt these climate-change adaptation and disaster-risk reduction strategies;

4. Scale up community-based initiatives by promoting interactions between researchers, policy makers, and women leaders;

5. Increase integration of women-led community-based adaptation strategies into policy and planning by the Delta State Executive and Legislature.

This research report focuses mainly on the first objective which is on knowledge generation and development.

Study area

Delta State is one of the thirty-six states forming the Federal Republic of Nigeria. It was part of the defunct Bendel State of Nigeria. The state came into existence on 27 August 1991, when it was created as a separate state from the former Bendel State by the then Military Government. Delta State was initially made up of twelve political divisions called Local Government Areas (LGAs), which later increased to 19 in 1996. Presently there are 25 LGAs in Delta State. Delta State has a land area of 16,842 square kilometres and its geographical location is defined as follows:

Longitude: 5^{O} 00' and 6^{O} 45' East of the Greenwich Meridian
Latitude: 5^{O} 00' and 6^{O} 30' North of the Equator

Delta State is bordered by Edo State to the north, Anambra and Rivers States to the east, Bayelsa State and the Atlantic Ocean to the south, and Ondo State to the west. The shape of the state is less compact, compared with its neighbours, such as Edo, Anambra and Bayelsa; the distance of the Eastern boundary to the Western boundary being about 165 kilometres, while that of the northern boundary to the southern boundary is about 125 kilometres.

Methodology

Data collection entailed:

(i) Literature review through secondary data collection;

(ii) Field surveys were carried out in ten LGAs sampled from the three ecological zones as follows:

(a) Mangrove Swamp (Warri South, Isoko South, Burutu and Patani);
(b) Freshwater Swamp (Ethiope East, Ughelli South, and Sapele) and
(c) Lowland Forest (Ika South, Anioma North and Ndokwa East)

(iii) Administratively, the LGAs targeted in Mangrove Swamp ecological zone are in Delta South Senatorial District. Those in Freshwater Swamp are in Delta Central Senatorial District. Finally, those in Lowland Forest zone are in Delta North Senatorial District.

(iv) Quantitative data collection entailed the administration of between 400 and 450 household questionnaires in each selected LGA;

(v) A total of about 4000 successfully completed household questionnaires were retrieved cleaned up and used for the quantitative data analysis;

(vi) An average of between 1,250 and 1,500 household questionnaires were used in the analysis in each of the three ecological zones;

(vii) Qualitative data collection entailed the conduct of key informant interviews and focused group discussions amongst mainly community-based stakeholders;

(viii) A total of 107 key informants, with at least ten identified in each LGA were interviewed in the three ecological zones;

(ix) Also three categories of focus group discussions were organised in each target LGA comprising "all males", "all females" and a mix of "males and females", respectively. Hence a total of 30 focus group discussions were organised in the three ecological zones.

Household Characteristics

The key findings from the surveys with regard to respondents' household characteristics are as follows:

The majority of the households have a membership of 7 and more members. Household size is slightly higher in the lowland rainforest zone compared with the other two zones. This is obviously a reflection of the pressure on households living nearer the coast which are generally more vulnerable to climate change than those located in the upland areas.

The population of the Niger Delta region is significantly youthful in character. The vast majority (over 80 percent) of the respondents are below 61 years. Respondents of working age (18-40) are only about 35 per cent while those between age 41-60 percent constitute between 42 and 54 per cent.

The overall sex composition of the respondents shows that on the average there are more females than males in the rural communities of the Niger Delta region. The proportion of females is highest in the Freshwater Swamp with over 60 per cent compared with 54.2 per cent in the Mangrove Swamp and 48.9 per cent in the Lowland Rainforest ecological zone. This is a reflection of the fact that women are generally left behind in the more difficult and vulnerable communities nearer the coast by males that migrate to the upland areas.

The practices of polygamy and early marriage of young adults are very common phenomena in most communities of Niger Delta region. The proportion of the respondents that is single is less than 10 per cent in two of the ecological zones i.e. Freshwater Swamp and Lowland Rainforest. However it is about 14 per cent in the Mangrove Swamp ecological zone.

Over 80 per cent had some form of western education or literate. On the whole it can be stated that, across that Niger Delta communities, a good proportion of the respondents have the capacity to read and comprehend the issues raised in the questionnaires without requiring much assistance or being dependent on the field officers for interpretation. They are also in a position to appreciate the issues involved in their vulnerability to climate change challenge.

On the average, the highest proportions of persons employed are engaged in the Agriculture, Forestry and Fishing Industry. Employment in agricultural and other related activities is followed by those in trade or selling activities and general services. What emerges from the nature of employment in the communities is that mining and quarrying play an insignificant source of employment for the people of the state. This implies a high level of dependence on the rich biodiversity of the Niger Delta region. The implication of this for vulnerability to climate change is significant, as the changes in the climate variables will have direct impacts on households' income and livelihoods.

Over 70 per cent of the respondents have been engaged in their present occupations for over 10 years with as much as 30 per cent engaged in their occupations for a period of over 20 years. This finding indicates that the respondents are in a position to report on their experiences with respect to the impact of climate change on their activities.

A significant proportion of the agricultural activities in which the respondents are engaged provide only subsistence income. One other major characteristic of the respondents' agricultural practices relates to the fact that most of them have more than one farmland which indicates that they are indeed small scale farmers who cannot use modern technical farming equipment because of the small size of their farmlands.

The survey shows that about 32.3 per cent of the employed in the surveyed households indicated that they earn less than 10,000 Naira per month. The proportion increased to between 30.7 and 49 per cent in the income group (10,000 - 20,000 Naira per month). At income level of above N20,000 Naira, the proportion of the employed in that group declined to between 31.5 per cent and 47.2 per cent. These findings on income level in the Niger Delta region have implications for vulnerability, adaptive capacity and overall adaptation to climate change in the communities.

Housing for the vast majority of the respondents' households is poor in terms of the materials used in constructing houses which makes them vulnerable to any violent or extreme climate change events such as flooding, erosion, windstorm and thunderstorm. A large proportion of the households still depend on the local ecosystem in terms of the materials for the construction of their dwellings. Consequently, climate change effects on the ecosystem constitute problems for many households.

About 30 to 40 per cent of the households in the surveyed communities of the three ecological zones in Delta State have access to safe drinking water almost the same proportion goes for safe bathing water. In effect, most communities in the three ecological zones in Delta State are extremely vulnerable to climate change in terms of access to water because whenever rains fail to come at the right time and the quality of water in the rivers within the state declines, the people become susceptible to diseases due to the poor quality of water which they drink.

Only about 40 per cent of the dwellings can be said to have good means of sanitary disposal. Over 70 per cent of the dwellings surveyed dumped their refuse on public dumps or burn them within their compound where nobody cares for them. During the period of heavy rain and flooding occasioned by climate variability and change some of these wastes are transferred to rivers from which many households collect drinking water.

Wood fuel is still overwhelmingly used for cooking in most households in the communities of Delta State. This implies that the forests are exploited regularly for cooking fuel and this further contributes to the reduction of carbon sinks and increases atmospheric warming and climate change in the three ecological zones of Delta State.

Awareness of Climate Change

The key findings from the surveys with regard to the awareness of climate change are as follows:

Respondents in the three ecological zones of Delta State have some knowledge of what climate change is. About 90 per cent of the respondents indicated that they had knowledge of the occurrence of climate change. The majority of the respondents perceived that these changes in climatic variables affect their agricultural products as well as a decline in the availability of forest products. Some of these climate events and variables which the respondents revealed that has increased include shift in the start or end of rains, early rains that were not sustained, as well as the increase in occurrence of smothered crops by excessive heat.

A significant proportion of the respondents (almost 40 per cent) in the three zones had knowledge of climate change effects in their communities over a period of between 10 and 30 years. Some of these climate events and variables which the respondents revealed that has increased include shift in the start or end of rains, early rains that were not sustained, as well as the increase in occurrence of smothered crops by excessive heat.

The major source of information on climate characteristics for the respondents in the three zones shows that radio is the most important source of climate information to the respondents. Television also provides climate information for a reasonable proportion of respondents in the Mangrove Swamp zone. The other sources provide limited sources of information to respondents. In addition to these mass media sources, respondents also share climate information with their colleagues.

An examination of the accessibility of the available sources to respondents indicates that virtually all the respondents reported not having access to formal climate information sources. Climate institutions such as, the *Nigerian Meteorological Agency* that is responsible for climatic data collection and dissemination do not make information available to the farmers in remote rural

communities. Therefore, it can be inferred that farmers in the rural communities of Delta State may not be getting reliable information on climate. Thus, they may not be properly informed and equipped for effective adaptation to climate change.

Most of the respondents said that, the climate information supplied is never correct. The situation where information available is "never correct" could be attributed to the fact that it is not tailored to the need of the farmers and fisher folks.

While the lowland appears more knowledgeable, none of the agro-ecosystems are completely knowledgeable about climate change issues. This may be a reflection of the lack of climate information earlier pointed out. Without accurate knowledge of climate change issues, the farmers and fisher folks would hardly be able to take effective climate change adaptive measures.

Vulnerability of Households to Climate Change

The key findings from the surveys with regard to the vulnerability of households to climate change are as follows:

The results of the survey show that some geographical and physical factors contribute to the vulnerability of households in the three ecological zones in the Niger Delta region. Geographical factors such as distance from coastline and population within 100km of the coastline have been identified as capable of making households vulnerable to climate change impact.

The assumption is that the nearer households and communities are to climate hazard-prone sites such as the coast, ravines and erosion sites, the more vulnerable they are to climate change impacts. In the Mangrove Swamp ecological zone over 61 per cent of the respondents are located in communities which are prone to flooding because of the extremely wetland in which they are situated. In Mangrove Swamp ecological zone, just about 38 per cent of the respondents are located in upland areas which are not easily susceptible to flooding. The Freshwater Swamp and Lowland Rainforest ecological zones have a greater proportion of the communities sited in upland areas in which case most of the inhabitants are not exposed to frequent flooding. Even then over 30 per cent of the inhabitants in these two ecological zones live in communities that are prone to flooding.

The economic factor that can make households vulnerable to climate change impact is the extent of households' dependence on agriculture. The extent of dependence is measured by number of household members in agriculture as well as offering services as hired agricultural labour. Respondents identified various economic factors that affect their household vulnerability to climate change including non-availability of: irrigation, water for livestock, excessive rainfall, increase in drought, sea level rise, increased flooding, decreased availability of arable land, lack of food storage facilities, lack of food processing facilities, lack of transportation, increasing population, prevalence of conflicts and violence, loss of biodiversity and the invasion of pests, etc.

Impact of Climate Change

The key findings from the surveys with regard to the impact of climate change are as follows:

Respondents in different ecological zones identified various impacts of climate change in their localities including, deceased crops and fish output and yields, loss of plants and animal species, shorter duration of rainy season and conflicts among others.

Non availability of agricultural lands, reduced quantity of fish produced, loss of plants and animal species and flooding were the most severe impacts in the freshwater swamp forest while in the mangrove swamp forests, the respondents identified sea level rise, sea surge, coastal erosion and inundation, and migration as the most severe impacts.

Another outstanding result is that the severity of the impact increases from the lowland forest to the mangrove swamp forest. Moreover, the impact is more severe among the females than the males. This implies that the severity of climate change impact is both place and gender specific. While emigration is highest in the mangrove swamp, conflict is more in the lowland forest which in most cases is the receiving end of most of the migrants.

Key informants made the point that because the yield is poor and income is getting low, people have to struggle for more agricultural land for farming purposes. This leads to land disputes which in some cases result in communal clashes. Flash floods, which can remove topsoil and reduce fertility, are particularly common in the three ecological zones of the Niger Delta region during the May-to-September rainy season. But rising sea levels that risk bringing salt water onto arable land have become a perennial problem, and climate change means farmers in coastal areas are at greater risk than ever.

Among the effects of flooding in the Niger Delta are the destruction of crops, livestock, houses, farm building and equipment, a reduction in output, build-up of diseases and infections, contamination of water, death, sickness, increase in costs of farm activities, and psychological trauma.

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

The major impacts of climate-related hazards on crop production include loss of soil nutrients due to seeping, leaching and erosion, soil compaction caking due to drought, changes in farming practices, flood and excess heat, water logged soil, low yield, low output, migration from farm lands, invasion of pests, scorched crops due to drought and early cessation of rains, overturning of boats due to violent ocean surges and loss of lives were recorded in the past 30 years. All stakeholders in the communities are affected while the women, who are mostly farmers, are the most vulnerable.

The impact of conflicts and violence in the Niger Delta region is still felt in many communities of the region. Generally climate change induced conflicts are part of the general resource exploitation conflicts in the Niger Delta region. Climate change induced conflicts associated with the depletion of fishing ground has also increased in the Mangrove Swamp ecological zone with over 71 per cent of the respondents reporting increased conflicts.

One of the socio economic impacts of climate change as reflected in the survey communities in the three ecological zones is related to changes in the gender roles. Majority of women in the three ecological zones said that due to aridity caused by increasing length of dry season, they spend more hours searching for water and pasture at the expense of other economic activities and sometimes have to get up at midnight to fetch water.

Due to lack of drinking water near the villages men are now helping women with water collection. Men participate in fetching of water using bicycles, wheel barrows, motor cycles and other means hence these changes have altered the gender distribution of family roles. They also said that due to depletion of forest areas, fetching firewood has been difficult hence men also have to take bicycles and motor cycles for fetching them. Fetching water and fire woods in the past were the primary roles for women but with scarcity even men now do involve in these activities.
Despite this changing trend, the vast majority of the respondents, both men and women, agree that the climate change indicators such as water shortage, shortage of firewood, extreme rainfall, flooding, livelihood disruption and family dislocation have more effects on women/girls than men/boys in their communities.

Adaptation Practices and Strategies

The key findings from the surveys with regard to adaptation practices and strategies of households to climate change are as follows:

As an adaptive strategy respondents in the three ecological zones have diversified their economic activities; for instance they also altered their lifestyle and switched to other income generating activities such as: Establishing of commercial motorcycles driving business, selling of oil and petrol, saloon, petty shops and business, small scale poultry keeping, selling food items across the roads and shops as new income generating activities.

Crop diversification features prominently in Niger Delta region's farming household climate change adaptation strategies. Through crop diversification, farming households can spread production and income risk over a wider range of crops, thus reducing livelihood vulnerability to weather or market shocks. A few farmers have indicated that they use new type of maize seeds that produce maize within a short time (three months) and do not require a lot of rain. Therefore, farmers are trying to adapt to the changing climate by changing the type of seeds they use. This change has been noted by farmers in some communities indicating that there is a change in the type of bananas they plant now compared to what was obtainable some few decades ago.
A greater proportion of the respondents in the three ecological zones reported that they have at various times adopted early maturing crops particularly maize as a strategy for adapting to climate change which they described as effective.

Findings show that the lowland forest area picked economic diversification, dry season farming and late planting as the best options. While the freshwater swamp forest practised more of economic diversification, mixed cropping and agricultural diversification, the mangrove swamp forest zone used more of economic diversification, netting of fishing ponds and planting on mounds and ridges. This implies that as the impacts vary from ecological zone to the other so also is the adaptation strategies. What is common in the three ecological zones is economic diversification. All the adaptation options are autonomous which will fail with increasing severity of climate change impacts, except planned adaptation measures are put in place.

In order to adapt to the effects of climate change at household level, some respondents in the three ecological zones of Delta State diversify their economic activities by doing both crop production and animal keeping. Respondents usually move with their animals from one place to another in search of water and pastures especially during the dry season. These movements in most cases are not planned and not coordinated to negotiate resource use which sometimes results into conflicts between groups. Other measures include change of new breed of animals that resist diseases and climate change impacts, construction of ponds and reservoirs for water storage.

Since the rainfall intensity is getting higher by the day in the Niger Delta region, erosion is also increasing thereby reducing soil fertility. In order to preserve soil fertility, farmers use various ways such as the use terraces, mulching, grass strips and other traditional methods. However, some farmers still do not use any methods to preserve soil fertility.

The major reason for bush fallowing as revealed by the respondents was to restore soil fertility that is normally lost from excessive farming and soil erosion. In addition, farmers use different ways to manage their farms. Some of them use local manure from livestock. Apart from this, very few of the respondents use industrial fertiliser, pesticides, certified seeds and pesticides. Some farmers indicated that, they would have also liked to use fertilisers but they cannot afford to buy. So they normally just plant the seeds and hope for the best which does not work in most cases.

Empowerment of Women to Play Key Roles on Climate Change Adaptation

The key findings from the surveys with regard to the empowerment of women to play major roles in climate change adaptation are as follows:

The gender question in the Niger Delta region like the larger Nigerian society is historically, a socio-cultural phenomenon which denigrates the female person (whether as a girl-child, or adult woman) as an inferior and weak human-being who is incapable of participating in leadership; while her male counterpart is celebrated as the superior person, imbued with all the potentials for leadership.

Older men usually take the lead in community decision-making, with women and younger men tending to have a very limited say in decisions, be it within their families or communities. Typically, older men are granted greater authority in community decisions, with men generally having the responsibility for household decision-making.

The findings from the household survey and focus group discussions in various communities in the three ecological zones of Delta State show that both men and women reported taking part in key decisions including those entailing actions to adapt to climate change. The issues women had with respect to tradition and culture were expressed in terms of male sexual behaviour (multi-partner relationships, keeping of multiple wives and concubines, and fathering many children).

Exclusion from decision-making by women was expressed in terms of women being marginalized from participation in political structures as well as tribal and community councils. It was also expressed in terms of women not being able to negotiate with the oil companies directly and therefore women felt they were unable to access the community funds and jobs that were provided in concessions. This was also expressed in terms of traditional leaders appointing women "leaders" who did not represent the needs and interests of women. Women felt there was no authentic voice for positive change for women.

Women were perceived mostly as decision makers conjointly with their spouses but rarely individually, as observed by their partners. Male spouses perceived women having sole decision-making power only for responsibilities of which women are traditionally in charge, namely cooking and weeding. This contrasts with women's perceptions of their own decision-making authority. Women saw themselves more often as having sole decision-making authority in particular for some crop production and land management decisions (for example, clearing the land, leaving land fallow, start planting, hiring labour).

The empowerment of women will significantly enhance the efficiency of adaptation and mitigation efforts at all levels. By significantly increasing the number of women in decision-making, and drawing on their gender-based experiences in the formal and informal workforces, communities, and households, climate responses can be more effective, sustainable, and fair. Investing in women will enormously benefit communities as a whole due to the role that women play in production and reproduction within and outside the household.

Respondents in the three ecological zones identified specific roles which they think women should play in climate change adaptation including household dietary management, proper child care system, augmenting family income, conservation of resources, energy management and creating awareness and advocacy.

Respondents identified several relevant empowerment actions which need to be put in place to make women play major roles in climate adaption and disaster risks reduction in their communities. The empowerment actions recommended include improved access to farm inputs, access to climate information, access to training, access to extension services, access to credit and freedom from traditional and cultural barriers. It was emphasized by most respondents that a combination of the various actions identified must be provided if women are to play a major role in climate change adaption. In other words, providing one or two of the identified actions is not adequate.

Implications for the Promotion of Women-led Adaptation Strategies

There are two relevant implications of the knowledge generated in this study for the promotion of women's participation and leadership role in climate change adaptation in Niger Delta region.

The first relates to the implications of the findings for the empowerment of women to play key roles in climate change adaptation. Elements the following strategies need to be followed in the implementation of the intervention component of the project.

1. *Activities that work with women and girls to challenge traditional gender norms as they relate to women*. This type of programming aims to challenge traditional gender norms that limit women's expectations of themselves and their role in the family, the community and their country. Such programming tends to seek to "empower" women and to help women and girls seek alternatives to harmful cultural practices such as early marriage, early first births and traditional roles that circumscribe their full participation in society. This type of programming may assist women by providing "empowerment" including leadership training, public speaking skills and negotiation skills. Similarly they often work to move women into "non-traditional" roles by providing vocational skills training and business skills.

2. *Activities that work with men and boys to challenge traditional gender norms as they relate to women*. This type of programming was developed in response to the limitations that appeared in programs that only focused on women. This type of programming is designed to help men change their attitudes and expectations of women to promote more gender equitable gender norms. Much of this type of programming tries to encourage men to value women and girls, educate girls, avoid early and forced marriages, "allow" their wives to participate in community development programmes. Many of these programs focus on a specific topic such as working with men to stop gender based violence or to promote the use of family planning services. This type of programming is usually what people refer to as the "constructive engagement of men and boys" in women's empowerment.

3. Activities that work with men and boys and women and girls together to challenge traditional gender norms as they relate to women. This type of programming brings boys and girls together to investigate traditional gender norms as they relate to girls. It reflects a different methodology from the programs described above.

4. Programs that work with men and boys to challenge traditional gender norms as they relate to men. These activities focus on helping men and boys critically reflect upon the socially constructed notions of masculinity and what it means to be a man in a given culture. They are designed to help men understand the negative health and social outcomes of masculinities. To help men and boys acknowledge that there are negative outcomes that are associated with masculinities such as being tough, in control, not seeking help and having multiple sex partners. These activities are often aimed at promote more health seeking behaviours for men and to enable men to create more healthy constructions of manhood.

Secondly the findings have implications for the promotion of relevant and women led adaptation activities. In all the three ecological zones in Delta state, most farmers reported that they had noticed changes in climatic conditions over the last 10 years, with more than 60% reporting increase in temperature and changes in rainfall patterns. However, it is clear that the respondents' perceptions of climate change, regardless of whether these are correct or not, are already causing some of them to change their agricultural practices and have important consequences for their

livelihoods. Moreover, farmer perceptions of climate change are important factors driving the adoption of different livelihoods strategies and adaptation measures.

However, while a significant proportion of the respondents in the three ecological zones already perceive the impacts of climate change, only a relatively small proportion have changed their farming systems in response to these changes. The limited uptake of adaptation strategies by farmers is probably due to the high levels of household food insecurity, which make it risky for farmers to adopt new strategies that may affect their agricultural production and food availability. In addition, most farmers in the study area simply lack the resources needed to implement adaptation measures. The fact that the use of adaptation measures was positively correlated with farmer education level, use of diversified agricultural practices, diversified cropping systems and livestock ownership indicate that farmers who are better educated and already have more diversified systems are more likely to be willing to adopt new strategies. Other studies have similarly highlighted the importance of educational level, wealth, access to credit and information, extension services, safety nets, resources and adequate agricultural inputs and technologies in increasing the probability of uptake of adaptation measures by smallholder farmers

To assist the communities adapt to identified hazards such as flooding, windstorms, drying up of rivers, erosion and sea level rise, early warning system for extreme climate events need to be established at community level. Without this warning system, such events could destroy crops and livestock that people rely on for livelihoods. Emergency evacuation systems should be established al local level to evacuate communities during extreme climate events. Adaptation to climate change at the local level requires capacity development including economic empowerment. Income generation opportunities and income support programmes and capacity building on enterprise development and management are essential as this will enable the farmers and fisher folks to diversify their income sources in order to reduce their vulnerability to climate change.

Certain cultural practices such as hand irrigation, land augment/management with fertilizer, planting on mounds/ridges and planting shade trees need be improved upon and scaled up. Irrigation schemes should be established so that water is available for farming purposes. This requires the preparation and implementation of community-based climate change adaptation plans entailing the participation of the key stakeholders.

Chapter 1

General Background

Research Problem

Rural communities in the Niger Delta that depend on natural resources for their livelihoods are particularly at risk and therefore critical to climate change amelioration. Rural communities need support to strengthen resilience and increase their ability to manage climate change risks. The preferred and sustainable solution is to support rural communities to better manage and adapt to climate change pressures through community-based adaptation. It is essential to put rural communities in Niger Delta at the centre of actions on climate change and disaster risk reduction by empowering their inhabitants to adopt and adapt climate change strategies in innovative ways based on current and future evidence, so as to give them not only the ownership but also the confidence to take leadership of the process.

It is in this context that the role of women and girls in the promotion of climate change adaption becomes critical. Women and girls in the Niger Delta, are most at risk to climate change impacts due to their heavy reliance on climate-vulnerable natural resources, limited asset base, and reduced access to adaptive measures. Similarly, while disasters pose threats to everyone in their paths, they often have disparately harsher impacts on women and girls. This is due mainly to gendered differences in the capacity to cope with such events and insufficient access for women to information and early warnings. While women's vulnerability is almost always assumed, their unique capacities and contributions to adaptation and across the disaster management cycle (mitigation, preparedness, response and recovery) have not been well recognized and documented in the Niger Delta region. Women serve their communities as leaders in ways that often go unrecognized by national and sub-national governments in Nigeria. In fact, women's individual and collective knowledge and experience in natural resource management at the household and community levels equip them with unique skills that benefit adaptation and disaster risks reduction efforts. Women shape behaviour and transmit culture and knowledge through kin and social networks, which are critical to risk prevention and response efforts. Women participation are critical to effectively managing disaster risk and designing, resourcing and implementing gender-sensitive disaster risks reduction policies, plans and programmes. Women's leadership in civil society organizations can provide the potential for their participation in more formal processes of disaster response and recovery efforts. Consequently, adequate capacity-building measures need to be taken to empower women and girls for preparedness and alternate livelihood means in post-disaster situations in the Niger Delta region.

The project is designed to strengthen the ability of women, girls and other stakeholders in rural communities in the Niger Delta to make informed decisions and manage likely climate change driven pressures on their livelihoods. It attempted to make the tasks of adoption and scaling-up of innovation on climate change adaptation more effective by setting up mechanisms to increase interaction between researchers on the one hand and policy makers, rural women and other stakeholders on the other so as to ensure the inclusion of an increasingly diverse range of actors at community, sub-national and national levels in the development and scaling up of innovative approaches on community-based climate change adaptation and disaster risk reduction. The project is expected lead to the reduction in the vulnerability and enhancement of the resilience and adaptive capacity of rural communities to the adverse impacts of climate change in the Niger

Delta. It was also to lead to the emergence of a governance structure to manage climate change in the Niger Delta with local climate knowledge incorporated in national and sub-national development planning.

The overall objective of the research project is to contribute to socially-equitable development in Niger Delta region by promoting women-led, community-based initiatives on climate change adaptation and disaster risk reduction. The project is organized into five work packages with the specific objectives as indicated below.

The project has five specific objectives organized into four work packages: Knowledge development (objective 1), Pilot activities (objective 2), Capacity building (objective 3), and Knowledge translation (objectives 4 & 5) as follows:

6. Increase understanding of the varied impacts of, responses to, and adaptations to climate change in rural communities to enable identification of effective and affordable community-based approaches;

   This entails Surveys of the vulnerability and adaptation patterns in rural Niger Delta and their impact on women and girls as well as the prevailing gender characteristics.

7. Improve climate-change adaptation and disaster-risk reduction strategies in rural communities by testing and validating the most effective and affordable women-led, community-based initiatives;

   This entails the Implementation of women led community-based interventions on climate change adaptation and disaster risk reduction in ten pilot communities

8. Scale out validated community-based initiatives by strengthening local capacities to generate the necessary conditions to adapt these climate-change adaptation and disaster-risk reduction strategies;

   This entails the Training of women and girls leaders**,** women and girls' community-based organisations and other stakeholders to empower them on adaptation and disaster risk reduction

9. Scale up community-based initiatives by promoting interactions between researchers, policy makers, and women leaders;

   This entails the Mobilisation of policy makers, women leaders and other stakeholders to collaborate with the research team to implement the research program

10. Increase integration of women-led community-based adaptation strategies into policy and planning by the Delta State Executive and Legislature.

    This entails holding Meetings of Delta State Government officials and other stakeholders on presentation of the policy implications of the project results.

Literature Review

The review of the literature for this project so far can be categorised into three broad areas of focus. The first is on the broad issues of climate change phenomenon in Nigeria. The second reviews the literature on climate change occurrence, impact and adaptation approaches with specific focus on the Niger Delta region. Finally, the third section is on the nature of disaster risks and reduction strategies with special attention to the Niger Delta region.

Climate Change in Nigeria

The review of the literature shows that observed changes in Nigeria's climate will continue at least through 2030. Changes in Nigeria's climate include an increase in average temperatures, sea level rise, and variation of rainfall patterns trending towards increased extreme rainfall events. Generally, there has been inadequate information to date in Nigeria on future climate scenarios and impacts. In order to rectify this situation, a study was commissioned to provide scenarios of future rainfall, temperature changes, heat waves, droughts and extreme weather events. The work was undertaken through a partnership between the Climate Research Analysis Group, University of Cape Town, South Africa and the Institute of Ecology and Environmental Studies at Obafemi Awolowo University, Ile-Ife, Nigeria. A statistical downscaling approach was employed to downscale simulations of 9 GCMs over 40 NIMET stations in Nigeria. Downscaled baseline climate data (1961 – 2000) was established over the 40 Nigerian stations and the four zones, using the empirical downscaling method (Hewitson and Crane, 2006). Findings suggest a warmer climate in the future. The strongest scenario projects a temperature increase of 0.04 oC per year from the present period till 2050. The coastal regions are projected to warm less than the interior regions, because of the cooling effects from the Atlantic Ocean. The northerly stations are expected to be warmer than the southerly stations. The highest increase occurs in the northeast. The projected changes in precipitation vary across the country, with the scenario suggesting a wetter climate in the south along the coast, but a drier climate in the northeast from now till 2050. The scenarios suggest a peak increase in rainfall of about 2 mm/day in August over Mangrove and Rainforest zones and about 1 mm/day in rainfall in the same month over the derived and guinea savannah zones.

At the policy-making level, the Federal Ministry of Environment of Nigeria (FMENV) set up a "Special Unit" on Climate Change. It was established in recognition of "importance attached to the issue of climate change and global warming, and in view of the enormity of activities required for the implementation of the Climate Change Convention and the Kyoto Protocol" (FMENV 2010). It is this Unit that has been the driver of the Ministry's Programmes on climate change. In addition, it was recently reported that the Ministry has commenced "massive" awareness programme on climate change in the nine erosion-prone states in the Niger Delta region and northern parts of Nigeria. According to a Director in the Ministry, the programme would enlighten the people in the area about the threat and impact of climate change. However, this awareness programme which illustrated the impact of climate change, through jingles on television, radio and drama also had in participation "people at the grassroots" and some NGOs. It should be noted, however, that programmes, policies and activities of the Ministry on climate change do not seem to have specifically targeted and involved farmers e.g. the awareness campaign mentioned above (FMENV 2010). Consequently, farmers as major stakeholders appear

to have inadvertently been left out in the climate change debate and policy making in the Niger Delta by governmental authorities.

In a related development, the climate change discourse in Nigeria received a big boost with a major conference that was organized by the Department of Geography, University of Nigeria (UNN) in 2009. The conference whose theme was Climate Change and the Nigeria Environment touched on various facets of the climate change phenomenon including agriculture and food security, socio-economic development, vulnerability and adaptation to climate change, climate change education and awareness (Anyadike, 2010). However, only a few papers dealt with climate change and its impacts in the Niger Delta region of Nigeria (Efe, 2010; Ekuase et al, 2010; Ubuoh et al, 2010), while very little on indigenous knowledge systems and climate change awareness in Nigeria was presented (Nabegu, 2010). Niger Delta-specific data indicates a trend of late onset and early cessation of the rainy season. In recent decades, instances of heavy rainfall leading to flooding have become more commonplace. Sea level rise combined with land subsidence will result in a higher rate of relative sea level rise in the Delta, risking inundation of a significant proportion of the Delta's land. These changes increase the risk of flooding, a serious concern for an urbanizing Niger Delta region.

Climate Change Patterns in Niger Delta Region

Recently there has been a flurry of activities regarding climate change in the Niger Delta region of Nigeria. Some of these have been by non-governmental organizations (NGOs) and civil society groups while others are more academic and policy-oriented. In terms of research, it has been estimated that over 70 million cubic meters daily, amounting to about 70 million tonnes of carbon dioxide are flared off during oil and gas exploration and production activities in the Niger Delta region (UNDP/World Bank 2004). Approximately 75 percent of total gas production in Nigeria is flared. It has been further estimated that Nigeria accounts for about 17.2% of global gas flaring. As a result, more gas is flared in Nigeria's Niger Delta than anywhere in the world. Flaring in Nigeria contributes a measurable percentage of the world's total emissions of greenhouse gases (GHGs) and is probably the greatest contributor of GHGs in the Niger Delta region. Due to the low efficiency of many of the flares much of the gas is released as methane (which has a high warming potential), rather than carbon dioxide. At the same time, the low-lying Niger Delta is particularly vulnerable to the potential effects of sea levels rising.

Climate change in the Niger Delta contributes to sea level rise, affects rainfall pattern, emergence of diseases and pests, crop and animal production, fisheries, biodiversity, frequency and regularity of floods. This being the case, communities in the Niger Delta would seem to be especially at risk with serious consequences for property, livelihoods and the environment (Ugochukwu, 2008; Ugochukwu et al, 2008). The few other studies of climate change in the Niger Delta region have tended to be orientated to social aspects and food security. For example, Edino et al, (2010) examined people's perceptions and attitudes towards gas flaring. This study concludes that most residents appear to be resigned to the continued presence of gas flaring activities in the community. The study, however, raised several questions on modelling perception and attitudes toward environmental problems in areas where political tension and economic adversity are prevalent. A related study explored the spatial variability effects of gas flaring on the growth and development of cassava *(Manihot esculenta)*, waterleaf *(Talinum triangulare)*, and pepper *(Piper*

spp.) crops commonly cultivated in the Niger Delta (Dung et al. 2008). Findings of this study indicate that cassava yields were higher at location further away from gas flare while starch and ascorbic acid tended to decrease when cassava plant is grown close to gas flare. Curiously, however, the study also found that the waterleaf plant appeared to thrive better around the gas flare point (Dung et al. 2008).

Some Niger Delta-based NGOs such as Community Research and Development Centre (CREDC) and Environmental Rights Action (ERA) have also been active in trying to create awareness about impacts of gas flaring and its linkages with climate change and poverty in the region (Ibeanu, 2006; Uyigue and Ogbeibu, 2007; Uyigue and Agho 2007, 2009). Another National Non-governmental Organisation, Building Nigeria's Response to Climate Change (BNRCC) in collaboration with Nigeria Environmental Study/Action Team (NEST) have carried out some of their studies in parts of the Niger Delta region but key policy promotion activities have not taken place. Most of the recent studies in the Niger Delta have addressed issues of environmental degradation and vulnerability and mitigation of climate change impacts (Akinro et al, 2008), coastal management and adaptation to climate change (Etuonovbe, 2008), climate change, poverty and women's socio-economic challenges (Chinweze and Abiola-Oloke, 2009). The need for building institutional and professional capacity of urban and regional planners in the face of the climate challenge has also been advocated (Olujimi, 2007).

The available literature on climate change in Nigeria in the context of the Niger Delta region is characterized by some challenges. In the first place, research quality in Nigeria including climate change research during the last thirty years has been impacted by the poor funding of higher education in the country. Local research on climate change issues has been generally weak and limited. Most of the limited research activities carried in the country is funded by international agencies and foundations and these focused mainly on socio-economic issues largely as a result of the socio-economic problems facing the country since the early 1980s. Even then the limited research activities on climate change were carried out at the national level with little attention paid to specifically to the Niger Delta region, especially during the period when conflict and violence characterized the region. Secondly, due to the poor funding of research and the inability of researchers in Nigeria to effectively compete for grants from international donors, most of the studies are small scale, focusing on isolated issues relating to climate change mainly focusing on environmental degradation. Thirdly, an examination of the available literature indicates that in the context of the Niger Delta region and indeed other parts of Nigeria, the understanding of vulnerability to climate change and the strategies and pathways for adaptation are currently enveloped in high uncertainties because of inadequate scientific data in many respects.

Disaster Risks and Reduction

The occurrence of disasters in Nigeria has increased in frequency and intensity in the last three decades and especially in recent times. Rapid population growth and urbanization and social political issues compounded by ethnic plurality have been resulting in fierce competition for scarce resources leading to deteriorating livelihoods, social marginalization, crime and general insecurity. Examples of the wide range of hazards experienced in Nigeria, in recent years, includes the following:

- Market Fire in Sokoto destroying Market stores and other items;
- Dam failure in Zamfara state leading to flood;
- Market Fire in Adamawa State destroying market and other items;
- Fire outbreak and Civil disturbance in Plateau State;
- Market Fire at Suleja in Niger State;
- Civil disturbance in Maiduguri Borno State;
- Windstorm and Fire at Efelodun Iree Local Government Area in Osun state;
- Rainstorm and Fire outbreak at Ado Ekiti Oye and Ikole Local Government Area in Ekiti State;
- Communal clashes and rainstorm at Okehi, Ibaji Ijumu, Lokoja, Kogi State;
- Flood in Kubwa, Gwagalada, and Abuja Enirons;
- market fire outbreak in Southern Kaduna;
- Market fire in Sokoto;
- Fire outbreak in Gaya Ungoggo Wudil and Minjibir Local Governtment Area of Kano State;
- Communal clashes at Ikwano Local Government Area in Abia State;
- Communal clashes and fire at Kalfiringo and Bambam Local Government Area in Gombe State;
- Wind Storm and Fire outbreak at Zagga Jega and Birnin Kebbi in Kebbi State;
- Fire and Flood at Bama Kondoga Hawul and Biu Local Government Area in Borno State;
- Fire and Flood at Bida Borgu, Kotagora and Mashegu Local Government Area in Niger;
- Fire and Windstorm at Dutse Babura, Ringin, Dogon Make and Yankweshi; and
- Soil Erosion at Auchi Local Government Area in Edo State.

However, soil erosion, rainstorm and flood disasters are prevalent in the Niger Delta region. Ologunorisa (2004) carried out an assessment of flood vulnerability zones in the Niger Delta region by using a hydrological technique based on some measurable physical characteristics of flooding and vulnerability factors. On the basis of these factors, 18 settlements randomly selected across the three ecological zones in the region were assessed. Three flood risk zones emerged from the analysis. These are severe flood risk zones, moderated flood risk zones and low flood risk zones. Strategies for mitigating the hazard of flooding in the region were recommended. In another study in Niger Delta region, Ologunorisa (2005) found, among other things, that the population regards most important the causes of floods as heavy, prolonged rainfall and river overflow. Nevertheless, they have little knowledge of the frequency of severe floods, and flood alleviation schemes. Most flood victims do not get compensation or relief during flood disaster, and the reason why they remain in the Niger Delta region is influenced by their occupations, especially fishing, subsistence agriculture, and the presence of crude oil in the region which has attracted many migrants who cannot afford the high cost of accommodation and are therefore forced to live in vulnerable areas of the floodplain. Finally, the study concludes that flood control in the region needs the cooperation of government, community efforts and an enlightenment programmes through environmental education and mass media.

Gobo and Abam (2005) in their study examined the socio-economic implications of flooding in the Niger Delta area using the Kruskal-Wallis function. The study focused on areas that are prone to annual or flash floods, back swamp flooding, tidal floods, and some cases urban floods which vary in magnitude and effect from one state to the other. The results enabled the authors to predict the behavioural responses of the dwellers in the flood prone areas of the Niger Delta. The needs for enlightenment programmes, contingency plans, emergency measures to be adopted by local dwellers when flooding occur were highlighted.

Ologunorisa (2009) evaluated flood risk mitigation strategies in the Niger Delta that suffers from perennial flooding. The author argues that the structural methods of flood control tend to give a false sense of security to flood plain dwellers in the Niger Delta and thereby encouraging investments in flood prone areas. The study observes that for flood risk mitigation strategies to be effective in the Niger Delta, there is need for establishment of coastal management zone authority, land-use zoning, legislation, building codes, flood forecasting and warning systems, flood insurance and engineering control of the major river systems.

Finally, Uchenna ,Wekpe and Obafemi (2016) reviewed and provided an understanding of flood vulnerability mapping as an often neglected non-structural measure in flood prone regions of developing countries, and showcases its applicability in the Niger Delta region of Nigeria for flood risk disaster reductions. The review further reveals the underlying potentials and procedure of flood vulnerability mapping as a robust non-structural strategy that is reliable and should precede structural measures in the management of flood risks and flood hazards in the Niger Delta region.

Public Policy Response to Disasters in Nigeria

In response to the upsurge in disasters, the Federal Government of Nigeria through the then Decree No. 12 of 1999 established the National Emergency Management Agency (NEMA) as the apex public sector agency for emergency management. This legal instrument was fashioned after the USNEMA law, but its operation has been handicapped by several factors among which are inadequate funding and equipment, weak executive capacity and lack of decentralization. The enabling legislation contains concepts like co-ordinate, liaise, monitor and collect, etc. which presupposes that NEMA is a coordinating agency. Whereas, NEMA is structurally incapacitated, the situation is worse at the state and local levels. Although the 1999 NEMA Decree directs each state to have a fully equipped emergency management agency, this has not been realized in most states in Nigeria.

The means of tackling flooding in Nigeria include but not limited to structural measures (such as dams, bridges and drainage systems), policy formulation, physical intervention, social measures and research, relocation of human populations and relief assistance to internally displaced persons. For tackling floods in the country, the key institutions include: Federal Emergency Management Agency (FEMA), National Emergency Management Agency (NEMA), State Emergency Management Agency (SEMA), Local Emergency Management Agency (LEMA), National Orientation Agency (NOA), National Environmental Standards and Regulations Enforcement Agency (NESREA) which by 2009 Nigerian Acts supersedes the FEPA, Nigerian Meteorological Agency (NIMET) and Nigerian Hydrological Services Agency (NIHSA).

With NEMA as a coordinating body, specific actions towards tackling flooding in Nigeria can be conceived as follows: policy formulation, data collation from relevant agencies, education of the general public on flooding, distribution of relief materials to disaster victims within the states and local government areas (LGAs), protection and development of the environment through enforcement of all environmental laws, guidelines, policies, standards and regulations in Nigeria, as well as enforcing compliance with provisions of international agreements, protocols, conventions and treaties on the environment to which Nigeria is a signatory (key roles of NESREA), provision of reliable and high quality hydrological and hydro-geological services and

data on a continuous basis (key roles of NIHSA, which since 2013 has been creating awareness of flooding through the "flood outlook" initiative), flood forecast and weather report along with other meteorological information (NIMET).

Co-habitation among families in Nigeria offers a comparative advantage in the event of flooding as individuals within family setting offer mutual assistance to cope with the hazard and to recover speedily from losses incurred. In many flooding incidences in Nigerian cities, the general public has often converged at the scenes the incidence to offer help to victims, assist in evacuation of those displaced and in protecting property from further damage. Many IDPs easily find shelter and other humanitarian needs from families and friends while awaiting intervention by authorities. However, unlike the developed countries, the vulnerabilities of local communities to flooding in Nigeria may indicate among other factors the overwhelming lack of responsibility towards flooding and ways of addressing its challenges. For example failure to comply with environmental laws and regulations and to adhere to weather warnings and alerts are possible situations where lack of responsibilities of local communities and the general public is highlighted (Aderogba 2012).

The indifference of most people towards research questionnaires and surveys most likely compounds the situation. Humanitarian response to flooding in Nigeria has been overwhelming. Almost in all cases of flooding in Nigeria have victims received humanitarian supports with most notably the International Federation of Red Cross (IFRC), United Nations, World Bank, Foreign countries including UK, the United States, China, Japan, France as well as religious organizations including the Catholic, Anglican and Pentecostal churches and missionary societies. The 2012 flooding saw humanitarian response amounting to over US$70 million (OCHA 2012).

Considerable attention has been given to flooding in Nigeria through research and scientific studies. However, the need for science and technology to embrace environmental education in Nigeria has been identified (Terungwa & Torkwase 2013). Despite these progresses, there are a number of critical issues regarding these present efforts at tackling flooding in Nigeria (Obeta 2014). With regards to facilitating the evacuation of victims affected by floods and providing them with urgent humanitarian needs, the level of dissatisfaction and agitations from large numbers of the flood victims, especially the IDPs, queries the effectiveness of these measures. Although it is unjustifiable to claim that the limitation with these present efforts probably leads to more frequent flooding in the country, however, the fact that such measures have not improved the country with regards to the idea of "living with floods" is clearly acknowledged (Adelekan 2010, Akintola & Ikwuyatum, 2012).

Key Findings from the Ongoing Secondary Data Collection are as Follows:

- Trend analysis of rainfall and temperature confirms that climate change is occurring in the Niger Delta region;
- Available weather information gathering institutions do not make weather/climate information available to the public. Climate information from the media is not addressed to the particular needs of the farmers and fisher folks. Therefore, policy is required to ensure that relevant climate-based information is available on time to the different end-users;

- Majority of the people in rural communities lack science-based knowledge of climate change. Therefore, rigorous awareness creation using science-based information is needed as the starting point for policy aimed at effective adaptation by all stakeholders to climate variability;
- Men and women are equally vulnerable to the impacts of climate change. The cost of impacts of climate change hazards such as flooding, erosion, heat and cold was higher for women than for men. Also the cost of adaptation to climate change impact was higher for women than for men;
- Indigenous knowledge of climate is not preserved or widely appreciated in most communities in the Niger Delta region. This knowledge may be facing the danger of extinction. The use of indigenous knowledge should be promoted through patronizing the services of custodians of this knowledge;
- Local people in the Niger Delta region have limited capacity to adapt to the impacts of climate change. This poses immediate challenges to policy makers as well as development agencies.
- Majority of the people in rural communities of the Niger Delta region are vulnerable to sea level rise, flooding, coastal inundation, windstorms, drying up of streams and erosion
- Several factors are rated as "very important" in exposing the farmers and fisher folks to the impacts of climate hazards in the Niger Delta region. These are low agricultural output, non- availability of irrigation facilities, insufficient farm labour, and lack of agricultural commodities/food storage facilities, low income and inadequate means of transportation etc.
- For climate change issues and adaptation strategies to be taken seriously, key stakeholders, especially in the decision making public sector organisations such as Federal, state, local government, private sector, and media need to be empowered through training and research uptake.
- The fact that the use of adaptation measures was directly correlated with farmer education level, use of diversified agricultural practices, diversified cropping systems and livestock ownership indicate that farmers who are better educated and already have more diversified systems are more likely to adapt to climate change impacts.
- The most effective way of reducing the vulnerability of farmers and fisher folks is through general adaptation strategies that focus on improving their overall well-being. This suggests the need for place-based studies of adaptive strategies to assess which specific projects will be most effective at reducing farmer or fisher folks' vulnerability under a wide variation of climate hazards.

Conceptual Framework

Vulnerability and Adaptation

Vulnerability refers to the level of exposure to injury, damage or harm. Vulnerability to climate change is the degree to which geophysical, biological and socio-economic systems are susceptible to, and unable to cope with, adverse impacts of climate change (IPCC, 2007). The IPCC-CZMS (1992) defines vulnerability of coastal communities as the degree to which they are incapable of coping with the impact of climate change and accelerated sea level rise. The literature is replete

with studies on vulnerability assessments but there is no concise and generally accepted definition of vulnerability, since the issue of vulnerability transcends biophysical, socio-economic, political and environmental boundaries. In an attempt to provide a comprehensive definition for vulnerability to climate change, Patwardhan (2006) provides a five-part definition which relates to the questions and objectives of a vulnerability assessment. In his view vulnerability may be defined as:

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

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

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

In this respect, three broad characteristics of vulnerability to climate change and natural disasters and hazards have been identified. If combined, these will address the dynamics and integrated nature of social and environmental vulnerability. The first characteristic of vulnerability in terms of exposure to hazardous events (e.g. droughts, floods) gives an indication as to how this affects people and structures. In this respect, a physical event puts individual households and the community in danger. Thus the focus is to identify vulnerable places. The second characterization views vulnerability as a human relationship and not just a physical one, where vulnerability is socially constructed rather than determined by the occurrence of a physical event. Thus vulnerability is a function of social conditions and historical circumstances that put people at risk to a diverse range of climate-related, political, or economic stresses such as poverty (Dolan and

Walker, 2004). The third characterization integrates both the physical events and the underlying characteristics of populations that lead to risk exposure and limited capacity of communities to respond. Vulnerability is thus the extent of exposure of the Niger delta communities to danger in both the biophysical environment and human environment (socio-economic, cultural, political susceptibility, resilience and degradation) (Dolan and Walker, 2004; Sullvian and Huntingford, 2009).

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

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

The indicators of adaptive capacity in socio-economic systems include (Dolan and Walker, 2004):
1. Efficient transmission of knowledge across space and time;
2. Diversification and sustainable intensification of resources;
3. Mobilization of social networks;
4. Mobility for relocation and access to resources; and
5. Decentralization of decision making.

The report of the Working Group II to the third Assessment Report of the IPCC (IPCC, 2001) identified the determinants of adaptive capacity to include (IPCC, 2001; Dolan and Walker, 2004):
1. Available technology options;
2. Available resources and their distribution;
3. Stock of human capacity including education and security;
4. Stock of social capacity including property rights;
5. Structure of critical institutions;
6. Ability of decision-makers to manage information and validate it; and
7. Public perception.

To effectively measure vulnerability, elements of the human-environmental system must be considered (Dolan and Walker, 2004). These elements are determinants of adaptive capacity within social systems that interact and co-evolve with changes in the physical environment. The adaptive capacity of coastal communities to cope with the effects of severe climate impacts decline if there is a lack of physical, economic and institutional capacities to reduce climate-related risks (IPCC, 2007). Exposure of the coastal environment can be characterized by susceptibility (or sensitivity), resilience and resistance. This study combined physical and socio-economic characteristics and cost/value of losses to the physical environment due to climate

related hazards, to reach conclusions about vulnerability of the individual households in line with Pawardhan (2006). In particular, households are determined to be vulnerable by the cost of impact of climate hazards in a 'do-nothing' scenario. The higher the cost, the more vulnerable is the household.

Adaptation to Climate Change

Adaptation has been defined by the IPCC (2001) as the adjustment in natural or human systems in response to actual or expected climate hazards or their effects. Stated differently, the assessment of adaptation strategies for climate change impacts refers to the identification and evaluation of possible options or changes in policies, practices and technologies as well as actual or expected climate hazards, or their actions designed to adapt to or take advantage of new opportunities that become possible as a result of climate change (FME, 2003).

Adaptation is not new to human history as humans have always had to adapt to a certain degree of change in climate variability and the environmental dynamics. There is now a new dimension to adaptation as the pace at which the climate is changing is faster and poses a greater challenge thus requiring much faster adaptation than before. Delaying action will certainly lead to increased costs and eventually greater risks to vulnerable communities. The choice of appropriate adaptation may be based on the following criteria identified by Tear fund (2009):

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

Determinants of Adaptive Capacity

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

Vulnerability Assessment

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

$PV = \sum CV*(1 + r)$ Where:

PV = is the Present Value of cost of losses to climate change-related hazards;

CV= Losses incurred in event of climate change-related hazards; costs and benefits were valued with the 'willingness to pay' approach (Field and Field, 2009). Respondents, however, did not report any financial or social benefits;

r = the opportunity cost of capital, (that is the market rate of interest =21% in this case); and

(1 + r)=1.21= is the compound factor that will bring the CV from the past to the present value.

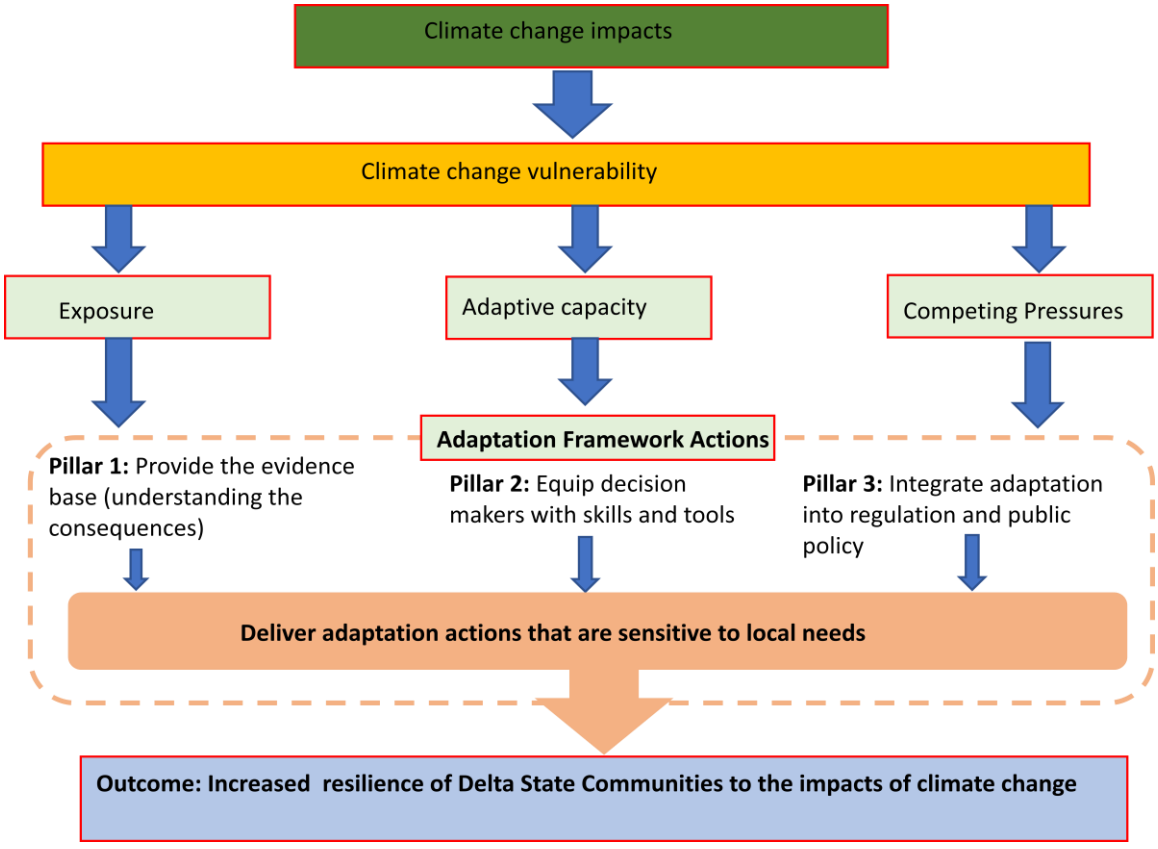

Fig 1: Climate change vulnerability and adaptation actions to build resilience
Source: Modified after the Scotland Government (2009)

The conceptual basis of this study is modified from that of the Scotland Government (2009) framework for climate change shown in Fig 1. The climate change impacts, vulnerability and adaptation options in Delta State were looked into by providing evidence base data which will help in understanding the consequences of the changing climate. Such evidence based knowledge will help to equip decision makers with skills and tools which will help them to integrate adaptation into regulation and public policy. The study hoped to go further by deliver adaptation actions that are sensitive to local needs and this will help localised decision making by individuals and organisations. The outcome will be increased resilience of Delta State communities to the impacts of climate change.

The Study Area

Delta State is one of the thirty-six states forming the Federal Republic of Nigeria. It was part of the defunct Bendel State of Nigeria. The state came into existence on 27 August 1991, when it was created as a separate state from the former Bendel State by the then Military Government. Delta State was initially made up of twelve political divisions called Local Government Areas (LGAs), which later increased to 19 in 1996. Presently there are 25 LGAs in Delta State (Figs 2-4). Delta State has a land area of 16,842 square kilometres and its geographical location is defined as follows:

Longitude 5^{O} 00' and 6^{O} 45' East of the Greenwich Meridian
Latitude: 5^{O} 00' and 6^{O} 30' North of the Equator

Delta State is bordered by Edo State to the north, Anambra and Rivers States to the east, Bayelsa State and the Atlantic Ocean to the south, and Ondo State to the west. The shape of the state is less compact, compared with its neighbours, such as Edo, Anambra and Bayelsa; the distance of the Eastern boundary to the Western boundary being about 165 kilometres, while that of the northern boundary to the southern boundary is about 125 kilometres.

The location of Delta State within the Federation of Nigeria has been a major economic advantage. It is situated in the heartland of the Nigerian economy, as it is the highest producer of petroleum amongst the oil-producing states in the country. A large number of oil-producing companies are based in the state, while many petroleum-related industries are also located in it. Thus, Delta State, located in the centre of oil production in the country, has great potential to profit to the extent that the industry stimulates economic growth of the state.

Fig 2: Nigeria showing the Niger Delta region

Fig 3: Niger Delta showing Delta State

Ecological Zones

As in most parts of the Niger Delta region, four major ecological zones characterise Delta State. The zones consist of Beach/Barrier Ridge Islands, Mangrove Swamp Forest, Freshwater Swamp, and Lowland Rainforest. In this study, the three most pronounced ecological zones are studies, namely; the Mangrove Swamp Forest, Freshwater Swamp Forest and the Lowland Rain Forest (Fig 5)

Beach/Barrier Islands Forest Zone lay along the fringe of the coastline of the Niger Delta. The zone stretches from boundary between Delta and Ogun States, through the Benin to the Imo Rivers. These 'islands' range in length between 5 km. and 37 km, with a mean of 18 km, and in width from a few meters to more than 10 km, with an average of 5 km. The maximum elevation range for the islands is 2 to 4 m above mean sea level (MSL).

The dominant vegetation of the Barrier Island Zone of Delta State, as in other parts of the Niger Delta region, is Freshwater Swamp Forest, but occasionally there occur small salt marshes, where seawater washes over beaches. As the poorly drained and sandy soils are not conducive to farming, there is little direct conversion of forest to agricultural land. Timber felling is common. In a few areas canals, dug to facilitate log extraction, allow the incursion of salt water, killing the freshwater forest. Such areas turn into barren salt marshes.

Mangrove swamp forest zone (Fig 5) is found at less than 3 meters elevation above sea level and is colonised primarily by mangroves *Rhizophora* . The tidal flat is inundated twice daily. The tidal flat area comprises three subunits: the main distributaries, also known as feeder channels, the minor interconnecting creeks, and the inter-channel flats in between the creeks. Mangrove forests of Delta State occupy inter-tidal land in a broad zone of tidal creek behind the barrier islands. The mangrove zone is up to 25 km wide but it narrows in flood-dominated estuaries where the discharge of the rivers flowing from land dilutes and pushes back tidal saline waters. The details of the interaction between tidal and river waters differ for each estuary and river-system, and accounts for many local ecological variations in the mangrove ecosystem of the Delta state.

Typical mangrove forests in Delta State consist almost entirely of the red mangrove tree *Rhizophora mangles* with its characteristic stilt or prop roots. The trees grow tallest along creek edges where fresh mud is deposited. Further behind, in the old-growth back swamp areas, trees are very stunted, especially in areas not receiving nourishing waters from the ocean or the Niger flood. The back swamp may have other, smaller mangrove species - the white mangrove (*Languncularia racemosa)* and the black mangrove *Avicennia germinans.* Higher areas of the swamp contain the unique salt fern and the salt grass, and at the back there is a boundary zone of shrubs and small trees and the spiny false date palm. Several of these 'semi- mangrove' species tend to colonize cleared areas, including dredge soils.

The mangrove floor is important to innumerable smaller flora and fauna, and so ultimately to the whole food chain leading to man. Many invertebrate species live hidden in burrows e.g. polychaete worms, crabs and certain shrimps, clams and eel- like fish. Soft organic mud in shallow depressions and near the creek edge is home to microscopic mobile algae easily visible at low tide when they form a golden-brown film on the mud surface. Firm ground consists of

peat and may have filamentous mats brown algae, which also cover the lower parts of breathing roots. The algae, decomposing mangrove leaves are fed on by the many larger animals characteristic of the mangrove forest -crabs, periwinkles and mudskippers, joined by birds at low tide, and by fish and shrimps at high tide.

The Freshwater Swamp Forest zone (Fig 4) constitutes a broad ecological zone lying between the Mangrove Swamp Forest belt and the Lowland Rain Forest Zone. The Lower Floodplain is underlain near the surface by a thick layer of fine sand, silt and clay mixed with decayed organic matter. It is generally less than 6 m above sea level. The main features here are the strongly meandering distributaries of the rivers flowing into the Atlantic Ocean and the intervening poorly drained flat surfaces. Historically, the whole area is subject to regular flooding which caused the creeks to change their course, a process that has led to the formation of numerous cut-off lakes (now largely seen as bogs) along the creeks. The poorly drained terrain was covered by thick rain forest but now severely degraded due to activities connected with agriculture and crude oil production. However, permanently water logged sites still support profuse growth of raphia palms. The boundary of this morphological unit is with tidal flats to the south.

Freshwater Swamp Forests (Fig 4) cover the Delta State's major source of timber and forest products (snails, cane, ogbono, palm wine and gin), and are important areas for rare and endangered wildlife. There is great variation in the ecology and development potentials of swamp forest types, depending on the differences in underlying hydrological regimes. Swamp forests, which are subject to the silt-laden ‘white water’ of the Niger flood, have very high fishery and agricultural potentials. The features of the zone, including flood-free levees, back swamp and cane forests, help give the zone a high diversity of habitat types. Large areas of the forest are inundated during the flood, becoming vast seasonal nursery areas for fish. The shortened season for farm crops is compensated for by the nourishing silt from the flood, which allows for yearly farming without fallow periods. A major constraint to farm production, as well as timber felling, is not so much lack of suitable land as its accessibility through difficult terrain, especially as concerns evacuating produce. For this reason, most of the conversion of forest to farmland occurs more in a 500-meter band along the banks of creeks. Lower down, between the Flood Forest and the mangrove zone, lies a permanently swampy, tidal- freshwater zone with more narrow and muddy channels -what has been called the 'transition' or 'Marsh forest' zone. Raphia swamps are more common, and timber felling involves the digging of long canals for log evacuation. The zone also has wildlife and fisheries different from the Flood Forest zone.

Elsewhere in the state, there are tracts of 'black water' swamp forest, especially in low areas bordering the mangrove zone, on barrier islands, and in the black water zone between the Forcados and Nun distributary channels. Another swamp forest type, already mentioned, is riparian swamp forest along rivers in the Lowland Forest Zone.

The lowland Rain Forest Zone (Fig 4) is the northern limit of the Niger Delta region. The Upper Flood Plains are generally well-drained, and lying at the foot of the sandstone hills and ridges. The lowland forest zone occupies the non-riverine or 'upland' areas, the upper flood plains, of the state. The natural rainforest of the area has been cleared for agriculture, and the dominant vegetation types are now farm-bush (a mosaic of cropped and fallow areas, usually with many oil palms trees) and plantations (mainly oil palm and rubber). Open farmed areas lead to the entry of

invasive grassland or 'savannah' species. Some forest species can survive in old fallow land but disappear as fallow periods shorten with increasing population pressure.

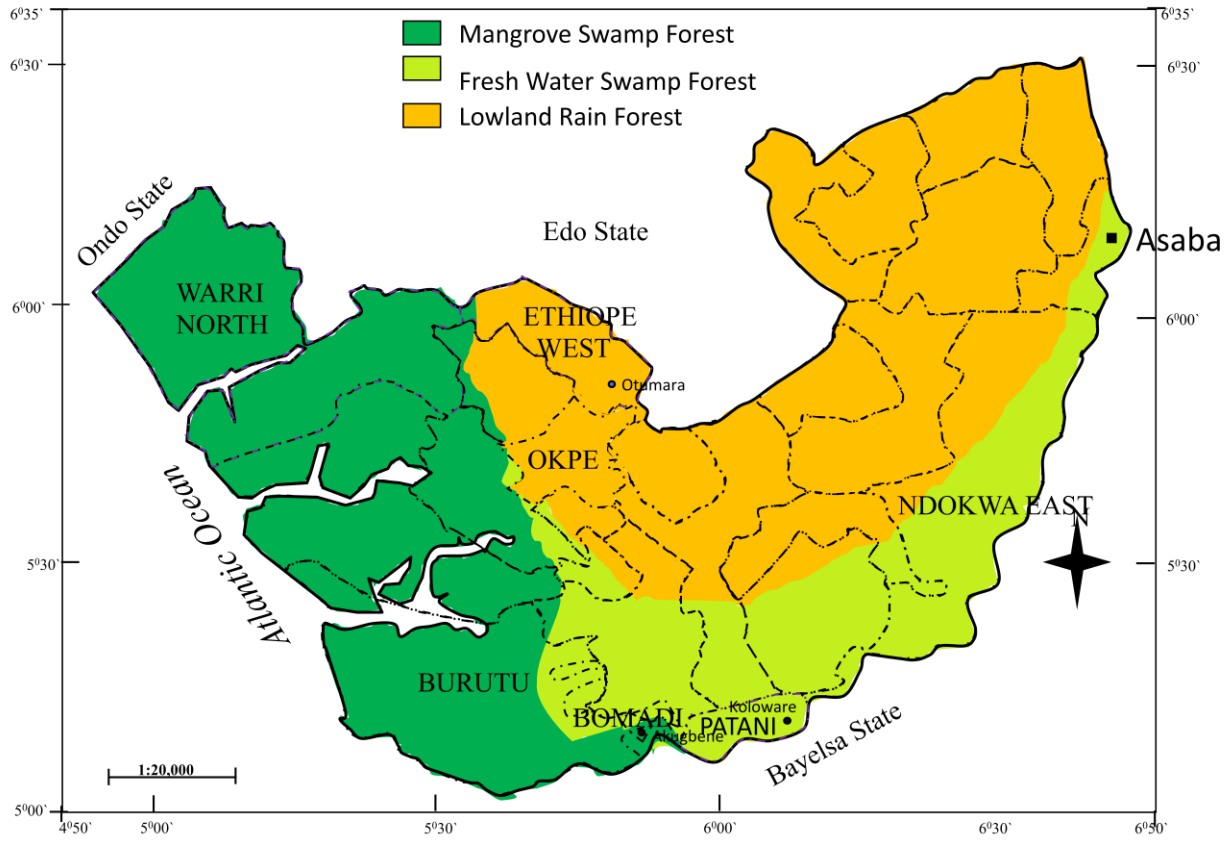

Fig 4: Delta State showing the Ecological Zones

Climate

The climatic characteristics of Delta State as in most parts of the Niger Delta region are classified as Equatorial type. Two air masses influence the climate of Delta State. The first is the moisture-laden south-westerly air mass (Tropical maritime), which originates from the southern Atlantic Ocean. The second is the dry north-easterly (Tropical continental) air mass, which originates from the Sahara Desert and brings harmattan condition to the area during the dry season. The maximum daily air temperature ranges between 24^{O}C and 34^{O}C and mean annual range of 25^{O}C and 28^{O}C. The lower mean temperatures are recorded in the rainy season, while the higher mean temperatures are recorded before the onset of the rains in February and March. Rain falls throughout most months of the year with a dry spell in some parts of the state during the months of January to March. In the interior locations at the northern apex of the state, the dry season may persist for five months (between November and March). Mean annual rainfall varies from about 3,500 mm in the coastal area, to about 1,500 mm in the northern part of the State.

The relative humidity in Delta State is usually more than 80 per cent in the morning and greater than 60 per cent in the afternoon, even during the dry season. Because of its nearness to the equator, there is much cloud cover and indeed, certain parts of Delta State are more or less under permanent cloud cover throughout the year. Winds in Delta State generally range from calm to light. Concentrations of suspended particulate matter are high, especially when the harmattan is prevalent. Values may exceed 10,000ug/m3 (24 hr). Point sources (gas flares, heavy industries, vehicles) contribute substantially to the fluxes of particulate matter. Gaseous emissions are generally within recommended limits, except areas close to emission sources. Of special interest is the phenomenon of acid rain. While inorganic acid rain precursors (SOx and NOx) in the atmosphere of the state, have low concentrations, rainfall acidity in some areas is as far below level of acidity (pH =5.67). In the southern and western parts of the state rainfall acidity is fairly high (pH 3.3 – 6.2), due to higher concentration of gas flaring (Fig 6), and urbanization.

Economic Activities

Farming and Food Resources: Farming is the major economic activity of Delta State as in other NDDC States and indeed Nigeria. Farming activities employ over 60 per cent of the working population in the state. The farming systems in Delta State involve principally the traditional peasant subsistence/crop farming method, with land and labour being the principal inputs of production. It is further characterised by small-sized farm holdings of less than one hectare per household. Commonly, very simple traditional farming tools including cutlasses, hoes and axes are employed in single and mixed crop farming. Major crops cultivated in Delta State include cassava, yam, maize, cashew, cocoyam, oranges, rice, plantain, groundnut, cowpeas, melon, banana, pineapple, okra, pepper and pumpkin. The two major tree crops cultivated are oil palm and rubber. It is evident that cassava remains the largest grown crop. Cassava also has the highest crop yield per hectare of all the major crops produced. Yam and maize are the next most abundantly produced food crops. Generally, the total food production levels have increased with the impact of the Agricultural Development Programme of the state. More farmers are changing cropping patterns by engaging in double, mixed, and inter-cropping practices.

There is still a *low* level of adoption of fertilizers, agro chemicals and improved seeds. In the state, fertilizer usage is lower in the southern zone (15.48%), but higher in the central and-northern zones (44-54%). Harvesting methods are manual and processing/storage facilities are rather poor and grossly inadequate. This shortcoming leads to losses resulting from spoilage. In addition, facilities for appropriate post-harvest processing and storage are grossly lacking. Consequent, farmers are constrained to dispose of harvest promptly and cheaply resulting in low-income returns, which in turn, could potentially constitute a disincentive to increase in productivity

Livestock Production: The number of Delta State families involved in livestock production (except fishery) is quite low, especially as it relates to commercial production. The limited domestic rearing involves goats and sheep as well as poultry. There is, however, an increasing level of awareness as to the income potential of this source. Consequently, poultry, rabbit, and pig production is now being taken up by an increasing number of farming families

Fisheries Production: The main ecosystems important for fishing include inshore marine waters, estuaries and river mouths, brackish mangrove creeks, large white water rivers, and floodplain swamps and lakes. The brackish waters in the Niger Delta consisting of intertidal creeks, swamps

and mangroves are either the spawning or nursery ground for much coastal water and some freshwater finfish and shellfish species. Among the most important fish are bonga, mullets, juvenile croakers, tilapias, mudfish, crayfish, shrimps and the silver catfish. Women and children gather shellfish especially the periwinkle in large numbers. In the freshwater zone, clear- and black water streams of the coastal sand plains appear not productive enough to support full-time fishermen. Part-time fishing is done to meet household needs. In the white water sector, the fishery is traditionally divided between riverine and floodplain fisheries. Individual families or communities own floodplain ponds and lakes variously; fishing rights may be sold for specific years 'and seasons, sometimes to other ethnic groups practiced in special techniques. Riverine fishing is more open but often subject to communal or clan regulations on seasons. Traditional ceremonies for the opening of fishing seasons are common. In recent years, illegal fishing practices, using explosives (in creeks and rivers) or pesticides (in freshwater swamp channels) have become common in some areas, and communal efforts to stop these practices are often frustrated by low co-operation from civil authorities. In freshwater floodplains, there is increasing use of cross-channel traps to catch all sizeable fish moving through migration routes -the huge 'otta' traps for wide creeks, and small basket traps used by women for fingerlings returning to the river in small streams and gutters. In estuaries and large rivers, large beach seines are subject of complaints on account of the large kills of small fish.

Fish processing and marketing: Given the high temperatures in the surrounding environment, fish perishability and the remoteness of most fishing communities in Delta State from the major consumer centres is a critical issue. Regrettably, solar drying and salt preservation are generally not practised on the coast. Rather, fish curing is effected by heat and chemicals derived from wood fires. Smoke drying occurs in makeshift wood-fired houses, or fuel-inefficient least-cost, low technology, and operationally simple mud ovens. Smoke drying also may occur in the open, or in semi-covered, un-insulated common areas. Smoke and heat control deficiencies, together with undesirable wind-induced flames multiply the drudgery, often jeopardising product uniformity, batch capacity and processing time**.**

Very often, smoke-dried fish is held in storage in anticipation of the weekly or fortnightly market day. It is fired to sustain the 10-30% low moisture level, and to discourage infestation. In the process, some of the products become charcoal black, bone dry, fragmented, and even foodless. Charring often leads to low consumer pricing and considerable post-harvest and preservation waste. Several attempts to improve the process through the introduction of superior, fuel-efficient ovens are yet to yield widespread dividends. And, the spirit of "cut one, plant one" is yet to take a foothold. The resulting short supply of fuel wood induces fishermen to buy up whole forests to ensure regular energy supply. Wood smoke has also been implicated in the incidence of conjunctivitis and red eyes not uncommon among fish processors in the Delta State. Secondly, processing capacity often falls far short of the production glut in the clupeid fishery. Consequently, there have been frequent mass burials of fish rather than its optimum production for the market.

Fishery product marketing in Delta State as in other parts of the NDDC States is extremely complex. It is complicated by the specificity of the fishing culture of ethnic groups, and even fishing villages. Some fishermen sell their catch to their wife or wives and/or the highest bidder for immediate or subsequent cash payment, without any regard to sentiments based on marriage or other relationships. For some, wives take responsibility for the fish processing and some

marketing components of the fishing -household enterprise. Depending on the type of fishery, some of the catch is disposed of fresh on the beach to other women processors. In other instances, the financier takes over the catch for marketing and rewards the fishermen in kind or in cash, which is usually a token not at all commensurate with the fishermen's efforts.

Very often the fisherman's wife, who is the processor and primary level marketer, has a clientele, or a first refusal, or exclusive trading relationship with a particular fish merchant or select group. The fish merchants either sell wholesale to secondary level marketers, to retailers directly, or through select groups of market residents and immobile wholesalers. Both the itinerant and resident wholesalers are organised into tightly controlled, price-fixing cartels. Invariably, product quality loss results from the long four-to-five point marketing chain. As a result, the consumer bears the brunt of the inflationary cost, since at each stage, 10-30% profit margin is added on. Overall, the fishing household who has to commit 80-90% the requisite human and material capital, but remains fully connected with the all-or-nothing product perish ability, is totally disadvantaged by the marketing chain, in terms of profit levels and other benefits.

Forest Resources and Activities: The economically significant timber resources in Delta State are saw logs, transmission poles, building poles, bamboo, fuel wood and chewing stick. Sawn-timbers are available mainly in the freshwater swamp zone. Very few areas of lowland rain forest presently remain in Delta State as in other parts of Niger Delta region. Most of these have been converted to farmland. The coastal beach ridge forest with species similar to those of the rain forests is another source. However, given the small extent of this area, the resources available are limited. Abura *(Mitragyna ciliate)* is one of the most commonly occurring sawn-timbers. The dominant position of fuel wood exploitation in the state derives largely from the fact that, in most rural areas, virtually all households exploit firewood in one form or another. In many areas of the state, cultural groves characterised by preserved forest areas are common. These usually serve a number of cultural purposes and are thus preserved as the abode of divinities and 'evil forests' or the home and groves harbouring the masquerades. In certain cases, ability to enter into such areas serves as a mark of cultural identity, a symbol of authority or of one's position in the community's system of social stratification. Various types of non-timber forest resources are relatively more numerous than the timber ones. They include oil palm, raffia palm, various fruits, such as bush mango (ogbono), spices, various roots, tree barks, a variety of leaves, various climbers and giant snails, among others.

Research Methodology

Data collection entailed:

(x) Literature review through secondary data collection;

(xi) Field surveys were carried out in ten LGAs sampled from the three ecological zones as follows:

(d) Mangrove Swamp (Warri South, Isoko South, Burutu and Patani);

(e) Freshwater Swamp (Ethiope East, Ughelli South, and Sapele) and

(f) Lowland Forest (Ika South, Anioma North and Ndokwa East)

(xii) Administratively, the LGAs targeted in Mangrove Swamp ecological zone are in Delta South Senatorial District. Those in Freshwater Swamp are in Delta Central Senatorial District. Finally, those in Lowland Forest zone are in Delta North Senatorial District.

(xiii) Quantitative data collection entailed the administration of between 400 and 450 household questionnaires in each selected LGA;

(xiv) A total of about 4000 successfully completed household questionnaires were retrieved cleaned up and used for the quantitative data analysis;

(xv) An average of between 1,250 and 1,500 household questionnaires were used in the analysis in each of the three ecological zones;

(xvi) Qualitative data collection entailed the conduct of key informant interviews and focused group discussions amongst mainly community-based stakeholders;

(xvii) A total of 107 key informants, with at least ten identified in each LGA were interviewed in the three ecological zones;

(xviii) Also three categories of focus group discussions were organised in each target LGA comprising "all males", "all females" and a mix of "males and females", respectively. Making a total of 30 FGDs conducted in the three ecological zones.

Methods of Data Analysis

Data quality assurance and processing are crucial components of any data collection activity and hence the usefulness of the output generated from the input data. Over the years CPED has developed its data quality control system and in-house Scientific Coding Scheme (SCS) used for data entry in order to ensure data accuracy. The Coding Scheme is updated periodically to meet with the exigencies of time and study pattern. CPED's SCS was put into use in the processing of the data collected. This entailed the use of data capture and entry mechanisms, variable definition and measurement, data editing, and data verification/validation. These processing techniques were applied to the quantitative data collected. The data were analysed using percentages. Qualitative data from interviews, focus group discussions and observations were transcribed and used to elaborate on the statistical results.

Limitations

Views represented in the findings are from a small randomly selected sample of small scale farmers and fisher folks. This may limit the generalization of study findings. Notwithstanding the fact that the number of farmers and fisher folks interviewed is small, the sample was selected scientifically, hence they represent the true population of farmers and fisher folks in Delta State. In addition, focus group discussions with key stakeholders were held to supplement the views of

farmers and fisher folks. Farmers and fisher folks may have over- or under-stated responses because of perceived benefits they may obtain from providing the ‘correct’ answers. To limit these potential biases, preliminary discussions with community groups clearly stated that respondents would not receive any benefits contingent on their answers to the survey questions. This statement was repeated at the beginning of each survey. Due to limited time and finance, the physical scientific investigations of the exact areas to be inundated due to sea level rise, the ecological shift that this will cause, settlements that will be displaced, the volume of emigration and investments that will be affected among others, as a result of the inundation are not investigated.

Chapter 2

Household Characteristics of Respondents

Households in the study area constitute major unit of production and consumption. It is therefore generally affected by climate conditions and in turn affects climate change through its activities.

Household Size, Composition and Economic Activities

Results of the household survey show that the majority of the households have a membership of 7 and more members. The average household size is 7 for the communities studied (Table 2.1). This shows that the household size in the study areas of Delta State is slightly higher than the average for Nigeria as a whole, which is about 5 people (NBS, 2012). Table 2.1 further shows that there are some slight variations among the communities selected from the three ecological zones in the state. Household size is slightly higher in the lowland rainforest zone compared with the other two zones. This is obviously a reflection of the pressure on households living nearer the coast which are generally more vulnerable to climate change than those located in the upland areas.

Table 2.1 Percentage Distribution of households according to their size

Ecological Zones	1 Member	2 Members	3-4 Members	5-6 Members	7 and above members
Mangrove Swamp	9.5	8.5	11.0	12.0	59.0
Freshwater Swamp	3.0	11.0	10.0	21.0	55.0
Lowland Rainforest	7.0	10.5	10.4	12.1	60.0

In the study area, as in other parts of Nigeria, decision making is often bestowed on the head which makes the headship of the household quite important. Table 2.2 shows that a higher proportion of the respondents are heads of their respective households. In the lowland rainforest 57.4 per cent are heads of households while the respective proportions in Mangrove Swamp and Freshwater Swamp are 52.7 and 53.4.

Table 2.2: Percentage Distribution of the household status of Respondents

Ecological Zones	Heads of Household	Other Members of Household
Mangrove Swamp	52.7	47.3
Freshwater Swamp	53.4	46.6
Lowland Rainforest	57.4	42.6

The population of the Niger Delta region is significantly youthful in character. This is reflected in the age distribution of the respondents in the survey. Table 2.3 shows that the vast majority (over 80 percent) of the respondents are below 61 years. Respondents of working age (18-40) are only about 35 per cent while those between age 41-60 percent constitute between 42 and 54 per cent. Respondents aged 61 and above constitute less than 20 percent. Table 2.3 shows that differences in age distribution are quite insignificant among the ecological zones in the Niger Delta region. Thus in terms of pressure on household resources, households in the Niger Delta region are more likely to be overburdened in terms of taking care of the young members of the population. Finally it can be stated that with the proportion of the population that is over 40 years being quite high a significant proportion of the community members are well positioned to recall notable changes in climatic conditions in the past 30 years and the way they have responded to these challenges.

Table 2.3: Percentage Distribution of Respondents according to age

Ecological Zones	18-40 Years	41-60 Years	61 Years and above
Mangrove Swamp	38.8	42.6	18.6
Freshwater Swamp	29.8	54.9	15.3
Lowland Rainforest	36.1	49.1	14.8

The overall sex composition of the respondents as indicated in Table 2.4 shows that on the average there are more females than males in the rural communities of the Niger Delta region. However, there are some differences in terms of the sex composition of the respondents among the communities in the three ecological zones. The proportion of females is highest in the Freshwater Swamp with over 60 per cent compared with 54.2 per cent in the Mangrove Swamp and 48.9 per cent in the Lowland Rainforest ecological zone. This is a reflection of the fact that women are generally left behind in the more difficult and vulnerable communities nearer the coast by males that migrate to the upland areas. The sex selective nature of migration in Nigeria contributes to the pattern of sex ratios, which prevails in some localities in the Niger Delta which are negatively affected by climate change and other environmental factors.

Table 2.4: Percentage Distribution of Respondents according to sex

Ecological Zones	Male	Female
Mangrove Swamp	45.8	54.2
Freshwater Swamp	39.7	60.3
Lowland Rainforest	51.1	48.9

The practices of polygamy and early marriage of young adults are very common phenomena in most communities of Niger Delta region as in other parts of Nigeria. By age of 19 years, a significant proportion of the females are married. Not only are many women married by the time

they are 19 years old, they tend to stay married throughout. However, the pattern is changing as more women now wait for a longer time before marriage. Table 2.5 shows that for the proportion of the respondents that is single is less than 10 per cent in two of the ecological zones i.e. Freshwater Swamp and Lowland Rainforest. However it is about 14 per cent in the Mangrove Swamp ecological zone. The proportion of respondents married is about 70 per cent in Mangrove Swamp and 74.7 per cent in Freshwater Swamp while the proportion is highest in the Lowland Rainforest with about 85 per cent married. The proportion of the household members divorced, separated and widow are quite insignificant as they combine to account for less than 15 per cent. This pattern indicates that a relatively high proportion of respondents are mature and responsible enough to describe the impact of climate change on their households and provide cogent information with which to assess their vulnerability as well as being able to indicate suitable adaptation measures.

Table 2.5: Percentage Distribution of Respondents according to Marital Status

Ecological Zones	Single	Married	Widowed	Separated
Mangrove Swamp	14.1	69.4	11.7	4.8
Freshwater Swamp	8.9	74.7	12.4	4.0
Lowland Rainforest	7.3	84.9	4.0	3.8

Education is a human right and one of the major stimulants and impetus to development, and as such, its importance cannot be over emphasized. Education is essential in providing people with the basic knowledge and needed skills to improve the quality of their lives. In effect, a household with many educated members is likely to have better welfare and improved standard of living. Thus, policies and programmes that help to expand access to, and the proper utilization of, educational opportunities will also assist in reducing poverty. Ability to read and write is an achievement that affords the individual a wide range of choice of means of livelihood. One is expected to acquire literacy after completing three years of formal primary education. The recommended age for entry in primary one is 6 years, by the end of primary three; these children should be 9 years. When computing adult literacy, persons aged 15 years and above are considered following the international convention. It is also important to analyze the adult literacy rates since after the introduction of Universal Primary Education (UPE) different persons enrolled in different classes whether adult or young. Table 2.5 shows that the educational status of the respondents, at the time of the survey, is about over 80 per cent in which case over 80 per cent had some form of western education or literate. However, differences exist among the three ecological zones.

As Table 2.6 shows similar differences exist among the three zones with respect to the attainment of primary, secondary and post-secondary education with the coastal communities being largely disadvantaged. On the whole it can be stated that, across that Niger Delta communities, a good proportion of the respondents have the capacity to read and comprehend the issues raised in the questionnaires without requiring much assistance or being dependent on the field officers for

interpretation. They are also in a position to appreciate the issues involved in their vulnerability to climate change challenge.

Table 2.6: Percentage Distribution of Respondents according to educational status

Ecological Zones	No formal education	Primary education	Secondary education	Tertiary education
Mangrove Swamp	8.7	19.8	38.3	33.2
Freshwater Swamp	17.5	31.1	37.7	13.6
Lowland Rainforest	11.1	18.6	45.3	25.3

Examining the composition of household populations by type of economic activity is vital for monitoring the development of any region such as the Niger Delta. The distribution of opportunities in the working age population is an important element to the wealth of the population. A person of working age, 15 years and above is said to be employed if he or she is engaged in an activity through which he or she earns a wage or salary, in cash or in kind. The employer could be government, private establishment or a self engaged activity. Table 2.7 shows the industry in which the respondents in the surveyed households are employed. Results of the survey indicate that, on the average, the highest proportions of persons employed are engaged in the Agriculture, Forestry and Fishing Industry. Employment in agricultural and other related activities is followed by those in trade or selling activities and general services. The other activities accounted for between 5 and 15 per cent of the employees. However, significant differences exist among the three ecological zones in terms of the proportion of the population employed.

In the ecological regions, employment in agricultural and related activities is lower in the Mangrove Swamp zone compared with the Freshwater Swamp and Lowland. What emerges from the nature of employment in the communities is that mining and quarrying play an insignificant source of employment for the people of the state. This implies a high level of dependence on the rich biodiversity of the Niger Delta region. The implication of this for vulnerability to climate change is significant, as the changes in the climate variables will have direct impacts on households' income and livelihoods. In this regard men and women are likely to suffer differential impacts as the distribution of men and women in the various occupations differ somewhat.

Table 2.7: Percentage Distribution of Respondents according to Main Occupation

Ecological Zones	Farming and other agricultural activities	Trading	Public Sector	Private Sector including mining and quarrying
Mangrove Swamp	46.9	25.0	13.2	14.9
Freshwater Swamp	81.1	12.0	3.7	3.2
Lowland Rainforest	51.9	28.4	7.8	11.9

Table 2.8: Percentage Distribution of Respondents according to length of time in their present occupation

Ecological Zones	Less than 10 Years	10-20 years	Above 20 years
Mangrove Swamp	28.6	36.8	34.6
Freshwater Swamp	23.2	49.9	26.9
Lowland Rainforest	23.9	46.1	30.1

Table 2.8 indicates that most of the respondents have been engaged in their present occupation for a considerable length of time. It shows that less than 30 per cent of the respondents in the three zones have been engaged in their present occupations for a period of less than 10 years. On the other hand over 70 per cent of the respondents have been engaged in their present occupations for over 10 years with as much as 30 per cent engaged in their occupations for a period of over 20 years. This finding indicates that the respondents are in a position to report on their experiences with respect to the impact of climate change on their activities.

Table 2.9: Percentage Distribution of Respondents according to type of agricultural activities

Ecological Zones	Subsistence	Commercial	Both Commercial and subsistence
Mangrove Swamp	42.9	25.7	31.4
Freshwater Swamp	22.4	5.8	71.9
Lowland Rainforest	43.4	3.9	52.7

Table 2.9 indicates that a significant proportion of the agricultural activities in which the respondents are engaged provide only subsistence income. In Mangrove Swamp and Lowland Rainforest ecological zones over 40 per cent of the respondents derive subsistence living from their agricultural activities while the proportion of subsistence farmers is lower (22.4 per cent) in Freshwater Swamp ecological zone. Table 2.9 further shows that an insignificant proportion (less than 10 per cent) of the respondents in Lowland Rainforest and Freshwater Swamp ecological zones focuses mainly on commercial agriculture. The proportion of respondents focusing on commercial agriculture is about 25 per cent in the Mangrove Swamp ecological zone. The findings indicate that basically a significant proportion of the respondents in the three ecological zones carry out both subsistence and commercial agriculture although the proportion is lowest in Mangrove Swamp ecological zone. The findings indicate that most respondents depend on both subsistence and commercial agriculture for survival.

One other major characteristic of the respondents' agricultural practices relates to the fact that most of them have more than one farmland which indicates that they are indeed small scale farmers who cannot use modern technical farming equipment because of the small size of their farmlands. Table 2.10 shows that over 50 per cent of the respondents in the three ecological zones have between one and five farmlands. However, the proportion is higher in the Lowland Rainforest ecological zone with 85.8 per cent and Mangrove Swamp ecological zone with 60.4 per cent than that in the Freshwater ecological zone with just 50.6 per cent. With respect to the respondents that have between 6 and 10 farmlands, the proportion is higher in the Freshwater Swamp ecological zone compared with 23.4 per cent and 12.9 per cent in the Mangrove Swamp and Lowland Rain forest ecological zones respectively. These patterns reflect the availability of land available to respondents in the various ecological zones. In localities where land is scarce for agricultural activities farmers have to search for land in different places where they can carry out their farming activities. Table 2.10 therefore suggests that land for farming activities tend to be more limited hence a greater proportion of the respondents have between 6 and 10 farmlands.

Table 2.10: Percentage Distribution of Respondents according to the number of farmlands

Ecological Zones	1-5 farmlands	6-10 farmlands	Above 10 farmlands
Mangrove Swamp	60.4	23.4	16.2
Freshwater Swamp	50.6	39.7	9.7
Lowland Rainforest	85.8	12.9	1.3

The measurement of income level is generally a major problem in Nigeria because of the reluctance of respondents to give accurate information on their real income. Moreover, there is the problem of quantifying the real income of the rural working population because a good proportion of the production do not enter or pass through the market system but are consumed directly by the producers. Despite these constraints, an attempt was made to extract from the respondents in the households the estimate of their earned income per month excluding what they consume directly from their production activities.

Table 2.11: Percentage Distribution of Respondents according to monthly income

Ecological Zones	Less than N10,000	N10,000-N20,000	Above N20,000
Mangrove Swamp	22.2	30.7	47.2
Freshwater Swamp	18.7	41.7	39.6
Lowland Rainforest	19.5	49.0	31.5

The survey shows that about 32.3 per cent of the employed in the surveyed households indicated that they earn less than 10,000 Naira per month (Table 2.11). The proportion increased to between 30.7 and 49 per cent in the income group (10,000 - 20,000 Naira per month). At income level of above N20,000 Naira, the proportion of the employed in that group declined to between 31.5 per cent and 47.2 per cent. Differences exist among households in the communities in the different ecological zones with income level generally higher in the zones toward the upland areas compared with those nearer the coast. What can be deduced from the findings so far is that income levels are quite low in most communities in Niger Delta region as most of the respondents earn less than 2 dollar per day. While the bulk of the income comes from those dwelling in the Niger Delta region, supplementary income is also received from husbands, wives and relations that travelled out of the region. These findings on income level in the Niger Delta region have implications for vulnerability, adaptive capacity and overall adaptation to climate change in the communities.

Respondents Housing Type and Characteristics

Housing, food, clothing and fuel, is a basic human requirement. Housing is required for the protection of persons and of property from the vagaries of weather elements (sun, rain and wind). The provision of good housing has a profound influence on the health, efficiency and well-being of any community. Fundamental to the analysis of housing requirement is the definition of housing need. Housing need may be defined as the number of dwellings to be built or improved to provide each household or family with adequate dwellings of acceptable standards. This need should not be confused with effective housing demand, which is the number of dwellings that can be afforded by families, through unsubsidized loans from credit institutions. Housing demand is the desire for better housing supported by the economic ability to satisfy the desire. Hence, households living in overcrowded, dilapidated or makeshift dwellings only represent a housing need if they do not have the money to pay for better housing. It cannot be denied that the determination of the housing need is a basic tool in the formulation of any housing policy in terms of housing production targets and priorities, and the preparation of the corresponding housing programme as part of the overall economic and social development programme of any region such as Delta State. The need in terms of dwelling units will indicate not only the volume of construction materials and skills to be made available but also the investments and level of savings to be achieved.

Table 2.12: Percentage Distribution of Respondents according to Types of Houses

Ecological Zones	Mud wall with thatch roof	Mud wall with zinc roof	Brick wall with zinc	Cement block with Zinc roof	Zinc Wall with Zinc roof
Mangrove Swamp	2.3	12.9	2.8	79.0	2.1
Freshwater Swamp	0.5	17.5	8.7	71.8	0.8
Lowland Rainforest	3.8	26.2	1.4	64.1	1.7

Table 2.12 which present key indicators of housing quality in the surveyed communities suggest two basic features. In the first place, housing for the vast majority of the respondents' households is poor in terms of the materials used in constructing houses which makes them vulnerable to any violent or extreme climate change events such as flooding, erosion, windstorm and thunderstorm. Secondly, a large proportion of the households still depend on the local ecosystem in terms of the materials for the construction of their dwellings. Consequently, climate change effects on the ecosystem constitute problems for many households. On the other hand dependence on the immediate environmental resources such as forest resources, which are depleted by frequent cutting down, negatively affects climate in the different parts of the Niger Delta region. A major characteristics of buildings in the study area is high foundations and the respondents revealed that it is an adaptive measure to frequent floods in the area

Table 2.13: Percentage Distribution of Respondents according to sources of water

Ecological Zones	Public pip-borne system	Borehole	Open well	Ring well	River/streams
Mangrove Swamp	15.1	50.9	7.6	4.1	22.3
Freshwater Swamp	4.8	44.6	29.2	19.9	1.6
Lowland Rainforest	8.7	48.7	6.3	14.4	21.9

The quality of drinking water is of great importance to the health of every individual. Access to good water is, therefore, a measure of development. Drinking water is considered safe and good when it is from any of the following sources namely: piped water, boreholes and protected wells and springs. Access to good and safe water was defined for households with a good water source less than 30 minutes away. The findings of the survey (Table 2.13) show that less than 15.8% of households in the surveyed communities of the three ecological zones obtain their drinking water from a pipe born treated and untreated water. On the other hand, about 7.6 per cent and 6.3 per cent in the Mangrove Swamp and Lowland Rainforest ecological zones use water from unprotected wells. The proportion of respondents using water from unprotected wells in the

Freshwater Swamp ecological zone was higher at 29.2 per cent. Thus about 30 to 40 per cent of the households in the surveyed communities of the three ecological zones in Delta State can be described as not having access to safe drinking water almost the same proportion goes for safe bathing water.

In effect, most communities in the three ecological zones in Delta State are extremely vulnerable to climate change in terms of access to water because whenever rains fail to come at the right time and the quality of water in the rivers within the state declines, the people become susceptible to diseases due to the poor quality of water which they drink. This explains why a large proportion of the households cover long distances before getting the water they need for drinking and even for bathing and other uses. Generally access to water for bathing and other uses is not a major problem to most communities in Delta State but the quality is so poor that some of the water available may not be safe for bathing. The quality of the water is worst during the peak of the dry season when most of the rivers, wells and ponds are almost dried up. Crude oil spillages also contribute to scarcity of water for domestic use in some communities of Delta State.

The type of toilet facility used by a household depicts its hygienic status. A good means of sanitary disposal was defined as households with flush to sewage system, flush to septic tank, covered pit latrine and ventilated pit latrine. The findings of the sample survey (Table 2.14) show that only about 40 per cent of the dwellings can be said to have good means of sanitary disposal. The proportion of the dwellings which have uncovered pit latrine and open defecation is over 49 per cent in the Lowland Rainforest ecological zone while the proportion is about 40 per cent in the Freshwater ecological zone. Households using open defecation constitute 36 per cent of the respondents in the Mangrove Swamp ecological zone. If the area is flooded, the flood enters the pit and open toilets. The bacteria and other infectious microbes therefore act as free agents to attack individuals that wade through the water leading to various diseases and ailments.

Table 2.14: Percentage Distribution of Respondents according to toilet facilities

Ecological Zones	Open defecation	Pit Latrine	Water Closet
Mangrove Swamp	36.0	12.5	51.5
Freshwater Swamp	26.6	39.9	33.9
Lowland Rainforest	10.2	49.3	40.5

Refuse disposal facilities are also important for the hygienic status of the people living in a house. The findings from the survey shows that solid wastes, including dried wastes like yam or cassava peelings, leaves and food remnants are usually heaped on open grounds near dwellings within the communities. Over 70 per cent of the dwellings surveyed dumped their refuse on public dumps or burn them within their compound where nobody cares for them (Table 2.15). These dumps

constitute comfortable breeding grounds for rodents, rats, etc., all of which contribute to the spreading of diseases like plague once there is flood. It is only in a few cases that these dried refuses are disposed of by burning especially during the period of dry season; otherwise they are left to rot away and decay through the natural process of decomposition. During the period of heavy rain and flooding occasioned by climate variability and change some of these wastes are transferred to rivers from which many households collect drinking water.

Table 2.15: Percentage Distribution of Respondents according to Methods of solid waste disposal

Ecological Zones	Burying	Evacuated by an accredited waste manager	Burning	Indiscriminate dumping
Mangrove Swamp	5.3	20.5	20.3	53.9
Freshwater Swamp	7.3	6.3	29.5	56.9
Lowland Rainforest	19.6	12.2	54.6	13.6

Table 2.16: Percentage Distribution of Respondents according to Types of cooking fuel

Ecological Zones	Wood	Kerosene	Gas	Wood and kerosene	Wood and gas	Kerosene and gas	Wood, saw dust, kerosene and gas
Mangrove Swamp	14.1	8.1	15.4	25.6	9.8	11.2	9.8
Freshwater Swamp	42.4	10.7	5.7	26.9	6.5	2.9	1.1
Lowland Rainforest	30.4	4.5	7.8	25.1	9.3	7.1	8.3

Wood fuel is still overwhelmingly used for cooking in most households in the communities of Delta State. The survey (Table 2.16) shows that over 42 per cent of the respondents in the Freshwater Swamp ecological zone use firewood as the main source of fuel for cooking while the proportion is 30.4 per cent in the Lowland Rainforest ecological zone. The Mangrove Swamp ecological zone has the lowest proportion with 14.1 per cent. The use of wood and kerosene constitutes over 25 per cent of the respondents' households in the three ecological zones. This implies that the forests are exploited regularly for cooking fuel and this further contributes to the reduction of carbon sinks and increases atmospheric warming and climate change in the three ecological zones of Delta State. The unclean fuel (Wood, charcoal/coal and kerosene, etc) used for domestic purpose amounted to over 80 per cent in each of the three ecological zones. Less than 20 per cent of the respondents' households use clean energy like liquefied natural gas and electric heaters.

Chapter 3

Awareness of Climate Change

Respondents in the three ecological zones of Delta State have some knowledge of what climate change is. Over 70% are aware of changes in the climatic variables, but they are unable to express their feelings about the unfolding events as the years rolled by. Table 3.1 shows that about 90 per cent of the respondents indicated that they had knowledge of the occurrence of climate change with women constituting 48.4 per cent and men 42.1 per cent. This knowledge appears to be shared by the respondents in the three ecological zones which indicated that there is general knowledge of the phenomenon of climate change in the remote communities of the various ecological zones in Delta State.

Table 3.1: Percentage Distribution of Respondents according to knowledge of climate change

Ecological Zones	Yes	No
Mangrove Swamp	88.9	11.1
Freshwater Swamp	90.0	10.0
Lowland Rainforest	93.3	6.8

The majority of the respondents perceived that these changes in climatic variables affect their agricultural products as well as a decline in the availability of forest products. Some of these climate events and variables which the respondents revealed that has increased include shift in the start or end of rains, early rains that were not sustained, as well as the increase in occurrence of smothered crops by excessive heat. Most of the respondents reported on their understanding of the main causes of climate change. Table 3.2 indicates that respondents identified various causes of climate change including burning fossil fuels, cutting down of trees, overgrazing and a combination of various factors. Some of the respondents, however, tend to attribute these changes to God, the Creator and saw themselves incapable of doing anything. The respondents also noticed increase in extreme weather events like floods, excessive heat and higher temperature, high rainfall intensity and high wind velocity.

Table 3.2: Percentage Distribution of Respondents according to their understanding of the main causes of climate change in their communities

Ecological Zones	Burning fossil fuels	Cutting down of trees (deforestation)	Incineration	Burning fuels and cutting down of trees	Overgrazing and cutting down of trees	Combination of all the causes enumerated
Mangrove Swamp	24.6	16.6	1.7	20.4	1.2	33.7
Freshwater Swamp	10.0	33.0	5.3	18.0	14.3	11.3
Lowland Rainforest	1.0	5.8	1.8	17.1	9.5	65.1

Table 3.3 shows that the respondents in each of the three ecological zones have observed the occurrence of climate in their communities over a period of time. It indicates that over 54 per cent and 57 per cent of the respondents in the Freshwater Swamp and Rainwater Swamp ecological zones respectively observed the occurrence of climate change in their community in the last 1 to 9 years. On the other hand, the proportion is about 43 per cent in the mangrove Swamp ecological zone.

Table 3.3: Percentage Distribution of Respondents according to how long climate change has been observed by them in their community

Ecological Zones	Less than 10 years	10-30 years	More than 30 years
Mangrove Swamp	42.8	38.3	18.9
Freshwater Swamp	54.4	39.4	6.2
Lowland Rainforest	57.2	37.1	5.7

A significant proportion of the respondents (almost 40 per cent) in the three zones had knowledge of climate change effects in their communities over a period of between 10 and 30 years. A greater proportion (18.9 per cent) of the respondents in the Mangrove Swamp zone reported that their communities had observed the climate change phenomenon over a period of over 30 years. The respondents' knowledge and experience with respect to climate change is derived from changes in key indicators of climate variation in their locality. With respect to rainfall, an attempt was made during the field survey to determine respondents' perception of the changes in rainfall in their locality over the years. The findings indicate that respondents' observations of rainfall vary across the state by location i.e. ecological zones. Overall more females (53.9%) observed climate change in their community over the years compared with males (46.1%). Again this can be explained by the fact that more females are on the ground farming compared with males. Table

3.4 shows that over 84 per cent of the respondents in the three ecological reported early onset of rain in their communities with 40.6 per cent females and 43.7 per cent males. However the respondents in the three ecological zones were almost equally divided with respect to the early cessation of rain (Table 3.5).

Table 3.4: Percentage Distribution of Respondents according to knowledge/experience about early onset of rain

Ecological Zones	Yes	No
Mangrove Swamp	86.9	13.1
Freshwater Swamp	86.9	13.1
Lowland Rainforest	84.3	15.8

Table 3.5: Percentage Distribution of Respondents according to knowledge/experience about early cessation of rain

Ecological Zones	Yes	No
Mangrove Swamp	48.9	51.1
Freshwater Swamp	48.2	51.8
Lowland Rainforest	52.9	47.1

Table 3.6 indicates that over 92 per cent (45.6 % males and 54.4 % females) of the respondents in the three ecological zones reported that they had observed increased rainfall in their communities over the years. This is further confirmed by the fact that most of the respondents (45.6% males and 54.1% females) in the three ecological zones indicated that rainfall has not decreased in their communities over the years (Table 3.7).

Table 3.6: Percentage Distribution of Respondents according to knowledge/experience about increase in rainfall amount

Ecological Zones	Yes	No
Mangrove Swamp	92.4	7.6
Freshwater Swamp	92.7	7.3
Lowland Rainforest	97.0	3.0

Table 3.7: Percentage Distribution of Respondents according to knowledge/experience about decrease in rainfall amount

Ecological Zones	Yes	No
Mangrove Swamp	28.1	71.9
Freshwater Swamp	20.1	79.9
Lowland Rainforest	48.2	51.8

However, participants in the focus group discussion across the three zones indicate that rainfall has been erratic and heavy which affects farming activities. These findings indicate that, from the farmers' perspectives, there are some imperceptible changes in the pattern of rainfall in Delta State which has implications for their farming activities.

Table 3.8: Percentage Distribution of Respondents according to knowledge/experience about increase in temperature

Ecological Zones	Yes	No
Mangrove Swamp	91.8	8.2
Freshwater Swamp	81.3	18.7
Lowland Rainforest	98.6	1.4

The percentage distribution of respondents, according to their perception of variation in temperature, is presented in Table 3.8. It shows that in the vast majority of the respondents in the three ecological zones reported that temperature has increased remarkably in their communities over the years. Similarly, Table 3.9 indicates that the vast proportion of the respondents indicated that they have observed increased hours of sunshine, although the proportion is lower in the Freshwater ecological zone. Furthermore, Table 3.10 shows that the vast majority of the respondents reported increased sunshine intensity in their communities over the years.

Table 3.9: Percentage Distribution of Respondents according to knowledge/experience about increase in hours of sunshine

Ecological Zones	Yes	No
Mangrove Swamp	73.4	26.6
Freshwater Swamp	59.8	40.2
Lowland Rainforest	91.9	8.1

Table 3.10: Percentage Distribution of Respondents according to knowledge/experience about increase in sunshine intensity

Ecological Zones	Yes	No
Mangrove Swamp	84.3	15.7
Freshwater Swamp	81.5	18.5
Lowland Rainforest	90.2	9.8

In general, it can be noted that there have been some slight variation on the direction of change in temperature as reported by the respondents. Testimonies of participants in the focus group discussions as well as the key informants point to the fact that there is an increase in temperature in their communities. Different opinions on the direction of variation in temperature simply show that climate variation and long-term climate change studies and discourses are in the early stages among the respondents. The farmers in particular may be yet unable to read meaning into variation in climatic elements taking place. This, again, may adversely affect their readiness and ability to adapt or to mitigate climate impacts. Higher than normal temperature, for instance, without mitigation could reduce food availability because of its negative effects on the basic elements of food production – soil, water and biodiversity.

Table 3.11: Percentage Distribution of Respondents according to knowledge/experience about changes in wind speed

Ecological Zones	Yes	No
Mangrove Swamp	78.1	21.1
Freshwater Swamp	71.1	28.9
Lowland Rainforest	75.3	24.8

Table 3.11 shows the percentage distribution of respondents' perception of variation in wind speed. Windstorms and whirlwinds are known to be destructive, particularly to tree crops such as banana and plantain, rubber, oil palm trees, pawpaw, orange, etc. The findings show that over 70 per cent of the respondents in the three ecological zones observed changes in wind speed with their community over the years. Like the case on farmers' perception of the variation of other climatic elements, there are differences of opinion across the ecological zones on the pattern of wind speed. For communities in all the three zones it can be concluded that no significant variation in the wind speed was observed. This is because majority of the respondents reported "no variation" and a small proportion reporting a "decreased" wind speed. It would be expected that wind-related hazards will not be a serious problem in the communities in the study area of Delta State. However during discussions in the focus group and in key informant interviews, there were reported instances of occurrence of wind-related disasters in some of the study communities, especially during the beginning and end of rainy seasons.

Scientifically, the wind hazards (to buildings, cash and root crops) in these periods of the rainy season (beginning and end) are associated with the incidence of line squall due to the annual south –north swing of the Inter-tropical Convergence Zone (ITCZ) (Odjugo, 2005 and 2009). Thus it can be concluded that although the variation in wind speed is not noticeable by some of the respondents, it however exists (as revealed by over 70 per cent of the respondents) as a climate change-related hazard that cause destruction to property in Delta State.

Climate Information Sources and Accessibility

The sources of information on climate change for the respondents in the three zones are presented in Table 3.12 and it shows that radio is the most important source of climate information to the respondents. In the Freshwater Swamp zone, 40.0% of respondents said they obtain climate information through radio announcements. The proportions are lower in the Mangrove Swamp with 25.5 per cent and it is least in the Lowland Swamp zone with 17.8 per cent. Television also provides climate information for a reasonable proportion of respondents in the Mangrove Swamp zone. The other sources provide limited sources of information to respondents. Thus radio and television seem to be the dominant sources of climate information available to the respondents. In addition to these mass media sources, respondents also share climate information with their colleagues. Overall 54 per cent of females compared with 45 per cent of the males reported that they have information from various sources of climate information. Discussants in the focus group discussions and key informant interviews reported that in the absence of climate information institutions and irregularity of the "news" on weather from the radio stations, they rely more on their peers for climate information. Apart from the aforementioned sources of information, respondents claimed that from their personal experiences, they are able to compare the current situations with the past and form an opinion as to how the climate situation is. Based on this, they make decisions on their livelihood activities.

Table 3.12: Percentage Distribution of Respondents according to sources of climate information

Ecological Zones	Radio	Television	Newspaper	Internet	GSM	Friends	Town crier/Announcer
Mangrove Swamp	23.5	11.7	2.4	1.0	3.8	4.6	2.3
Freshwater Swamp	40.0	6.7	0.4	1.3	5.1	3.8	3.0
Lowland Rainforest	17.8	1.6	0.2	0.3	5.8	3.3	1.3

Climate institutions such as, the *Nigerian Meteorological Agency* that is responsible for climatic data collection and dissemination do not make information available to the farmers in remote rural communities. Of interest too is the fact that extension agents do not act as climate information sources to farmers and fishermen in the communities. Both climate institutions and extension agents are crucial in agricultural development, particularly for rain-fed farming as practised in Nigeria. The farmers need regular information on the weather/climatic situation and extension agents are expected to be in regular contact with the farmers to disseminate this

information on new technologies that might assist farmers to forecast weather. The fact that they are not playing that role requires action. Climate information gathering (climate database) and dissemination needs to target farmers and fisher folks. The aim of targeting and tailoring information is to ensure that the most vulnerable to climate change-subsistence farmers and fisher folk, women and the poor get the right kind of services at the right time to increase their adaptive capacity. The non-availability of climate information to farmers in the rural communities has serious implications for households who depend on agriculture for livelihood. If farmers are without information on climate change which could affect them, then they may be vulnerable to the adverse impacts. This implies that the farmers may not be well informed to take preventive actions to mitigate the impact of climate change.

Accessibility of Climate Information

An examination of the accessibility of the available sources to respondents indicates that virtually all the respondents reported not having access to formal climate information sources. Discussants at the focus group discussions and key informant interviews said they were aware of the existence of meteorological weather data but they do not readily access the weather/meteorological stations for weather information. Some of the respondents said they are aware of the existence of meteorological/weather stations but have never used or had access to any information from them. These consist of both public weather stations such as Nigerian Meteorological Agency (NIMET) and those in research institutions/centres as well as private stations, particularly those owned by oil companies. However, these stations do not provide weather information to communities or directly to the public. This situation causes community members to rely more on their own perceptions of weather or information provided by neighbours or fellow farmers. But these are not likely to be reliable sources of climate information. Therefore, it can be inferred that farmers in the rural communities of Delta State may not be getting reliable information on climate. Thus, they may not be properly informed and equipped for effective adaptation to climate change. This situation calls for re-examination of the mandates of weather stations. Should their duty not include providing information to the farmers, then this should be looked into and corrected so that farmers and fisher folks whose livelihoods are vulnerable to the impact of climate change are well informed to adapt accordingly. In general, most of the participants in focus group discussions said that, the climate information supplied is never correct.

The situation where information available is “never correct” could be attributed to the fact that it is not tailored to the need of the farmers and fisher folks and not passed in the way they could understand them. Field observation show that the weather stations collect information for use by either institutions such as airlines, shipping companies and researchers, without a specific focus on the needs of farmers/fisher folks. Indeed, the weather parameters that are reported occasionally on the television and radio stations are always on rainfall and temperature in various urban locations across the country. The limited prints of the forecast are distributed to the few top government officials and academia that were invited. The result, therefore, points to the fact that farmers in the state do not have reliable climate information to assist them in their livelihoods. This might account for reliance by farmers and fisher folks on their peers for information on climate as pointed out earlier. This suggests that targeted climate information need to be collected and disseminated regularly to those who rely on it.

Chapter 4

Vulnerability of Households to Climate Change

Geographical Factors Influencing Vulnerability

The results of the survey show that some geographical and physical factors contribute to the vulnerability of households in the three ecological zones in the Niger Delta region. Geographical factors such as distance from coastline and population within 100km of the coastline have been identified as capable of making households vulnerable to climate change impact (Heger and Julca, 2008). The assumption is that the nearer households and communities are to climate hazard-prone sites such as the coast, ravines and erosion sites, the more vulnerable they are to climate change impacts. Table 4.1 shows the distribution of the respondents according to the location of their communities. In the Mangrove Swamp ecological zone over 61 per cent of the respondents are located in communities which are prone to flooding because of the extremely wetland in which they are situated. In Mangrove Swamp ecological zone, just about 38 per cent of the respondents are located in upland areas which are not easily susceptible to flooding. The Freshwater Swamp and Lowland Rainforest ecological zones have a greater proportion of the communities sited in upland areas in which case most of the inhabitants are not exposed to frequent flooding. Even then over 30 per cent of the inhabitants in these two ecological zones live in communities that are prone to flooding.

Table 4.1: Percentage Distribution of Respondents according to Location of the Respondents

Ecological Zones	Flood-Prone Area	Upland Area
Mangrove Swamp	61.9	38.1
Freshwater Swamp	36.2	63.8
Lowland Rainforest	37.0	63.0

Other indicators of the vulnerability of households in the three ecological zones to climate change relate to the location of their communities near disaster risk prone areas. Table 4.2 shows that 33.2 per cent of the respondents in the Mangrove Swamp ecological zone are resident in houses within one kilometre from the coast/shore. This is followed by the Lowland Rainforest ecological zone with 25.7 per cent of their houses within the same distance. However, over 50 per cent of the respondents live in localities that are more than 1 kilometre from the coast/shore which suggests that half of the houses are not easily susceptible to sea invasion. Similarly, about 30 per cent of the respondents live in localities within one kilometre of rivers that can overflow during raining season into land areas with consequent effects on houses located nearby. Table 4.3 shows that about 35 per cent of the houses of respondents in Mangrove Swamp and Freshwater Swamp ecological zones are located more than one kilometre of rivers. The Lowland Rainforest ecological

zone has the highest proportion of its respondents living in houses which are located in communities that are more than one kilometre from rivers. This suggests that most houses in the Lowland Rainforest zone are less threatened by river flooding.

Table 4.2: Percentage Distribution of Respondents according to house distance to coast/shore

Ecological Zones	Less than 1 km	1 km	More than 1 km
Mangrove Swamp	33.2	15.9	50.9
Freshwater Swamp	10.3	12.4	77.3
Lowland Rainforest	25.7	4.2	70.1

Table 4.4 reflects the fact that a considerable proportion of the respondents live in localities that are less than 1 kilometre away from erosion sites. It shows that 43.6 per cent of the respondents in the Mangrove Swamp and Lowland Rainforest ecological zones respectively live within one kilometre of erosion sites while the Freshwater Swamp zone has the lowest proportion (31.1 per cent) of its respondents living within one kilometre of an erosion site. Table 4.5 shows that most of the houses occupied by respondents in the three ecological zones are more than one kilometre from gas flaring sites. However, a significant proportion (28.7 per cent) of the respondents in the Mangrove Swamp ecological zone live in less than one kilometre from gas flaring areas.

Table 4.3: Percentage Distribution of Respondents according to house distance to disaster risk area (rivers)

Ecological Zones	Less than 1 km	1 km	More than 1 km
Mangrove Swamp	50.6	14.8	34.6
Freshwater Swamp	29.2	35.8	35.0
Lowland Rainforest	28.6	10.3	61.1

Table 4.4: Percentage Distribution of Respondents according to house distance to disaster risk (erosion)

Ecological Zones	Less than 1 km	1 km	More than 1 km
Mangrove Swamp	43.6	18.7	37.7
Freshwater Swamp	31.1	24.4	44.5
Lowland Rainforest	50.9	7.7	41.5

Table 4.5: Percentage Distribution of Respondents according to house distance to disaster risk (gas flare site)

Ecological Zones	Less than 1 km	1 km	More than 1 km
Mangrove Swamp	28.7	12.9	58.4
Freshwater Swamp	7.5	5.2	87.3
Lowland Rainforest	13.2	5.7	81.2

Finally, Tables 4.6 and 4.7 show the distance of the houses of the respondents in relation to the location of flow station and refinery respectively. Again most of the houses of the respondents in the three ecological zones are located in more than one kilometre from flow stations and refinery which suggest that the houses are not threatened by any environmental hazard.

Table 4.6: Percentage Distribution of Respondents according to house distance to disaster risk (flow station)

Ecological Zones	Less than 1 km	1 km	More than 1 km
Mangrove Swamp	28.7	13.6	57.7
Freshwater Swamp	7.4	6.4	86.2
Lowland Rainforest	3.6	5.7	81.2

Table 4.7: Percentage Distribution of Respondents according to house distance to disaster risk (refinery)

Ecological Zones	Less than 1 km	1 km	More than 1 km
Mangrove Swamp	4.0	5.4	90.6
Freshwater Swamp	1.1	3.2	95.7
Lowland Rainforest	0.1	0.2	99.7

Economic Factors Affecting Vulnerability

Many studies report that agriculture is one sector that is very vulnerable to climate change (Berry et al., 2006, Priya, 2010 and Sehgal et al, 2013). For this reason, the economic factor that can make households vulnerable to climate change impact is the extent of households' dependence on agriculture. The extent of dependence is measured by number of household members in agriculture as well as offering services as hired agricultural labour. The results of

the survey as presented earlier in Chapter 2 indicate that a high percentage of the respondents in the three ecological zones are engaged in agricultural production. The implication of this situation is that most of the households in the three ecological zones are extremely vulnerable to climate change. Respondents identified various factors that affect their household vulnerability to climate change as indicated in various Tables below.

In situations of climate change and associated inadequate rainfall, irrigation becomes essential for sustainable agricultural activities. Table 4.8 shows that respondents identified the extent to which the non-availability of irrigation contribute to their economic vulnerability to climate change. The findings show that over 80 per cent of the respondents in the Lowland Rainforest ecological zone reported that the non-availability of irrigation had no effect on their household vulnerability to climate change apparently because they do not depend on irrigation for their farming activities. On the other hand significant proportions of the respondents in Mangrove and Freshwater ecological zones (24.4 and 31.1 per cent respectively) indicated that lack of irrigation affects their vulnerability because their agriculture partially depend on irrigation.

Table 4.8: Percentage Distribution of Respondents according to their assessment of non-availability of irrigation to the household vulnerability

Ecological Zones	None	Low	High
Mangrove Swamp	49.8	25.7	24.4
Freshwater Swamp	29.6	39.3	31.1
Lowland Rainforest	83.1	14.1	2.8

Similarly, water shortage can constitute challenges for livestock production activities and thereby expose farmers involved in livestock production to vulnerability. Table 4.9 indicates that the water shortage does not constitute a major challenge to a greater proportion of the farmers in the three ecological zones. It is only in the Mangrove Swamp ecological zone that about 24 per cent of the respondents indicated that non-availability of water is regarded as a major challenge. This can be explained by the fact that livestock production is not a major agricultural activity in the three ecological zones of Delta State.

Table 4.9: Percentage Distribution of Respondents according to their assessment of non-availability of water for livestock to the household vulnerability

Ecological Zones	None	Low	High
Mangrove Swamp	50.1	25.5	24.4
Freshwater Swamp	49.2	38.5	12.3
Lowland Rainforest	78.8	16.9	4.3

While rainfall is essential for agricultural production, excessive rainfall can be a major constraint to the activities of the farmers. Table 4.10 shows that the vast majority of the respondents (over 75 per cent) in the three ecological zones identified excessive rainfall as contributing remarkably to the vulnerability of their households. This indicates that excessive rainfall which has become a challenge associated with climate change is a major component of the economic vulnerability of the people of the Niger Delta region.

Table 4.10: Percentage Distribution of Respondents according to their assessment of excessive rainfall to the household vulnerability

Ecological Zones	None	Low	High
Mangrove Swamp	4.7	9.9	85.4
Freshwater Swamp	3.0	21.4	75.6
Lowland Rainforest	2.3	15.4	82.3

On the other hand, lack of sufficient rainfall also constitutes a major challenge thereby resulting in economic vulnerability of the households in the three ecological zones of Delta state. Table 4.11 shows that a major proportion of the respondents regarded the phenomenon of increased drought in their communities as exposing their households to economic vulnerability.

Table 4.11: Percentage Distribution of Respondents according to their assessment of increase in drought to the household vulnerability

Ecological Zones	None	Low	High
Mangrove Swamp	19.2	36.4	44.4
Freshwater Swamp	19.4	44.4	36.2
Lowland Rainforest	21.0	30.1	48.9

Sea level rise has been a major environmental challenge to people of the Niger Delta region particularly those who live in the coastal communities. Table 4.12 shows that respondents in the three ecological zones regard sea level rise as exposing their households to vulnerability. Indeed 65 per cent of the respondents in the Mangrove Swamp ecological zone which is nearer the ocean indicate that sea level rise has a major impact on their household vulnerability.

Table 4.12: Percentage Distribution of Respondents according to their assessment of the impact of sea level rise to the household vulnerability

Ecological Zones	None	Low	High
Mangrove Swamp	25.3	9.7	65.0
Freshwater Swamp	34.0	20.5	45.5
Lowland Rainforest	59.3	8.4	32.3

Excessive rainfall obviously contributes to the occurrence of flooding which is a common feature of the Niger Delta region. Table 4.13 shows that the vast proportion of the respondents in the Mangrove Swamp and Freshwater Swamp regarded increased flooding as impacting on their economic activities. This is understandable because the two zones are nearer the ocean compared with the Lowland Rainforest ecological zone that is in the upland area.

Table 4.13: Percentage Distribution of Respondents according to their assessment of the impact of increase in flooding to the household vulnerability

Ecological Zones	None	Low	High
Mangrove Swamp	6.6	9.7	83.6
Freshwater Swamp	9.2	30.1	60.7
Lowland Rainforest	16.8	8.4	32.3

Climate change obviously threatens agricultural output which in turn exposes agricultural households in the Niger Delta to economic vulnerability. Table 4.14 indicates that most of the respondents regard low agricultural output as a major challenge thereby exposing households to economic vulnerability. It shows that the vast proportion of the respondents in the three ecological zones regard the impact of low agricultural production as having low or high implications for the economic vulnerability of the households who depend on agriculture for their livelihood.

Table 4.14: Percentage Distribution of Respondents according to their assessment of the impact of low agricultural output to the household vulnerability

Ecological Zones	None	Low	High
Mangrove Swamp	13.4	23.7	62.9
Freshwater Swamp	8.4	35.5	56.1
Lowland Rainforest	3.1	54.7	42.3

Farm labour is a key component of increased agricultural production in the Niger Delta region. When farm labour becomes unavailable or inadequate, farmers are negatively affected in terms of their agricultural production. Low incomes from farm activities tend to propel farm labourers to migrate to urban centres thereby contributing to the shortage of farm labourers. Respondents as indicated in Table 4.15 confirm that the lack of farm labour had high impact on the vulnerability of households in the three ecological zones to climate change.

Table 4.15: Percentage Distribution of Respondents according to their assessment of the impact of lack of farm labour to the household vulnerability

Ecological Zones	None	Low	High
Mangrove Swamp	24.5	34.6	40.9
Freshwater Swamp	10.3	45.2	44.5
Lowland Rainforest	11.1	72.3	16.7

With the prevalence of various climate change indicators such as increased rainfall leading to flooding and increased temperature leading to drought, arable farm land begins to decline which in turn has negative impact on agricultural production. Table 4.16 indicates that the vast proportion of the respondents in the three ecological zones regard the decreasing availability of arable land has considerable impact on the vulnerability of households.

Table 4.16: Percentage Distribution of Respondents according to their assessment of the impact of decreasing availability of arable land to the household vulnerability

Ecological Zones	None	Low	High
Mangrove Swamp	13.1	22.0	64.8
Freshwater Swamp	11.7	36.3	52.0
Lowland Rainforest	9.5	60.0	30.5

Food storage facilities are essential components of increased and sustainable agricultural production in the various ecological zones in the Niger Delta region. Consequently when food storage facilities are not available increased and sustainable agricultural production becomes a problem. As indicated in Table 4.17, the vast proportion of the respondents in the three ecological zones reported that lack of food storage facilities has considerable impact on the economic vulnerability of households.

Table 4.17: Percentage Distribution of Respondents according to their assessment of the impact of lack of food storage facilities to the household vulnerability

Ecological Zones	None	Low	High
Mangrove Swamp	15.9	25.2	58.9
Freshwater Swamp	8.9	34.9	56.2
Lowland Rainforest	9.6	58.5	31.9

Similarly lack of agricultural processing facilities imposed constraints on agricultural production and thereby enhances the vulnerability of households to the impact of climate change. Table 4.18 reports the finding that most of the respondents believe that lack of agricultural processing facilities exposes households in the three ecological zones to climate change vulnerability.

Table 4.18: Percentage Distribution of Respondents according to their assessment of the impact of lack of processing facilities to the household vulnerability

Ecological Zones	None	Low	High
Mangrove Swamp	16.6	23.1	60.3
Freshwater Swamp	9.0	31.9	59.1
Lowland Rainforest	9.2	59.5	31.4

Table 4.19: Percentage Distribution of Respondents according to their assessment of the impact of lack of transportation to the household vulnerability

Ecological Zones	None	Low	High
Mangrove Swamp	16.1	16.2	67.8
Freshwater Swamp	15.4	52.2	32.3
Lowland Rainforest	13.5	48.0	38.4

The transportation of agricultural outputs to markets is an essential component of the productive activities of farmers. When transportation is not available farmers suffer and face low incomes because they cannot market their products in urban markets where prices are higher. Table 4.19 confirms the challenge which the lack of transportation facilities imposes to the prosperity of farmers. The vast proportion of the respondents in the three ecological zones indicate that lack of transportation facilities exposes households to increased vulnerability. In the Mangrove Swamp ecological zone where transportation is much difficult a greater proportion (67.8 per cent) of the respondents indicated that lack of transportation is a major factor contributing to the vulnerability of households to climate change in the zone.

Table 4.20: Percentage Distribution of Respondents according to their assessment of the impact of increasing population to the household vulnerability

Ecological Zones	None	Low	High
Mangrove Swamp	13.3	14.5	72.2
Freshwater Swamp	18.3	44.5	37.2
Lowland Rainforest	10.8	46.2	43.0

There is no doubt that increasing population puts pressure on the resources available in the rural communities of the Niger Delta region. This pressure operates at the community level in terms of affecting the land available for farming for increased population. At the household level increased population means that more persons have to be taken care of in terms of feeding and provision of other livelihood means. Table 4.20 indicates that respondents believe that increased population has considerable impact on the vulnerability of households to climate change. This suggests that controlling population growth must be a key strategy to adapt to climate change effects in the ecological zones of the Niger Delta region.

Table 4.21: Percentage Distribution of Respondents according to their assessment of the impact of low income (poverty) to the household vulnerability

Ecological Zones	None	Low	High
Mangrove Swamp	7.6	18.2	74.3
Freshwater Swamp	5.6	11.4	83.0
Lowland Rainforest	10.0	43.0	47.0

There is no doubt that low income households are more negatively affected by climate change compared with those with higher incomes. This exposes low income households to increased vulnerability to climate change compared with higher income ones. The respondents confirm this fact because as indicated in Table 4.21 most of them reported that low income had considerable impact on the vulnerability of households in the three ecological zones.

Table 4.22: Percentage Distribution of Respondents according to their assessment of the impact of conflicts and violence to the household vulnerability

Ecological Zones	None	Low	High
Mangrove Swamp	28.9	29.1	42.0
Freshwater Swamp	30.4	33.1	36.5
Lowland Rainforest	44.0	38.3	17.8

The Niger Delta region has been characterised by conflict and violence during the last thirty years with remarkable negative impact on the socio-economic life of the people in various communities. If climate change is combined with the occurrence of conflict and violence it generates considerable impact on the poor households in the region. Table 4.22 show that some of the respondents in the three ecological zones indicates that conflicts and violence have low or high impact on the vulnerability of their households to climate change effects.

Table 4.23: Percentage Distribution of Respondents according to their assessment of the impact of lack of health facilities to the household vulnerability

Ecological Zones	None	Low	High
Mangrove Swamp	9.9	27.9	62.2
Freshwater Swamp	11.9	47.6	40.5
Lowland Rainforest	12.0	49.5	38.4

Table 4.24: Percentage Distribution of Respondents according to their assessment of the impact of lack of security to the household vulnerability

Ecological Zones	None	Low	High
Mangrove Swamp	11.6	27.9	60.5
Freshwater Swamp	11.2	40.3	48.4
Lowland Rainforest	11.5	62.6	25.6

In view of the conflict and violence challenges facing the Niger Delta region, the lack of adequate security poses major challenge to socio-economic activities in the communities of the region. Where such security is not provided it poses major challenges to the livelihood of the people in various communities. Table 4.24 shows the assessment of the respondents of the impact of lack of security on household vulnerability and it indicates that the vast majority of them believe that households in the three ecological zones are vulnerable to climate change because of the absence of adequate security.

Table 4.25: Percentage Distribution of Respondents according to their assessment of the impact of pest attacks to the household vulnerability

Ecological Zones	None	Low	High
Mangrove Swamp	17.3	27.9	60.5
Freshwater Swamp	12.2	36.6	51.2
Lowland Rainforest	11.4	45.8	42.8

Pests and diseases pose a threat to food security because they can damage crops, thus reducing the availability and access to food, increasing the cost of food. Plant pests and diseases may also negatively affect the palatability of foods resulting in changes to the traditional food preferences

of populations. Surveys of the relationship between pests and diseases and crop sustainability in several parts of Nigeria including the Niger Delta region indicate that the production of numerous crops has declined sharply as a result of major pest and disease outbreaks, and others are threatened with major decline because of a surge in virulence of an endemic pest or disease, the introduction of a virulent exotic pest or pathogen, or because a system of control used previously has collapsed. In other cases, crop sustainability has been preserved by vigorous farmer responses or by the intervention of national and international research institutions. Most pests and pathogens, however, remain within tolerable bounds most of the time, though this often requires the use of chemical or cultural controls, or the availability of adequate land to compensate for losses. As land availability declines, more strenuous management efforts may be needed to sustain productivity. Table 4.25 indicates that respondents in the three ecological zones of Delta State report that household vulnerability to climate change is greatly affected by pest attacks, which reduces agricultural productivity.

Table 4.26: Percentage Distribution of Respondents according to their assessment of the impact of reptiles invasion to the household vulnerability

Ecological Zones	None	Low	High
Mangrove Swamp	27.1	35.3	37.6
Freshwater Swamp	25.8	41.9	32.2
Lowland Rainforest	27.9	50.0	22.1

Biological invasions are a growing problem in Niger Delta region as in other parts of Nigeria. Many alien species have been introduced for various reasons and through multiple pathways over the past few centuries. Invasive alien reptiles and amphibians (herpetofauna) are not yet a major problem in the country. However, escalating difficulties with invasive species suggest a high risk of increased problems in the future. There is a need to consider the potential threat of these species, and others still to be introduced, in line with practices in other countries where formal risk assessment policies are in place to separate potentially invasive species from those that are unlikely to be problematical. Table 4.26 shows that while a significant proportion of the respondents indicate that reptile invasion is not a serious problem a majority assert that it has negative impact on households in the various ecological zones. This suggests the need to consider policies to contain reptile invasion as part of climate change adaptation.

Table 4.27: Percentage Distribution of Respondents according to their assessment of the impact of outbreak of diseases and epidemics to the household vulnerability

Ecological Zones	None	Low	High
Mangrove Swamp	25.9	25.8	48.3
Freshwater Swamp	22.9	32.7	44.4
Lowland Rainforest	25.2	39.1	35.7

Although public health has considerable experience with policies and measures to reduce health burdens of infectious diseases, some of which are climate-sensitive, current strategies, policies, and measures were not typically designed to account for alterations in the burdens of infectious disease associated with a changing climate. Assessing the potential infectious disease risks of climate change also requires considering the non-climatic factors that drive their incidence and distribution, including demographics, socioeconomic development, land use, urbanization, technology, and the political and health care context. Respondents are conscious of the impact of the outbreak of diseases and epidemics on household vulnerability to climate change. As shown in Table 4.27 most of them in the three ecological zones indicated as such.

Table 4.28: Percentage Distribution of Respondents according to their assessment of the impact of food shortage/hunger to the household vulnerability

Ecological Zones	None	Low	High
Mangrove Swamp	10.4	21.8	67.8
Freshwater Swamp	5.5	21.3	73.2
Lowland Rainforest	19.2	35.9	45.0

For hungry and undernourished people, climate change is a threat multiplier. Since the early 1990s, the number of extreme weather-related disasters has doubled. This has reduced the yields of major crops and contributed to an increase in food prices and a decrease in income. Table 4.28 shows that the vast majority of the respondents in the three ecological zones reported that food shortage and hunger enhances the vulnerability of households to climate change. This suggests that fighting climate change must also entail improving food supply in vulnerable communities.

Table 4.29: Percentage Distribution of Respondents according to their assessment of the impact of water pollution to the household vulnerability

Ecological Zones	None	Low	High
Mangrove Swamp	6.0	9.8	84.2
Freshwater Swamp	12.6	40.9	46.5
Lowland Rainforest	21.9	44.3	33.8

Water is an essential resource for good health and wellbeing. Unfortunately, there are countless communities throughout Niger Delta region that do not have access to safe, clean water for drinking, cooking, and hygiene as reported in Chapter 2. Moreover, viruses, bacteria, parasites, and pollution contaminate freshwater sources resulting in 'water scarcity.' Water scarcity, coupled with poor sanitation practices, has resulted in an abundance of illnesses, diseases, and deaths. A lack of clean water also affects the people of the Niger Delta region in other ways. Many families have to travel further to gain access to clean drinking water. The women and girls in the family often take on this responsibility of having to carry heavy buckets of water back to their homes. Younger girls often have to drop out of school and miss out on getting an education to help their families. These journeys to collect water are also dangerous and sometimes result in physical or sexual abuse of girls and women. Table 4.29 confirms the challenge which water pollution poses to the vulnerability of households to climate change. The vast majority of respondents in the three ecological zones indicated that water pollution has impact on the vulnerability of the households to climate change.

Table 4.30: Percentage Distribution of Respondents according to their assessment of the impact of loss of biodiversity to the household vulnerability

Ecological Zones	None	Low	High
Mangrove Swamp	16.1	30.0	53.9
Freshwater Swamp	12.2	50.0	37.8
Lowland Rainforest	10.1	67.3	22.6

The Niger Delta region is home to a rich and diverse animal, plant, and marine biodiversity that provide critical ecosystem services, driving the region's economy and serving as buffers to climate change. However, the region is experiencing a dramatic loss of biodiversity. Even more immediate are the ongoing threats to the region's biodiversity from natural habitat loss and degradation (especially from agricultural expansion), direct overexploitation of wildlife and fishery species (including from illegal hunting and trade), and the spread of certain non-native invasive species. This loss of biodiversity affects livelihoods, water supply, food security and

lessens resilience to extreme events, particularly for people living in rural areas who are often the poorest. Table 4.30 shows that the vast proportion of the respondents in the three ecological zones confirm that the loss of biodiversity in the region contributes to the vulnerability of the households in various communities to the impact of climate change.

Table 4.31: Percentage Distribution of Respondents according to their assessment of the impact of alteration of agricultural seasons to the household vulnerability

Ecological Zones	None	Low	High
Mangrove Swamp	16.7	31.9	51.4
Freshwater Swamp	11.9	42.7	45.4
Lowland Rainforest	12.6	56.1	31.3

Agriculture is an economic activity that is highly dependent upon weather and climate in order to produce the food and fiber necessary to sustain human life. Not surprisingly, agriculture is deemed to be an economic activity that is expected to be vulnerable to climate variability and change. It involves natural processes that frequently require fixed proportions of nutrients, temperatures, precipitation, and other conditions. Climate change affects agriculture in a number of ways; including through changes in average temperatures; rainfall and climate extremes with an important impact on soil erosion (i.e. floods, drought, etc): changes in pests and diseases, changes in atmospheric carbon dioxide, changes in the nutritional quality of some foods, changes in growing season, and changes in sea level. Crop yields show a strong correlation with temperature change and with the duration of heat or cold waves, and differ based on plant maturity stages during extreme weather events. Modified precipitation patterns will enhance water scarcity and associated drought stress for crops and alter irrigation water supplies. Table 4.31 shows that most respondents in the three ecological zones pointed out that alteration of agricultural seasons contribute to household economic vulnerability.

Table 4.32: Percentage Distribution of Respondents according to their assessment of the impact of low fish cash to the household vulnerability

Ecological Zones	None	Low	High
Mangrove Swamp	16.2	22.5	61.3
Freshwater Swamp	28.5	36.3	35.1
Lowland Rainforest	59.3	28.4	12.3

Fisheries and aquaculture play important roles in providing food and income in Niger Delta communities, either as a stand-alone activity or in association with crop agriculture and livestock

rearing. Thus fisheries and aquaculture make remarkable contribution to poverty reduction and food security in the region. When fish cash is low the implications for the vulnerability of farmers in the wetland areas of Niger Delta are obvious. Table 4.32 indicates that respondents are divided with respect to the degree of the impact of low fish cash on the vulnerability of households. Most of the respondents (over 61 per cent) in the Mangrove Swamp ecological zone where fish farming is the major economic activity reported that low fish farming contribute remarkably to household vulnerability. On the other hand, most of the respondents in the Lowland Rainforest zone where fish farming is limited indicated that low fish cash does not contribute remarkably to the vulnerability of the households.

Table 4.33: Percentage Distribution of Respondents according to their assessment of the impact of increasing temperature to the household vulnerability

Ecological Zones	None	Low	High
Mangrove Swamp	6.4	14.7	78.9
Freshwater Swamp	10.8	23.9	65.3
Lowland Rainforest	3.2	30.7	66.1

Rural households in Niger Delta region earn a substantial part of their living from rain-fed smallholder agriculture, which is highly sensitive to climate change. A key element of this change is increasing temperature which has negative impact on agricultural production. In effect increasing temperature is a major factor contributing to the vulnerability of farming households in the Niger Delta region. Data obtained from the survey (Table 4.33) confirms this pattern as the vast majority of the respondents in the three ecological zones believe that increasing temperature has negative impact on the vulnerability of households in various communities.

Table 4.34: Percentage Distribution of Respondents according to their assessment of the impact of lack of security of pastures to the household vulnerability

Ecological Zones	None	Low	High
Mangrove Swamp	24.1	35.9	40.0
Freshwater Swamp	24.7	33.4	42.0
Lowland Rainforest	19.3	68.3	12.3

Livestock are important assets in some communities in Niger Delta region, helping to improve the nutritional status of their owners, and contributing to livelihood. Lack of adequate pasture is probably the most important constraint to improving productivity. Table 4.34 show that respondents in the three ecological zones of Delta State recognise the problem posed by

inadequate pastures to the income of households actively involved in livestock production thereby exposing them to economic vulnerability as a result of climate change. Table 4.34 indicates that households in the Mangrove Swamp and Freshwater Swamp ecological zones are more vulnerable to climate change as a result of climate change because pastures are limited in the two zones characterised by wetland compared with the Lowland Rainforest ecological zone where more land is available for livestock production.

Table 4.35: Percentage Distribution of Respondents according to their assessment of the impact of crop failure to the household vulnerability

Ecological Zones	None	Low	High
Mangrove Swamp	15.0	18.9	66.0
Freshwater Swamp	11.9	28.5	59.7
Lowland Rainforest	5.3	30.8	63.9

In view of the dependence of households in the Niger Delta region on small scale farming for their livelihood, crop failure often constitutes a major economic challenge. Respondents in the three ecological zones of Delta State (Table 4.35) agreed that crop failure exposes households in their communities to economic vulnerability.

Table 4.36: Percentage Distribution of Respondents according to their assessment of how change in vegetation has affected their sources of livelihood

Ecological Zones	No effect	Positively	Negatively
Mangrove Swamp	16.9	3.7	79.4
Freshwater Swamp	13.4	10.0	76.6
Lowland Rainforest	8.7	17.0	74.3

Forests play many important ecological roles in the Niger Delta region. From helping to mitigate climate change; providing homes for many species of plants and animals (some endemic to forested regions); providing food, medicine and livelihoods for people in various communities; to the intrinsic values of forests, these essential ecological powerhouses are irreplaceable—and at risk. When climate change has negative effect on vegetation, this results in considerable impact on the livelihood of households depending on primary production. Again the vast majority of the

respondents in the three ecological zones of Delta State (Table 4.36) agreed that change in vegetation exposes households in their communities to economic vulnerability.

Overview of respondents' vulnerability

The findings of the survey show that most of the respondents live in precarious conditions and are intrinsically vulnerable to any shocks that affect their agricultural systems. As in most of rural Niger Delta region, the respondents live in rustic houses, lack electricity and running water, own few assets and rely on natural ecosystems for drinking water, firewood, wild foods and materials for household construction. Agriculture is their mainstay for livelihoods, serving both as the primary source of household food and principal means of income generation. Consequently, the fate of these respondents is closely interwoven with that of agriculture. Niger Delta farmers and fishermen are particularly vulnerable to any reductions in crop productivity for a variety of reasons. First, they cultivate very small parcels of land (less than 2 acres), dedicate most of their land to crop production for household consumption and obtain low crop yields, which are insufficient to meet household needs, let alone provide surplus for sale. In focal group discussions, farmers reported obtaining low yields. The low and declining yields basically reflect the limited use of inputs (fertilizers, pesticides, improved seed varieties, etc), the lack of animal traction, the use of low technology practices, the use of suboptimal land for production, the prevalence of slash and burn crop production, and land degradation—all of which have been identified as constraints to agricultural productivity not only in the Niger Delta region but in other parts of Africa.

The survey shows that majority of the households in all three ecological zones are chronically food insecure, which makes them extremely vulnerable to any climate or non-climatic shocks that further reduce agricultural production and food availability. Even in normal years, as revealed during interview and focus group discussion, three-quarters of the farming households lack sufficient food to feed their families and spend, on average, 3.8 months without sufficient food. Food pressure is most acute in the months immediately prior to the main harvest season. This seasonal pattern of food insecurity occurs across the Niger Delta region. The lack of sufficient food has significant livelihood impacts, including increased rates of malnutrition and child mortality. Another factor that increases the vulnerability of the households in the target communities is the remoteness of the villages and lack of adequate road infrastructure. In the rural communities across the three ecological zones, roads are in a poor state and unevenly distributed, with many villages lacking roads that connect them to other villages. Even the main roads are often accessible only during the dry season. The livelihood implications of this isolation are significant, as farmers and other primary producers have difficulties getting their products to markets as well as obtaining agricultural inputs; in addition, farmers generally have to pay higher prices for agricultural inputs in remote areas, reducing their profit margins.

A final set of factors that exacerbate household vulnerability in the target communities of Delta State is that most households lack access to formal safety nets to which they could turn in times of need. Most of the smallholder farmers remain outside a formal credit or banking system, lack capital and are unable to access credit or loans. There are no developed financial institutions located in them and instead farmers rely on informal support systems, borrowing money or food from family or friends. In addition, although there are numerous local NGOs working in the

three regions, there is no formal extension service and less than 10% of the farmers currently receive any technical support. Farmers are further constrained by having limited access to agro-meteorological or market information, which could help inform farm management decisions, such as the choice of crops, planting dates and management strategies, and which could serve as early warning systems for floods, rainstorms and windstorms.

Chapter 5

The Impact of Climate Change

Due to non-availability of documented information at the local level on climate change- related disasters, the study relied primarily on the results of the household surveys and oral testimonies from participants in focus group discussions, in-depth interviews of key informants and participant observations. The focus of the discussion in this chapter is mainly on the social economic status of the respondents, land related issues, changes and challenges in crop farming, fishing and livestock keeping in relation to climate change.

Respondents' Assessment of Some Broad Indicators of the Occurrence of Climate Change

Respondents in different ecological zones identified various impacts of climate change in their localities including, deceased crops and fish output and yields, loss of plants and animal species, shorter duration of rainy season and conflicts among others. Non availability of agricultural lands, reduced quantity of fish produced, loss of plants and animal species and flooding were the most severe impacts in the freshwater swamp forest while in the mangrove swamp forests, the respondents identified sea level rise, sea surge, coastal erosion and inundation, and migration as the most severe impacts. Another outstanding result is that the severity of the impact increases from the lowland forest to the mangrove swamp forest. Moreover, the impact is more severe among the females than the males. This implies that the severity of climate change impact is both place and gender specific. While emigration is highest in the mangrove swamp, conflict is more in the lowland forest which in most cases is the receiving end of most of the migrants. Apart from the internal migrations that create conflicts in the lowland forest, the pastoralists in their forced migration from the northern part of Nigeria with their animals due to hash environmental conditions created by climate change, also have series of conflicts with the farmers over destruction of crops. Such conflicts have led to cases of deaths, injuries and rape of inhabitants of Delta State by the pastoralists (Odjugo, 2014). Key informants made the point that because the yield is poor and income is getting low, people have to struggle for more agricultural land for farming purposes. This leads to land disputes which in some cases result in communal clashes. Farmers reporting losses in crop output and poor yield due to climate change is supported the findings of Speranza (2010) which asserts that direct dependence on rainfall accounts for the high sensitivity of sub-Saharan Africa agriculture to climate conditions, where agricultural yields fluctuate with climatic conditions.

Flash floods, which can remove topsoil and reduce fertility, are particularly common in the three ecological zones of the Niger Delta region during the May-to-September rainy season. But rising sea levels that risk bringing salt water onto arable land have become a perennial problem, and climate change means farmers in coastal areas are at greater risk than ever. Among the effects of flooding in the Niger Delta are the destruction of crops, livestock, houses, farm building and equipment, a reduction in output, build-up of diseases and infections, contamination of water, death, sickness, increase in costs of farm activities, and psychological trauma. Table 5.1 shows that the overwhelming proportion (over 67 per cent) of the respondents reported the occurrence of

floods in their locality almost annually in recent years. Table 5.1 further shows that the occurrence of flood is higher in the Mangrove Swamp ecological zone followed by the Freshwater Swamp ecological zone. Flood appears to be lower in the Lowland Rainforest zone that is further from the ocean and large river basins.

Table 5.1: Percentage Distribution of Respondents' assessment of the occurrence of flood in recent years

Ecological Zones	Yes	No
Mangrove Swamp	91.8	8.2
Freshwater Swamp	81.6	18.4
Lowland Rainforest	67.6	32.4

Table 5.2: Percentage Distribution of Respondents' report on the occurrence of agricultural losses due to climate change

Ecological Zones	Yes	No
Mangrove Swamp	80.8	19.2
Freshwater Swamp	85.2	14.8
Lowland Rainforest	83.6	16.4

Accumulated evidence indicates that agricultural production is being affected by climate change. Climate change poses an additional burden, especially for the vulnerable rural communities of the Niger Delta region, in achieving food security goals when the population is rapidly increasing; therefore, yield improvement is necessary to meet the increasing demand for food. However, in the recent literature on the consequences of an increase in greenhouse gas emissions and associated climate change on crop yields in the Niger Delta region as in other parts of West Africa, several studies (Sultan, B. & Gaetani, M. 2016) estimate possible crop yield losses with adverse impacts on food security in the next decades, although the extent of these losses remains uncertain. Table 5.2 shows that the vast proportion of the respondents (over 80 per cent) in the three ecological zones reported the occurrence of agricultural losses as a result of climate change in their locality over the years. In Table 5.3 respondents identified these losses as including farmland, farm input, crop failure, loss of livestock, loss of fish, loss of crops to fire and loss of access to non-timber resources. Although the degree of these losses varies from one ecological zone to another, there is no doubt that they have remarkable effects on the livelihood of the poor rural farmers in the Niger Delta region.

Table 5.3: Percentage Distribution of Respondents' report on forms of agricultural losses

Ecological Zones	Farm land	Farm inputs	Crop failure	Loss of livestock	Loss of fish	Loss of access to non-timber resources	Loss of crops to fire	Loss of farmland, farm inputs and crop failure	Others
Mangrove Swamp	5.4	3.2	12.8	2.5	7.5	1.1	0.9	41.1	6.6
Freshwater Swamp	4.0	16.9	14.3	1.8	0.8	0.3	5.5	40.9	1.5
Lowland Rainforest	1.3	2.9	8.0	1.0	0.5	0.3	1.2	69.3	15.4

A key component of agricultural losses experienced by respondents in the three ecological zones is food shortage. Table 5.4 shows that the vast majority of the respondents (over 77.8 per cent) of the respondents in the Mangrove Swamp and Freshwater Swamp ecological zones reported experiencing food shortage. The proportion is however lower in the Lowland Rainforest with about 60 per cent. Table 5.5 shows the length of time during which the respondents experienced food shortage varied considerably but the majority of the respondents in the three ecological zones experienced food shortage over a period of two months. The respondents in the three ecological zones attributed the food shortage which they experienced mainly to flooding but in the case of Lowland Rainforest a significant proportion of the respondents attribute the food shortage they experienced to a combination of a variety of other factors which included drought, bush burning and change in rainfall pattern (Table 5.6).

Table 5.4: Percentage Distribution of Respondents' that experienced food shortage in the last ten years

Ecological Zones	Yes	No
Mangrove Swamp	77.8	22.2
Freshwater Swamp	87.4	12.6
Lowland Rainforest	57.7	42.3

Table 5.5: Percentage Distribution of Respondents according to the length of the food shortage

Ecological Zones	Week (s)	Month (2)	Years
Mangrove Swamp	6.4	57.3	14.0
Freshwater Swamp	15.4	56.4	15.8
Lowland Rainforest	2.9	53.0	2.0

Table 5.6: Percentage Distribution of Respondents' assessment of the main causes of food shortage

Ecological Zones	Flooding	Drought	Strong wind	Bush burning	Indiscriminate grazing	Water pollution	Outbreak of pests and diseases	Change in rainfall pattern	Others
Mangrove Swamp	67.6	1.6	2.3	0.7	0.7	1.9	1.0	2.0	22.3
Freshwater Swamp	43.6	4.0	1.2	14.0	13.5	0.9	4.6	5.6	12.7
Lowland Rainforest	30.3	4.2	2.9	10.9	2.8	0.4	1.1	5.2	42.2

Table 5.7 shows how the respondents adjusted to the effect of climate change which impacted on the availability of food items. It shows that most of the respondents reported that they were able to purchase food within their community, especially when the effect of the climate change was not universal to all the households. Furthermore, a significant proportion of the respondents stated that they were able to obtain food items from other food crops produced by their households. This is a reflection of the fact that mixed cropping is common among the households and it is a sort of insurance against crop failure of certain types. Furthermore, Table 5.8 indicates additional measures taken by respondents to counter the effects of food shortage in their households including dietary adjustment, outmigration, change of occupation and livelihood diversification.

Table 5.7: Percentage Distribution of Respondents according to how they get main food items during climate change incidences of food shortage in their community

Ecological Zones	Self grown	Purchased within the community	Purchased outside the community	Donations
Mangrove Swamp	27.2	50.6	19.3	2.8
Freshwater Swamp	23.0	40.2	36.2	0.6
Lowland Rainforest	28.1	52.1	19.5	0.3

Table 5.8: Percentage Distribution of Respondents according to the action they took to deal with food shortage

Ecological Zones	Dietary adjustment	Out migration	Relief from government	Increase in production scale	Change of occupation	Livelihood diversification	Others
Mangrove Swamp	35.8	9.2	14.6	6.8	5.7	5.7	22.2
Freshwater Swamp	43.4	1.9	2.5	6.3	17.1	16.2	12.6
Lowland Rainforest	35.3	20.1	5.2	10.6	25.2	10.5	5.5

Forests play many important ecological roles in the Niger Delta region. From helping to mitigate climate change; providing homes for many species of plants and animals (some endemic to forested regions); providing food, medicine and livelihoods for people in various communities; to the intrinsic values of forests, these essential ecological powerhouses are irreplaceable—and at risk. When climate change has negative effect on vegetation, this results in considerable impact on the livelihood of households depending on primary production.

Table 5.9 shows that in the three ecological zones most of the respondents reported that vegetation in their localities has deteriorated during the past 10 to 30 years thereby impacting negatively on the livelihood of households depending on primary production and forest exploitation for livelihood. Table 1 further shows that few respondents reported that vegetation has improved in their locality while an equally small proportion indicated that vegetation cover has remained constant during the last 10 to 30 years.

Table 5.9: Percentage Distribution of Respondents according to their assessment of how vegetation has changed in the past 10-30 years

Ecological Zones	Improved	Deteriorated	Constant
Mangrove Swamp	9.5	77.7	12.8
Freshwater Swamp	3.1	87.7	9.2
Lowland Rainforest	16.5	71.7	11.8

Table 5.10 shows that the respondents have different explanations for the change in the vegetation of their locality. In the Mangrove Swamp and Freshwater Swamp ecological zones respondents identified flooding as the main cause of vegetation change with 64.9 and 41.4 per cent respectively. On the other hand bush fire is identified by respondents in the Lowland Rainforest ecological zone as the main cause of vegetation change.

Table 5.10: Percentage Distribution of Respondents according to their assessment of the main causes of change in the vegetation

Ecological Zones	Bush fire	Tree felling	Drought	flooding	Erosion
Mangrove Swamp	14.6	10.6	3.9	64.9	6.0
Freshwater Swamp	26.7	24.0	4.4	41.4	3.5
Lowland Rainforest	43.1	31.4	4.1	11.4	10.0

Niger Delta's wildlife, wild lands, and its rural communities bear the brunt of climate change. Humans and wild animals face new challenges for survival because of climate change. More frequent and intense drought, storms, heat waves, rising sea levels, melting glaciers and warming oceans harm animals, destroy the places they live, and wreak havoc on people's livelihoods and communities. Table 5.11 shows that the vast majority of the respondents (over 70 per cent), in the three ecological zones, reported that climate change has decreased the population of the wild life in their locality. It is only in the Mangrove Swamp ecological zone that about 20 per cent of the respondents reported that climate change contributed to increase in wild life. The respondents attributed that the decrease in wild life to a number of factors as indicated in Table 5.12 including bush fire, tree felling, flooding and hunting.

Table 5.11: Percentage Distribution of Respondents according to their assessment of how climate change has affected the population of wildlife

Ecological Zones	Increased	Decreased	Constant
Mangrove Swamp	20.1	73.0	6.9
Freshwater Swamp	7.0	85.2	7.8
Lowland Rainforest	6.2	87.3	6.5

Most of the respondents (52.4 per cent) in the mangrove Swamp ecological zone attributed the change in wild life in their locality to flooding. On the other hand most of the respondents in the Lowland Rainforest ecological zone attributed the changes in wild life in their locality to bush fire. In the Freshwater Swamp ecological zone, the changes in wild life were attributed to bush fire and flooding largely because the zone has elements of the characteristics of the Mangrove Swamp and Lowland Rainforest ecological zones. The vast proportion of the respondents (over 68 per cent) in each of the ecological zones reported that changes in wild life have negatively affected their sources of livelihood.

Table 5.12: Percentage Distribution of Respondents according to their assessment of the main causes of change in wildlife population

Ecological Zones	Bush fire	Tree felling	Drought	flooding	Farming	Hunting
Mangrove Swamp	14.7	18.5	1.7	52.4	1.5	11.3
Freshwater Swamp	26.2	19.1	1.9	26.6	7.0	19.2
Lowland Rainforest	41.8	11.6	1.4	3.0	7.2	34.9

Table 5.13: Percentage Distribution of Respondents according to their assessment of how changes in wildlife population has affected their sources of livelihood

Ecological Zones	No effect	Positively	Negatively
Mangrove Swamp	26.9	2.2	70.9
Freshwater Swamp	21.2	10.3	68.6
Lowland Rainforest	17.8	6.1	76.1

Table 5.14: Percentage Distribution of Respondents according to their assessment of how shoreline has changed in the past 10-30 years

Ecological Zones	Increased	Decreased	Constant
Mangrove Swamp	42.9	32.0	25.1
Freshwater Swamp	24.6	55.3	20.0
Lowland Rainforest	17.2	66.1	16.7

Climate change threatens coastal areas, which are already stressed by human activity, pollution, invasive species, and storms. Sea level rise could erode and inundate coastal ecosystems and eliminate wetlands. Warmer and more acidic oceans are likely to disrupt coastal and marine ecosystems. Table 5.14 shows that most of the respondents in the Mangrove Swamp ecological zone indicated that the ocean shoreline has increased during the last 10 to 30 years while most of the respondents in the Freshwater Swamp and Lowland Rain forest ecological zones indicated that it has decreased. The two later ecological zones are further from the ocean and this could explain their perception of a decrease in shoreline. In both directions of change in the shoreline the implications for the livelihoods of the people are negatively affected. This is confirmed by the fact that the vast majority of the respondents in the three ecological zones reported that changes in

the shoreline negatively affected the livelihood of the households in such localities. So, while those in coastal areas show that the coastal inundation is increasing those in the hinterlands either say it is decreasing or I don't know.

Table 5.15: Percentage Distribution of Respondents according to their assessment of the main causes of change in the shoreline

Ecological Zones	Sea level rise	Coastal erosion	Flooding	Don't know
Mangrove Swamp	28.2	29.4	31.2	11.3
Freshwater Swamp	9.1	14.9	35.5	40.5
Lowland Rainforest	21.5	8.2	70.0	0.2

Table 16: Percentage Distribution of Respondents according to their assessment of the how change in shoreline has affected their livelihood

Ecological Zones	No effect	Positively	Negatively	Don't know
Mangrove Swamp	17.9	3.0	65.9	13.1
Freshwater Swamp	26.5	4.5	47.1	21.9
Lowland Rainforest	5.0	10.4	82.2	2.5

Forest products are important sources of livelihood for Delta State communities. The impact of climate hazards on forests include increasing incidence of bush and wild fire, heat stress, decreased biodiversity, death and/or migration and loss of plant and animal species, gradual disappearance of some forest species such as antelopes, lions, bush pigs, muturu cattle, monkeys, leopards, grass-cutter, loss of timber species, medicinal plants and ornamental trees. Forests also show low yields and structural damage due to silt deposits and oil spills. Women, whose livelihoods depend on the collection of forest products, such as ogbono (*Irvingia gabonesis*), snails and medicinal leaves are vulnerable. Also, men whose livelihoods depend on timber and other economic trees are also vulnerable. In summary, average yield of crops, animal products and forest resources have witnessed a decreasing output during the last 30 years. It is no longer easy to predict the onset and cessation period of rains. It has been observed that high temperatures cause evapo-transpiration to occur more rapidly with drying occurring faster resulting in rapidly occurring moisture stress (MacCracken, 2004). It has also been observed that many terrestrial, freshwater and marine systems are already being affected by regional increases in temperatures. The implications of all of these impacts on food security are significant.

Plant developmental responses to the environment can take the form of altered initiation of developmental events, altered timing of developmental events, and altered final form or

architecture of individual organs and whole plants. With rapid temperature, ecosystems have been thrown into flux, exacerbating problems such as habitat loss that have already pushed many plant and animal species to the brink. The big question is whether plants and animals can adapt quickly enough to outpace climate change. Identifying genetic adaptations in response to climate change can be tricky. Long-term data sets can tell us the most about whether a species is truly evolving, but it's hard to tell if any genetic differences were selected for climate reasons alone. What's more, not all genetic adaptations may be beneficial in the long term. And some species may not even need to evolve to survive. Some respondents in the three ecological zones have observed that climate change has brought new species of plants and tree in their locality. Table 9 shows that respondents in the Mangrove Swamp and Freshwater Swamp ecological zone are almost equally divided with respect to their observation of the appearance of new species of plants or otherwise. In the Mangrove Swamp and Freshwater Swamp ecological zones 42.9 per cent of the respondents indicated that they experience the appearance of new species of plants while 57.1 per cent reported otherwise. The observations of the respondents in the Lowland Rainforest zone with respect to the appearance of new species of plants and trees are however, quite different from those of the two zones discussed above. In the Lowland Rainforest zone characterised by more forests than the Mangrove Swamp and Freshwater Swamp ecological zones a higher proportion (74.7 per cent) of the respondents indicated that new species of plants and trees have appeared in their locality in recent years. Similarly the respondents reported that they observed the disappearance of some species of plants and trees from their locality as a result of the impact of climate change. Again, as Table 5.17 indicates, a greater proportion of respondents in the Lowland Rainforest ecological zone observed the disappearance of some species of plants and trees from their locality as a result of the impact of climate change.

Table 5.17: Percentage Distribution of Respondents according to knowledge/experience about appearance of new species of plants and trees

Ecological Zones	Yes	No
Mangrove Swamp	42.9	57.1
Freshwater Swamp	42.9	57.1
Lowland Rainforest	74.7	25.3

Table 5.18: Percentage Distribution of Respondents according to knowledge/experience about disappearance of some species of plants and trees

Ecological Zones	Yes	No
Mangrove Swamp	56.4	43.6
Freshwater Swamp	65.6	34.4
Lowland Rainforest	76.6	23.4

Fire has always and will always be a natural and important phenomenon in environmental systems. However, because of an increase brought on through anthropogenic activities, fires are having a negative impact on the environment and more so on society and the economy. The likelihood of an 'accident' fulfilling the requirements to be classified as a disaster is increasing as a result of increased population densities and increased settlement in high-risk areas. Fire disasters are common in the Niger Delta region particularly in the forests of the rural areas with considerable negative effect on farmlands. Table 5.19 shows that most of the respondents (79.3 per cent) in the Mangrove Swamp ecological zone reported that there were no increase in the frequency of fire in their locality as a result of climate change outcomes compared with only 20.7 that observed increase in the occurrence of fire in their locality. The situation is rather different in the Freshwater Swamp and Lowland Rainforest ecological zones where over 73 per cent of the respondents indicate that there has been increase in the frequency of fire in their locality as a result of climate change.

Table 5.19: Percentage Distribution of Respondents according to knowledge/experience about increase in the frequency of forest fire

Ecological Zones	Yes	No
Mangrove Swamp	20.7	79.3
Freshwater Swamp	73.7	26.3
Lowland Rainforest	73.2	26.8

Deforestation is now the second leading cause of global climate change. Historically, forest cover in the Niger Delta region has been relatively stable. However, several major deforestation threats have appeared recently. These include growing demands for infrastructure, oil exploration and increased agricultural production. Respondents in the three ecological zones reported that they observed increased deforestation in their locality as a result of the impact of climate change. Table 5.20 indicates that over 86 per cent of the respondents in the three ecological zones pointed out that they observed increase in deforestation activities in their localities in the last few decades.

Table 5.20: Percentage Distribution of Respondents according to knowledge/experience about increase in deforestation activities

Ecological Zones	Yes	No
Mangrove Swamp	86.8	13.2
Freshwater Swamp	88.5	11.5
Lowland Rainforest	93.5	6.5

When sea levels rises even a small increase can have devastating effects on coastal habitats farther inland, it can cause destructive erosion, wetland flooding, aquifer and agricultural soil contamination with salt, and lost habitat for fish, birds, and plants. The Niger delta Coastal settlements, which are already under stress of demographic pressure and unsustainable oil exploitation, are equally under the threat of sea level rise. Table 5.21 shows that most of the respondents (over 60 per cent) in the Mangrove Swamp and Freshwater Swamp ecological zones indicated that they have experienced increases in seal level rise over the years. On the other hand, just about 36 per cent of the respondents in the Lowland Rainforest ecological zone observed increase in the sea level. It should be noted that the Lowland Forest zone is further from the coast compared with the other two which enables the respondents in those zone to be in positions to make more realistic observations.

Table 5.21: Percentage Distribution of Respondents according to knowledge/experiences about increase in sea level

Ecological Zones	Yes	No
Mangrove Swamp	72.6	27.4
Freshwater Swamp	60.8	39.2
Lowland Rainforest	36.0	64.0

It has been estimated that the 580 rivers of the Niger Delta region are prone to flooding and do affect 2,148 towns. Delta State has the highest communities at risk when water over flow their banks to about 500m. This is because the State has the highest number of rivers and many communities lie at the banks of these rivers. In Delta State, Ethiope river, River Niger and its other tributaries, Benin River, Escravos River, River Forcados which splits into Okumasi River, Opkara River, Edor River, and Warri River as well as Ramos River which bifurcates into Enikorogha creek transverse the entire landscape of Delta State causing it to flood the State especially Asaba, Warri, Aniocha North and South, Oshimili North and South, Burutu, Patani, Bomadi, Forcados. The results of the household survey confirms these empirical observations in that over 65 per cent of the respondents in the three

ecological zones reported that they observed increase in the magnitude of flooding in their localities over the years (Table 5.22). As expected the greater proportions of the respondents in the Mangrove Swamp (89.8 per cent) and Freshwater Swamp (75.3 per cent) reported having experienced increases in the magnitude of flooding in their localities over the years. Similar patterns were found with respect to the respondents' assessment of the duration of flooding. Table 5.23 shows that a greater proportion of the respondents in the three ecological zones pointed out that they observed increase in the duration of flooding. The views on coastal inundation are almost the same between those who said that it is on the increase and those who revealed that it is decreasing. The reason is that since their general knowledge of climate change is relatively low, they can only confirm climate related activities within their locality.

Table 5.22 Percentage Distribution of Respondents according to knowledge/experiences about increase in the magnitude of flooding

Ecological Zones	Yes	No
Mangrove Swamp	89.8	10.2
Freshwater Swamp	75.3	24.7
Lowland Rainforest	64.5	35.5

Table 5.23: Percentage Distribution of Respondents according to knowledge/experiences about increase in duration of flooding

Ecological Zones	Yes	No
Mangrove Swamp	87.8	12.2
Freshwater Swamp	55.7	44.3
Lowland Rainforest	60.5	39.5

Closely associated with flooding in the Niger Delta region is the occurrence of the increase in the volume of streams and the drying up of streams. Table 5.24 shows that the vast majority of the respondents in the Mangrove Swamp and Freshwater ecological zones reported increase in the volume of streams in their locality. With respect to the drying up of some streams Table 5.25 shows that most respondents in the three ecological zones reported that they have not experienced the drying up of their streams.

Table 5.24: Percentage Distribution of Respondents according to knowledge/experience about increase in the volume of streams

Ecological Zones	Yes	No
Mangrove Swamp	87.2	12.8
Freshwater Swamp	78.0	22.0
Lowland Rainforest	51.3	48.7

Table 5.25: Percentage Distribution of Respondents according to knowledge/experience about the drying up of some streams

Ecological Zones	Yes	No
Mangrove Swamp	46.3	53.7
Freshwater Swamp	38.3	61.7
Lowland Rainforest	27.3	72.8

Respondents Perceived Impacts of Climate Change on Agriculture

The results from survey show that the changes in climate related hazards over the past 30 years have affected agricultural productivity and the stock of aquatic life adversely. Yield and output from crops, NTFPs (Non timber forest products), fish stocks (population) in rivers/streams, fishery production have been observed by respondents to have declined over the years and food insecurity is thus imminent in the affected communities. The major impacts of climate-related hazards on crop production include loss of soil nutrients due to seeping, leaching and erosion, soil compaction caking due to drought, changes in farming practices, flood and excess heat, water logged soil, low yield, low output, migration from farm lands, invasion of pests, scorched crops due to drought and early cessation of rains, overturning of boats due to violent ocean surges and loss of lives were recorded in the past 30 years. All stakeholders in the communities are affected while the women, who are mostly farmers, are the most vulnerable.

The vast proportion of the people in the rural communities of the Niger Delta region depends on freshwater fish as their main source of protein. The major fish species that are common in the wild in Delta State include catfish, mudfish, crayfish, shrimps and tilapia. Fish production has been adversely affected, as fisher folks have lost their lives, livelihoods and fishing tools in storms and floods, faced declining fish populations and increased disease outbreaks in fisheries. Fisheries have been adversely affected by hazards of climate change such as flooding, sea surge, sea level rise, salt water incursion, erosion, turbidity, drought and increasing sea surface temperatures. The impacts of these hazards on fisheries include increased turbidity, destruction of natural habitat, water hyacinth bloom (hyacinth prevents light, oxygen penetration). Water hyacinth also disrupts navigation, reduces fish catch, alters fish migration and causes the disappearance of some economically valuable fish species.

Table 5.26: Percentage Distribution of Respondents according to knowledge/experience about disappearance of some species of fishes

Ecological Zones	Yes	No
Mangrove Swamp	59.1	40.9
Freshwater Swamp	55.2	44.8
Lowland Rainforest	16.8	83.3

Table 5.27: Percentage Distribution of Respondents according to knowledge/experience about appearance of new species of fishes

Ecological Zones	Yes	No
Mangrove Swamp	33.4	66.6
Freshwater Swamp	24.1	75.9
Lowland Rainforest	21.4	78.6

The endangerment of species is not only a critical issue for animal and plant life but can also have a detrimental impact for humans in the region. A species of fish critical to subsistence fishermen in Niger Delta region is known to be losing its ability to reproduce in the waters of the region as waters warm. Its reproductive output is estimated to have declined by more than 20 percent per decade over the past 30 years. Table 5.26 shows that most of the respondents in the Mangrove Swamp and Freshwater Swamp ecological zones reported the disappearance of some species of fishes from their waters while the proportion is just about 17 per cent in the Lowland Rainforest. This can be explained by the fact that fishing is not a major agricultural occupation in the Lowland Rainforest due to the absence of fishing waters. The respondents in this zone are therefore not in a position to make effective observations about the appearance or disappearance of new species of fishes. Table 5.27 shows that the vast proportion of the respondents (over 66 per cent) in the three ecological zones reported that they did not observe any appearance of new species of fish in the rivers of their locality.

Climate change and conflicts

When oil exploration began in the Niger Delta region in the late 1950s, the people expected that it would make a huge difference to their lives. The massive machines and technology that they saw indicated that their lives would change positively. However, after over fifty years, they realized that oil had brought misfortune and misery. Their natural resource had become a curse. Their land was taken for exploration, exploitation, pipelines and platforms. The much that was left were polluted and degraded by numerous oil spillages. The rivers and water systems were polluted. The land was no longer arable and the rivers had been deserted by fish colonies. The air was polluted by gas flares and acid rain was tormenting their house roofs just as the people had become

plagued by numerous diseases. The people had become under-employed and unemployed. Thus rather than attract development, oil and gas has actually under-developed and devastated the region. It has created land and water scarcity. A massive regime of oil spills and gas flares has caused soil fertility loss, forest loss, bio-diversity depletion, agricultural decline and decline in fishery. The negative externalities of oil and particularly the devastation of land and water upon which the livelihood sources, livelihoods and specifically primary economies of farming, fishing and hunting depend has deepened poverty, unemployment and underemployment.

These conditions of marginality, dispossession of resources including the impact of climate change, trickle benefits from resource endowments, developmental neglect have combined to create multifarious crises in the region. When democracy was reinstalled in 1999, the communities of the Niger Delta led by militant youth intensified the agitation for development benefits and compensation for land and agricultural resources from the oil prospecting companies. The civil agitation largely began with the Ogoni people in the Rivers State from 1990, with popular organizations, popular mobilization and mass protests, engaged the Nigerian State and Shell, in a minority, environmental and resource rights and self-determination struggles. The civil agitation was particularly reinforced by the emergence and flowering of civil society, by the late 1990s, a mosaic of civil groups of diverse hues; communal based organizations, civil and environmental rights groups, advocacy groups, nongovernmental organizations, ethno-cultural groups and youth groups had emerged which began to champion the cause and were able to construct a civil platform of networking, partnership and collaborations. With the amnesty program introduced in the region since 2009, relative peace has returned to the region. However, the impact of conflicts and violence in the Niger Delta region is still felt in many communities of the region to date. Generally climate change induced conflicts are part of the general resource exploitation conflicts in the Niger Delta region.

Table 5.28 indicates that the vast proportion of the respondents (over 61 per cent) in the three ecological zones report that conflicts due to scarcity of grazing land have increased while about a third of the respondents indicated that conflicts associated with scarcity of grazing land have declined. Climate change induced conflicts associated with the depletion of fishing ground has also increased in the Mangrove Swamp ecological zone with over 71 per cent of the respondents reporting increased conflicts (Table 5.29). On the other hand, respondents in the Freshwater Swamp ecological zone are almost equally divided with respect to their observation of the increase or decrease of conflicts associated with the depletion of fishing ground.

Table 5.28: Percentage Distribution of Respondents' assessment of the impact of climate change induced conflicts due to scarcity of grazing land

Ecological Zones	Increased	Decreased
Mangrove Swamp	61.5	38.5
Freshwater Swamp	64.6	35.4
Lowland Rainforest	79.6	20.4

Table 5.29: Percentage Distribution of Respondents' assessment of the Impact of climate change induced conflicts due to depletion of fishing ground

Ecological Zones	Increased	Decreased
Mangrove Swamp	71.5	28.5
Freshwater Swamp	56.4	43.6
Lowland Rainforest	29.2	70.8

Finally, only about a third of the respondents in the Lowland Rainforest ecological zone reported increased climate change conflicts while the proportion of respondents that indicated a decrease is 76.7. These findings from the three ecological zones with respect to conflicts arising from the depletion of fishing ground reflect the degree to which households in the communities of the three zones depend on fishing as means of livelihood. In the Mangrove Swamp zone and to some extent the Freshwater Swamp zone fishing is a major economic activity compared with the Lowland Rainforest ecological zone.

The shortage of fresh water associated with climate change and oil exploration is a common feature of the Niger Delta region. This has often generated conflicts in various communities in the region. Table 5.30 shows that decreasing fresh water supply has led increased conflicts in the three ecological zones with a higher proportion (over 60 per cent) of the respondents in the Mangrove Swamp and Freshwater Swamp reporting increased conflicts in their localities. On the other hand, the proportion of the respondents that reported decreased conflicts is higher (67.2 per cent) in the Lowland Rainforest ecological zone. Finally, Table 5.31 indicates that over two thirds of the respondents in the three ecological zones reported increased conflicts in their communities as a result of decreasing arable lands due to a combination of climate change and oil exploration.

Table 5.30: Percentage Distribution of Respondents' assessment of the impact of climate change induced conflicts due to decreasing fresh water

Ecological Zones	Increased	Decreased
Mangrove Swamp	62.3	37.7
Freshwater Swamp	60.3	39.7
Lowland Rainforest	32.8	67.2

Table 5.31: Percentage Distribution of Respondents' assessment of the impact of climate change induced conflicts due to decreasing arable lands

Ecological Zones	Increased	Decreased
Mangrove Swamp	69.8	30.2
Freshwater Swamp	63.0	37.0
Lowland Rainforest	75.0	25.0

A shift in Family and Gender Roles

One of the socio economic impacts of climate change as reflected in the survey communities in the three ecological zones is related to changes in the gender roles. Majority of women in the three ecological zones said that due to aridity caused by increasing length of dry season, they spend more hours searching for water and pasture at the expense of other economic activities and sometimes have to get up at midnight to fetch water. Due to lack of drinking water near the villages men are now helping women with water collection. Men participate in fetching of water using bicycles, wheel barrows, motor cycles and other means hence these changes have altered the gender distribution of family roles. They also said that due to depletion of forest areas, fetching firewood has been difficult hence men also have to take bicycles and motor cycles for fetching them. Fetching water and fire woods in the past were the primary roles for women but with scarcity even men now do involve in these activities. Table 5.32 shows that the vast majority of the respondents (over 88 per cent) in the three ecological zones reported that water shortage had effects more on women and girls compared with men and boys. Similarly Table 5.33 indicates that over 88 per cent of the respondents in the three ecological zones pointed out that shortage of firewood had more effects on women and girls than men/boys.

Table 5.32: Percentage Distribution of Respondents assessment of the impact of water shortage on men/boys and women/girls

Ecological Zones	Effect are more on men/boys than women/girls	Effect are more on women/girls than men/boys
Mangrove Swamp	11.2	88.8
Freshwater Swamp	6.2	93.8
Lowland Rainforest	7.9	92.1

Table 5.33: Percentage Distribution of Respondents assessment of the impact of shortage of firewood on men/boys and women/girls

Ecological Zones	Effect are more on men/boys than women/girls	Effect are more on women/girls than men/boys
Mangrove Swamp	11.1	88.9
Freshwater Swamp	4.5	95.5
Lowland Rainforest	3.3	96.7

Women play major farming roles in the Niger Delta region, but have very limited decision power and lesser access to production resources. Women farmers are more vulnerable to the changes in weather than men and supply most of the labour needed in the farm in addition to managing their own farms even though available agricultural resources are unevenly distributed across gender. Consequently, the negative effects of extreme rainfall impact on women than men. Table 5.34 reflects this pattern as over three quarters of the respondents in the three ecological zones pointed out that the impact of extreme rainfall is felt more by women/girls in their communities since men and boys tend to move away to the urban areas leaving behind women as farmers who bear the consequences of heavy rainfall. In the same vain Table 5.35 shows that the vast majority of the respondents in the three ecological zones reported that women and girls are more affected by flooding than men and boys. The same explanation of more women being involved in agricultural activities is relevant to the impact of flooding on them than their male counterparts.

Table 5.34: Percentage Distribution of Respondents assessment of the impact of extreme rainfall on men/boys and women/girls

Ecological Zones	Effect are more on men/boys than women/girls	Effect are more on women/girls than men/boys
Mangrove Swamp	24.1	75.9
Freshwater Swamp	23.1	76.9
Lowland Rainforest	25.5	74.5

Table 5.35: Percentage Distribution of Respondents assessment of the impact of flooding on men/boys and women/girls

Ecological Zones	Effect are more on men/boys than women/girls	Effect are more on women/girls than men/boys
Mangrove Swamp	18.8	81.2
Freshwater Swamp	22.7	77.3
Lowland Rainforest	32.5	67.5

The changing climate patterns, and especially the increased frequency and/or severity of extreme events, increase the vulnerability to natural disasters, both slower-onset ones such as droughts and rapid onset disasters such as floods and cyclones. Changing climate patterns and more extreme events will have impacts on new livelihood activities such as from tourism, that will limit diversification of opportunities which, combined with damage to infrastructure and other types of physical capital, will affect the wider range of vulnerabilities. The poor social and political capital, along with extremely limited access to financial capital, mean that communities in the Niger Delta region are least likely to be protected by investments in infrastructure. However, broad livelihood disruptions and other family dislocation impact more on women than men. Table 5.36 reports that there are marked differences between respondents in the three ecological zone with respect to the impact of livelihood disruption on men and women. In the Mangrove Swamp ecological zone, respondents are almost equally divided with respect to the effects of livelihood disruption on women and men. On the other hand, the vast majority (90.9 per cent) of the respondents in the Freshwater Swamp zone reported that women and girls are more affected by the disruption of livelihood caused by climate change and other activities. Finally, most of the respondents in the Lowland Rainforest ecological zone indicated that livelihood disruption affects men and boys more than women girls. With respect to the occurrence of family dislocation respondent are again almost equally divided in terms of the effects on women and men (Table 5.37).

Table 5.36: Percentage Distribution of Respondents assessment of the impact of livelihood disruption on men/boys and women/girls

Ecological Zones	Effect are more on men/boys than women/girls	Effect are more on women/girls than men/boys
Mangrove Swamp	44.3	55.7
Freshwater Swamp	9.1	90.9
Lowland Rainforest	75.7	24.3

Table 5.37: Percentage Distribution of Respondents assessment of the impact of family dislocation on men/boys and women/girls

Ecological Zones	Effect are more on men/boys than women/girls	Effect are more on women/girls than men/boys
Mangrove Swamp	31.3	68.7
Freshwater Swamp	59.5	40.5
Lowland Rainforest	49.4	50.6

Qualitative Analysis of the Impact of Climate Change on Communities

By way of summary, focus group discussions, key informant interviews with respondents and participant observations across the three ecological zones provide some insight into the nature of the impact of climate change on households in the communities within them as outlined in the next few paragraphs.

The respondents indicated that they have observed changes in rainfall seasons and pattern, temperature are higher in some areas than they were before and incidences of extreme events such as floods and drought have increased. In most cases rains delay and this result in crops drying out. Some farmers have observed changes in the rainfall pattern noting that in decades ago, some localities had rainfall throughout the year but now, it is highly seasonal and so unpredictable. According to them the rains start late and end before end of the usual rainy season. Some of the respondents pointed out that prior to the1970s they could cultivate crops like cassava twice in a year but now they could only harvest once.

They also indicated that they have been experiencing frequent and severe floods for the past ten to fifteen years. The respondents also said that with the changes in the pattern of rainfall in the past decades, they have designed various adaptation methods among others including changing the planting time. Unlike in the past when the planting period was well known, currently the planting depends on when the rains come. For example farmers indicated changes in planting crops such as yam, cassava, and maize. According to them there are also delays in planting and harvesting maize, when rains are late, it means they will plant late and harvest late.

Almost all the respondents in the three ecological zones agreed that they think that the changes in planting and harvesting time for various crops are due to climatic changes. Some other crops whose famers felt that their harvesting and planting period has undergone changes include: okro, vegetables, tomato, groundnuts and pawpaw. Many respondents felt that there were significant changes in terms of planning and harvesting time for cassava and yam in particular. It was observed that there were significant differences in the farmer's perception on where climate changes had affected the planning or harvesting time and therefore income. We could not find the reason for this situation, but we suspected that the ecological differences in perception on the effects of climate changes among respondents depended on whether the crop was a major crop or not. The majority of respondents admitted that crops harvest had declined due to many reasons: Shorter rainy season and decline in soil fertility were among the reasons. However, only a few of

the respondents believe that there were significant changes in planting, harvesting time and yield for various crops compared to the past years such as in the 1960s and 70s in which case they do not put the prevailing situation specifically in the context of climate change.

Generally, respondents indicate that rain has become unpredictable in the recent years and this has negatively affected their farming and fishing plans. As a result of changes in rainfall and temperature, farmers have noted the impact of these changes resulting in many other changes that affect crop production and livestock keeping. Farmers who also raise animals have indicated that one consequence of these changes is reduced areas for grazing, as availability of grass is reduced due to increasing length and aridity of the dry season and this has affected the amount of livestock products such as milk, hide and skin.

Reduction on Soil Fertility and Crop Yields

Some of the impacts of climate changes noted by respondents include reduction in soil fertility. Soil fertility negatively affects crop production to a large extent. The respondents agreed that soil fertility has been reducing over the years. This has resulted in reduced crop production. Examples were given by farmers that compare to the past crop harvests have drastically declined, due to reduced soil fertility; hence, if they do not use fertilizer the harvests become so low.

In the focus group discussion one participant indicated that "for the past 10 years fertilizer has been used by people who can afford it". Due to reduction in yields in crops in their localities some producers have opted to change the type of crops, now most farmers are farming vegetables, and other short term crops such as fruits. One can argue that soil fertility is not only influenced by climate change as it can decline for a variety of reasons. Farming system may also contribute; Some common farming practices, including burning crop residues and leaving soil bare and unprotected from the sun and wind, are part of the problem. Excessive, insufficient and improper use of fertilizers and crop rotations also lead to declining soil fertility. As pointed out in earlier parts of the study, most of the respondents have limited livelihood choices, therefore decreasing crop yields is a serious challenge to their survival.

Disappearance of Major Crops, Vegetable, Forests, Wildlife and Water Bodies:

Respondents and participants in focus group discussions have observed some changes in the type of crops that farmers prefer to farm now. Some crops are no longer grown or if grown its yields have declined such that farmers don't get equitable return. However, in a few communities some interviewed farmers said that, comparing the present and the past, there are no changes in their areas as they are cultivating the same crops; but the only difference they observed is that the crop production (yields) has been reducing overtime. Others said that old types of seeds for some crops have disappeared (maize, beans, banana, millet, mangoes, oranges). In addition to the disappearance of major crops, there have also been changes in what is considered as major crops in different areas. Farmers interviewed noted that there have been changes in major crops cultivated over the past ten years as a result of the changing climate. For example, before now red yam (*Dioscorea cayenensis*) was produced more but because of reduced length of rainy season, more of white yam (*Dioscorea rotundata)* that needs shorter growing period is produced. Such a shift in crop production due to the impact of climate change was also observed in the semi-arid

region of Nigeria (Odjugo, 2010). Some of the respondents claimed that the short-dry-season popularly called "August Break" with reduced rains and increased temperature favour the growth and yield of yam tubers especially the red yam, but with the shift of the August Break from August to July in most years in recent times, coupled with late on-set and early cessations of rainy season, most yam varieties like the red yam do not produce well, hence the shift to the production of white yam by the farmers. Although climate change and weather variability have been contributing significantly in farmers shift into new crops, price changes, world demand for new crops have also been contributing to crop/livestock changes.

According to the respondents these changes in the type of crops are influenced by the changes in climatic condition especially availability of rain and changes in temperature, however the market conditions have also contributed to the change in crops grown, the market conditions include the demand and prices of the crops in the domestic and international markets. According to them, cultivating crops such as vegetables, fruits, flowers provide more money (returns) when selling and they take a shorter time and also cope well with short rainy seasons that prevail at the moment. In general climate change has influenced the agrarian livelihood in terms of the type of economic activities and genders roles in the families.

Respondents indicated that some wildlife that was available in their localities is not seen anymore. Animals such as the bush-pigs (*Potamochoerus larvatus*), kanga (*Encephalartos)*, buffalo, and antelope were many in their localities are going into extinction. For supporting their livelihood people keep on destroying the forests and creating space for farms so animals move further away or being exposed to hunters. Other reasons that have contributed to disappearance of animals include urbanization, population increase and hunting. Large forests that existed in the past in their localities have substantially reduced and disappeared in some areas due to increase in population and economic activities affecting growth of forests and water resources. Respondents also reported that they have also observed changes in rivers/stream flow. There is reduced volume of water in some rivers in recent times making their navigability more seasonal. They pointed out that this has affected the catch of fishes and reptiles like crocodiles, alligator etc. Due to the changes in temperature and rainfall, some new weeds and pests are surviving and creating challenges for farmers. As new pests, diseases and weeds take over the farms they affect the farm output and as a result threaten the livelihoods of farmers.

Challenges in Livestock Keeping

In all the three ecological zones the primary producers practice agro-pastoralist and villagers keep the following animals chicken, turkey, pig, goat, cow, rabbit, and sheep; while chicken and goat are the most raised animals. When interviewed villagers were asked the reason why they keep these type of animals, more than a half (54.3%) said that livestock increases their income while the other reasons for keeping animals included nutrition factors (for milk, meat, eggs etc). Several other reasons were given by the respondents for keeping livestock they have. The interesting point from among the reasons for keeping livestock was that livestock is used as safety net during crisis; this has to be encouraged given the current price instability for cash and food crops in the markets, livestock helps to cushion income changes due to market instabilities. Establishment for livestock raising projects at family level such as traditional chicken, goats, pork could be one way of getting out of poverty for many respondents. However, livestock keepers complained of lack of

market for animal products. In terms of reasons for expansion/decrease in livestock keeping, the responses were somehow divided as about 50 per cent agreed that they have increased the scale of animals kept while the balance of 50 per cent disagreed. The reasons for not expanding livestock keeping include: expenses related with care, difficulty of feeding animals as pasture and water resources have declined. Other factors include: lack of price incentives for the animal products at the same time the cost of keeping livestock is escalating (medication) etc. Among all the reasons, drought was sighted as a major reason as one of the respondents pointed out "*due to drought occasioned by longer and hotter dry season, looking for foliage is becoming a herculean task, while some of the animals become malnourish and loss economic values, others even die as a result, many young people migrate to urban areas to look for jobs".* This is obviously one social impact of climate change.

The respondents also noted that challenges related to shortages of land and pasture have led to changes in livestock keeping style, as more villagers practise zero grazing system now unlike in the past where majority of the pastoralist practised nomadic type of animal grazing. Other climate changes that have negatively affected livestock keepers include the increase or the emergence of new diseases attacking animals. They mentioned new diseases such as bird flu attacking chicken. Most of the respondents did not know where these new diseases come from but some thought that they are related to weather changes causing shortages of rain that makes land dry and dusty that spread bacteria, migrating insects, while sometimes abnormal or heavy rains causing floods spreading virus and bacteria.

Income Change

Respondents mainly depend on crops, fishing and livestock output for their income and livelihoods, so, occurrence of adverse weather conditions such as limited rainfall, floods or drought means the farmers' income will be reduced. Interviews with the respondents indicate that, there are two factors that determine the amount of farm output. These are the size of the farm and whether the season was good, in terms of availability and duration of rain. Most respondents have small crop and fish farms and only able to produce enough for domestic use within the family. The second reason for not producing enough for sale is when farmers are faced with unfavourable weather condition due to lack of, or limited rains, high temperature and floods within the crops growing season. When there are changes in the season that affect agriculture negatively; then they neither produce enough for sale nor for their own food. This means their earning capacity is impaired and their income for other needs such as payment for social services which nowadays is literally not free such as health and education for their kids is compromised. When respondents were asked which group in the society they think is much affected with these changes, they thought that they as farmers or fisher folks do suffer a lot, and within the families children and elderly people are most affect as they have less copping mechanism for the adverse effects for climate changes. However, when farmers are able to produce enough for sale there are still challenges they face in selling their produce (marketing challenges). Farmers indicated that, when it is a good year with enough harvest; it is not necessarily translated to good returns from the crops they produce because of challenges like lack of storage facilities, low demand and poor selling prices, since the farmers have no freedom to decide the price.

Effects on Employment and Jobs

During the harsh weather condition due to climate changes such as occasional agricultural drought, the community suffers as a result of reduced economic activities that provide employment opportunities. This is because in rural communities, agriculture has big multiplier effects and provides a main source of employment. Consequently, when there are no rains during the crops growing periods, it means there will be no/little harvest for crops leading to low need for jobs in farms. Although some agriculture related activities provide only temporally employment or seasonal, with decline in rains, wage workers that are being used during harvesting will have no or little employment. This chain for decline in economic activities with the decline crops output also affect crops, middle men who buy the produce from farmers as there will be no crops to buy and sell. This results in reduced income for the agricultural marketing chain therefore include; farmers, the labourers, and the middle men. This climate change related decline in agricultural output, employment and income has another negative consequence in food security as less food is produced. Moreover, due to reduced crop output, the little food harvested makes food expensive and this affects negatively everyone in the community and the region in general.

Environmental Management and Climate Change

Although the respondents appreciated the presence of the environmental management projects in their localities, they however, agreed that the current efforts to rescue the environment are inadequate to deal with the environmental conservation issues and thought that the private sector could be convinced to put more resources to assist the government. Institutions such as Commercial Banks, Pension Funds, mining companies and other foreign investment firms could be approached. When respondents were asked what are the causes of all the said environmental changes? They listed a number of factors such as: increase in population that also increase economic activities, destruction of water sources, deforestation that has resulted in reduced rain and drought. Other contributing forces included increased farming and urbanization that are taking up the land and forests which were initially used for grazing.

Chapter 6

Adaptation Practices and Strategies

This chapter identifies the major methods used by households to adapt to climate change in the various ecological zones of Delta State, the factors that affect their choice of method, and the barriers to adaptation. A variety of adaptation measures have been adopted by households in the communities of the three ecological zones in Delta State to mitigate the impact of climate change. These adaptation measures are influenced by the geographical location of the communities and the common climate events. Overall strategies such as late planting, economic diversification, planting on mounds, agricultural diversification and mixed cropping among others are used by respondents. The use of land management adaptation techniques is also common to respondents in the three ecological zones. Planting on terraces is employed by a small proportion of the respondents. Farmers also plant flood-resistant or flood-tolerant varieties of crops like sugar cane and swamp rice. Many of the respondents during focus group discussion reported that they now plant late in the season, in response to the late onset of rain in recent years. Respondents in all the communities reported that they have diversified their income-earning activities as a survival strategy in the face of dwindling and unpredictable income from a single source. Farmers plant trees and cover crops to reduce windstorm and erosion effects. Besides, the measures which directly related to farming, another adaptation measure common in most communities relates to the planting of shades trees to protect homes from the scorching heat and wind.

Economic and Crop Production Diversification Strategies

As an adaptive strategy respondents in the three ecological zones have diversified their economic activities; for instance they also altered their lifestyle and switched to other income generating activities such as: Establishing of commercial motorcycles driving business, selling of oil and petrol, saloon, petty shops and business, small scale poultry keeping, selling food items across the roads and shops as new income generating activities. Table 6.1 shows that respondents in the three ecological zones reported that they engage in various economic activities to cope with the impact of climate change on their households. Respondents indicated that one of the strategies they adopted to increase agricultural production is to increase the size of cultivated land whenever available. When additional farmland is inadequate or unavailable respondents were not in a position to adopt this strategy.

Table 6.1: Percentage Distribution of Respondents' report on livelihood/income diversification used in response to climate change disasters

Ecological Zones	Livelihood diversification	Out migration	Share cropping	Obtain loans	Use of alternative strategy	Pre-mature harvest	Relocation of livestock	Combination of all the above
Mangrove Swamp	19.5	8.2	1.2	4.6	3.5	27.4	2.5	33.0
Freshwater Swamp	17.0	2.9	5.0	5.8	4.2	38.2	1.2	25.7
Lowland Rainforest	22.1	2.3	4.3	3.0	2.0	8.2	0.3	57.4

Table 6.2 shows that about half of the respondents in the Mangrove Swamp and Freshwater Swamp ecological zone where land for farming is generally inadequate indicated that they increase the size of their cultivate land while the remaining half said they were not able to do so because they had no additional land to put into farming. On the other hand, in the Lowland Rainforest ecological zone where more land appears available over 71 per cent of the respondents indicated that they were able to put more land into cultivation. Table 6.2 further shows that most of the respondents that who increased the size of their cultivate land reported that the strategy was effective in increasing their income in the phase of climate change.

Table 6.2: Percentage Distribution of Respondents' experience on adopting increasing the size of cultivated land as a strategy for adapting to climate change disasters and its effectiveness

Ecological Zones	Yes	No	Effective	Not effective	Not applicable
Mangrove Swamp	49.9	50.1	47.4	2.7	49.9
Freshwater Swamp	52.0	48.0	46.0	6.0	48.0
Lowland Rainforest	71.3	28.7	68.6	3.0	28.4

The rural non-farm sector in the Niger Delta region not only contributes directly to rural households' income that creates employment opportunities, but also it provides avenues for input supplies to the farming sector and value-adding opportunities for the farm production. A well-off and non-farm sector should be able to provide employment to marginal farmers who leave agriculture because they could no longer survive in farming. A growing interest in the rural non-farm sector reflects the increasing realization that rural peoples' livelihoods are derived from diverse sources and are not as overwhelmingly dependent on agriculture. Table 6.3 shows that the majority of the respondents (58.8 per cent) in the Lowland Rainforest reported diversification from farm to non-farm activities which can be explained largely by the availability of non-farm activities in the communities of the upland part of Delta State compared with the situation in the Mangrove Swamp and Freshwater Swamp ecological zones where such opportunities are limited. Table 6.3 further shows that most of the respondents who adopted this strategy described their strategy as effective.

Table 6.3: Percentage Distribution of Respondents' experience on adopting diversification from farm to non-farm activities as a strategy for adapting to climate change disasters and its effectiveness

Ecological Zones	Yes	No	Effective	Not effective	Not applicable
Mangrove Swamp	37.3	63.7	32.6	4.9	62.5
Freshwater Swamp	40.7	59.3	34.0	6.8	59.2
Lowland Rainforest	58.8	41.2	54.3	4.7	41.0

New agricultural technologies, such as high-yielding crop varieties, offer the promise of improving productivity in Niger Delta region and hence the welfare of farmers in the context of the negative effects of the prevailing climate change. Table 6.4 indicated that the vast majority of the respondents in the three ecological zones reported that they adopted planning different crop varieties as a strategy of adaptation to climate change. Table 6.4 further shows that the vast proportion of the respondents described their strategy as effective in terms of improving their incomes.

Table 6.4: Percentage Distribution of Respondents' experience on adopting planting different crop varieties as a strategy for adapting to climate change disasters and its effectiveness

Ecological Zones	Yes	No	Effective	Not effective	Not applicable
Mangrove Swamp	61.9	38.1	58.5	3.8	37.8
Freshwater Swamp	69.2	30.8	60.3	9.1	30.7
Lowland Rainforest	92.3	7.8	89.0	3.3	7.7

Farming communities in Niger Delta region have survived a long series of climate fluctuations in the past by adapting to widely varying weather conditions. One of which has been planting of their crops at different times within the year. Table 6.5 indicates that the vast proportion of the respondents in the three ecological zones reported that have been adopting different planting times for their crops as response to the effects of climate change and most of the respondents also described this approach as effective in improving their agricultural productivity.

Table 6.5: Percentage Distribution of Respondents' experience on adopting different planting times as a strategy for adapting to climate change disasters and its effectiveness

Ecological Zones	Yes	No	Effective	Not effective	Not applicable
Mangrove Swamp	54.1	45.9	49.2	5.3	45.5
Freshwater Swamp	72.7	27.3	64.3	8.5	27.3
Lowland Rainforest	71.7	28.3	64.3	7.6	28.1

Crop diversification features prominently in Niger Delta region's farming household climate change adaptation strategies. Through crop diversification, farming households can spread production and income risk over a wider range of crops, thus reducing livelihood vulnerability to weather or market shocks. A few farmers have indicated that they use new type of maize seeds that produce maize within a short time (three months) and do not require a lot of rain. Therefore, farmers are trying to adapt to the changing climate by changing the type of seeds they use. This change has been noted by farmers in some communities indicating that there is a change in the type of bananas they plant now compared to what was obtainable some few decades ago. As the rainfall duration is getting reduced the farmers tend to plant type of bananas that can resist drought (shifting from the tall to the dwarf species). Majority of respondents showed that they are gradually shifting from the production of 12 months to 6-8 months cassava species.

Table 6.6: Percentage Distribution of Respondents' experience on adopting planting of early maturing crops as a strategy for adapting to climate change disasters and its effectiveness

Ecological Zones	Yes	No	Effective	Not effective	Not applicable
Mangrove Swamp	60.6	39.4	57.7	3.0	39.3
Freshwater Swamp	68.3	31.8	59.6	8.5	31.9
Lowland Rainforest	79.9	20.1	78.3	1.9	19.8

Table 6.6 shows that a greater proportion of the respondents in the three ecological zones reported that they have at various times adopted early maturing crops particularly maize as a strategy for adapting to climate change which they described as effective.

However, the planting of flood tolerant crops appears not to be popular as a strategy for adapting to the impact of climate change in the three ecological zones (Table 6.7). Similarly the planting of drought tolerant crops as a strategy for adapting to the impact of climate change in the three ecological zones is not popular among the respondents (Table 6.8). Furthermore Tables 6.9 and 6.10 also indicates that respondents in the three ecological zones show that the vast proportion of the respondents reported that they do not adopt the planting of salt tolerant crops and pest resistant varieties largely because opportunities for the adoption of such strategies are not available.

Table 6.7: Percentage Distribution of Respondents' experience on adopting flood tolerant crop as a strategy for adapting to climate change disasters and its effectiveness

Ecological Zones	Yes	No	Effective	Not effective	Not applicable
Mangrove Swamp	31.3	68.8	24.6	7.1	68.3
Freshwater Swamp	25.0	75.0	19.3	5.7	75.1
Lowland Rainforest	8.5	91.5	7.8	0.9	91.3

Table 6.8: Percentage Distribution of Respondents' experience on adopting drought tolerant crop as a strategy for adapting to climate change disasters and its effectiveness

Ecological Zones	Yes	No	Effective	Not effective	Not applicable
Mangrove Swamp	26.8	73.2	19.8	7.3	73.0
Freshwater Swamp	19.9	80.1	12.3	7.5	80.2
Lowland Rainforest	6.3	93.7	5.9	0.7	93.4

Table 6.9: Percentage Distribution of Respondents' experience on adopting salt tolerant crops as a strategy for adapting to climate change disasters and its effectiveness

Ecological Zones	Yes	No	Effective	Not effective	Not applicable
Mangrove Swamp	10.1	89.9	8.0	2.4	89.6
Freshwater Swamp	11.2	88.8	5.5	5.7	88.8
Lowland Rainforest	3.1	96.9	2.9	0.6	96.5

Table 6.10: Percentage Distribution of Respondents' experience on adopting pest resistant varieties as a strategy for adapting to climate change disasters and its effectiveness

Ecological Zones	Yes	No	Effective	Not effective	Not applicable
Mangrove Swamp	13.9	86.1	9.3	5.0	85.8
Freshwater Swamp	29.6	70.4	24.9	4.8	70.4
Lowland Rainforest	21.8	78.2	19.7	2.5	77.8

Finally it can be stated that the lowland forest area picked economic diversification, dry season farming and late planting as the best options. While the freshwater swamp forest practised more of economic diversification, mixed cropping and agricultural diversification, the mangrove

swamp forest zone used more of economic diversification, netting of fishing ponds and planting on mounds and ridges. This implies that as the impacts vary from ecological zone to the other so also is the adaptation strategies. What is common in the three ecological zones is economic diversification. All the adaptation options are autonomous which will fail with increasing severity of climate change impacts, except planned adaptation measures are put in place.

Adaptive Strategies for Livestock Keeping

In order to adapt to the effects of climate change at household level, some respondents in the three ecological zones of Delta State diversify their economic activities by doing both crop production and animal keeping. Respondents usually move with their animals from one place to another in search of water and pastures especially during the dry season. These movements in most cases are not planned and not coordinated to negotiate resource use which sometimes results into conflicts between groups. Other measures include change of new breed of animals that resist diseases and climate change impacts, construction of ponds and reservoirs for water storage. Some livestock keepers said that they have abandoned the traditional cows that could not resist new diseases and also practise zero grazing that need more grass cutting along the river banks. Table 6.11 shows that the vast majority of the respondents reported that they are not adopting early maturing livestock as a strategy for adapting to climate change largely because such varieties are not viable in the various ecological zones. The situation with regard to the adoption of different breeds of livestock is largely similar as the vast majority of the respondents do not adopt that strategy. This could be explained by the limited opportunities for doing so as different varieties of livestock are not readily available (Table 6.12).

Table 6.11: Percentage Distribution of Respondents' experience on adopting early maturing livestock as a strategy for adapting to climate change disasters and its effectiveness

Ecological Zones	Yes	No	Effective	Not effective	Not applicable
Mangrove Swamp	24.4	75.6	21.6	3.2	75.2
Freshwater Swamp	14.3	85.8	10.3	4.1	85.6
Lowland Rainforest	18.5	81.5	18.1	0.8	81.2

Table 6.12: Percentage Distribution of Respondents' experience on adopting rearing different breeds of livestock as a strategy for adapting to climate change disasters and its effectiveness

Ecological Zones	Yes	No	Effective	Not effective	Not applicable
Mangrove Swamp	24.4	75.6	20.9	4.1	75.0
Freshwater Swamp	13.7	86.3	10.3	3.6	86.2
Lowland Rainforest	20.9	79.1	18.6	2.5	78.9

Soil Conservation

Since the rainfall intensity is getting higher by the day in the Niger Delta region, erosion is also increasing thereby reducing soil fertility. In order to preserve soil fertility, farmers use various ways such as the use terraces, mulching, grass strips and other traditional methods. However, some farmers still do not use any methods to preserve soil fertility. Although the proportion of those who do not practice any conservation methods seems small, there is need to encourage this group to at least use one of any means to preserve their soil for its fertility. Bush fallowing is one of the soil conservation practised by most famers. Farmers indicated that, they normally leave some farms empty for sometime before using them again (bush fallowing), so that the land can recover its fertility. Crop rotation is another method mentioned by farmers as one of the means they use to preserve soil fertility and ensure soil conservation. Some respondents indicated that, they use crop mixing as a method to ensure soil fertility. They mostly mix beans and maize or groundnut and yam or cassava.

Mulching as a process of covering the soil surface around the plants in order to create favourable conditions for the crop growth is practiced by some farmers in the Niger Delta region. This includes moisture and soil conservation, temperature moderation, salinity and weed control etc. Ideally, mulching has a significant effect on earliness, yield and quality of the crop. Types of mulching materials used may be organic plant residues, insert material like pebble etc. or and synthetic materials like plastics.

Table 6.13: Percentage Distribution of Respondents' experience on adopting mulching as a strategy for adapting to climate change disasters and its effectiveness

Ecological Zones	Yes	No	Effective	Not effective	Not applicable
Mangrove Swamp	35.2	64.8	26.9	8.8	64.4
Freshwater Swamp	40.8	59.2	34.6	6.5	58.9
Lowland Rainforest	38.6	61.4	35.6	3.0	61.4

Table 6.13 shows that a significant proportion of the respondents indicated that they are adopting mulching as a strategy for adapting to climate change, although the vast majority of them do not. A significant proportion of those adopting mulching reported that it was effective. Some respondents also reported that they use plastic mulch, in a similar fashion to mulch, to suppress weeds and conserve water in crop production and landscaping. Table 14 however indicates the vast majority of the respondents do not use plastic culture as a strategy for adapting to climate change.

Table 6.14: Percentage Distribution of Respondents' experience on adopting plastic culture as a strategy for adapting to climate change disasters and its effectiveness

Ecological Zones	Yes	No	Effective	Not effective	Not applicable
Mangrove Swamp	24.1	75.9	17.6	6.9	75.4
Freshwater Swamp	24.5	75.5	20.3	4.7	75.1
Lowland Rainforest	51.3	48.7	49.8	1.7	48.5

In view of the generally lowland nature of the Niger Delta region, terrace and contour farming as a strategy of adaptation to climate change is not popular. Tables 6.15 and 6.16 show that the vast majority of the respondents (over 77 per cent) do not adopt terrace and contour farming strategies because the environment in most of the ecological zone do not make such farming approaches necessary.

Table 6.15: Percentage Distribution of Respondents' experience on adopting terracing as a strategy for adapting to climate change disasters and its effectiveness

Ecological Zones	Yes	No	Effective	Not effective	Not applicable
Mangrove Swamp	23.6	76.4	16.8	7.5	75.7
Freshwater Swamp	23.3	76.7	17.0	6.5	76.5
Lowland Rainforest	11.3	88.8	10.9	0.4	88.7

Table 6.16: Percentage Distribution of Respondents' experience on adopting contour farming as a strategy for adapting to climate change disasters and its effectiveness

Ecological Zones	Yes	No	Effective	Not effective	Not applicable
Mangrove Swamp	21.6	78.4	16.6	5.5	77.9
Freshwater Swamp	22.3	77.7	15.8	6.9	77.3
Lowland Rainforest	8.7	91.3	8.0	1.0	91.0

Dry land farming in most of the communities in the three ecological zones of the Niger Delta region is made possible mainly by the fallow system of farming, a practice dating from ancient times. The system is necessary because in the process of field fallow the soil replenish with nutrients. Crop rotation is closely associated with the fallow system. Crop rotation helps to battle against the forces of erosion. Rotating crops helps to improve soil stability by alternating between crops with deep roots and those with shallow roots. Pests are also deterred by eliminating their food source on a regular basis. Tables 6.17 and 6.18 show that these systems of farming which the respondents use to compact the impacts of climate change on their livelihood are practised by the

vast majority of the respondents in the Lowland Rainforest and to some extent in the two other zones.

Table 6.17: Percentage Distribution of Respondents' experience on adopting bush fallowing as a strategy for adapting to climate change disasters and its effectiveness

Ecological Zones	Yes	No	Effective	Not effective	Not applicable
Mangrove Swamp	39.6	60.4	34.6	4.8	60.6
Freshwater Swamp	48.1	51.9	41.2	6.9	51.9
Lowland Rainforest	81.3	18.8	76.8	4.5	18.8

Table 6.18: Percentage Distribution of Respondents' experience on adopting crop rotation as a strategy for adapting to climate change disasters and its effectiveness

Ecological Zones	Yes	No	Effective	Not effective	Not applicable
Mangrove Swamp	56.6	43.4	53.7	3.2	43.1
Freshwater Swamp	61.9	38.1	55.9	6.1	38.0
Lowland Rainforest	83.4	16.6	82.1	1.3	16.6

Use of Fertilizers

The major reason for bush fallowing as revealed by the respondents was to restore soil fertility that is normally lost from excessive farming and soil erosion. In addition, farmers use different ways to manage their farms. Some of them use local manure from livestock. Apart from this, very few of the respondents use industrial fertiliser, pesticides, certified seeds and pesticides. Although the chemicals applied in these crops, are said to have positive impact to crop production; the challenge is how to minimize their associated negative effects and cope with environmental management aspects. However, as stated above few farmers do apply modern methods for soil conservations; there is a need to sensitize famers on the need for soil conservation. Some farmers indicated that, they would have also liked to use fertilisers but they cannot afford to buy. So they normally just plant the seeds and hope for the best which does not work in most cases. Most famers in the target communities rarely use modern farm management practices such as organic mature, pesticides, traditional and certified seeds, or chemical fertiliser. There is the need to find ways to assist famers to apply modern methods for agriculture inputs as this is a major way their adaptive capacity can be enhanced in the face of climate change. Although such application of modern agricultural inputs requires huge investments in terms of agricultural inputs subsidies, extension services and capacity development among others the government needs to focus on these areas so as to improve the adaptive capability of the people.

Table 6.19: Percentage Distribution of Respondents' experience on adopting use of fertilisers as a strategy for adapting to climate change disasters and its effectiveness

Ecological Zones	Yes	No	Effective	Not effective	Not applicable
Mangrove Swamp	32.9	67.1	24.2	9.1	66.8
Freshwater Swamp	52.5	47.5	46.3	6.8	47.0
Lowland Rainforest	64.4	35.6	58.8	5.8	35.5

Irrigation farming

Food production in the Niger Delta region still relies almost exclusively on rain-fed agriculture, leaving farmers and rural communities vulnerable to increasingly erratic rainfall patterns and extreme climate conditions. Yet there is vast potential to scale up irrigation to increase crop yields and improve resilience to climate shocks. Although irrigation in the communities of the Niger Delta region has the potential to boost agricultural productivities by at least 50 percent, food production on the region is almost entirely rain fed. The area equipped for irrigation, currently slightly more than 13 million hectares, makes up just 6 percent of the total cultivated area. Irrigation farming is being used in some communities. There are various forms of irrigation that are being used by farmers, but this is done in a very small scale when compared to the demand for irrigation. Many small scale farmers do not have financial means to install an irrigation system in their small farms. As a result, many tend to farm near the rivers using the flood water for dry season farming. Others resulted to the use of buckets while very few employ the use of pumping machines for dry season farming

Variations in ecological adaptation strategies are noticed in the communities of the different ecological zones. Table 6.20 shows that a significant proportion of the respondents in the Mangrove Swamp and Freshwater Swamp reported that they adopt irrigation as a strategy for adapting to climate change with limited effect. On the other hand only an insignificant proportion of the respondents in the Lowland Rain forest ecological zone have adopted irrigation as a strategy for adapting to climate change. This can be explained by the financial challenges of developing an irrigation system in the upland area of the Niger Delta region where access to river and water basins are quite far. This places the Mangrove Swamp and Freshwater Swamp at an advantage in carrying out small scale irrigation farming system because of the accessibility of rivers and water basins.

Table 6.20: Percentage Distribution of Respondents' experience on adopting irrigation as a strategy for adapting to climate change disasters and its effectiveness

Ecological Zones	Yes	No	Effective	Not effective	Not applicable
Mangrove Swamp	24.6	72.0	14.3	10.6	75.0
Freshwater Swamp	38.2	61.8	28.2	10.1	61.8
Lowland Rainforest	11.5	88.5	9.7	2.0	88.3

Planting early enables farmers to capitalize on initial rains to grow a full complement of crops. The farmers know they risk the replanting if rain break for more than two weeks damaging the planted crops.

Table 6.21: Percentage Distribution of Respondents' experience on adopting early planting as a strategy for adapting to climate change disasters and its effectiveness

Ecological Zones	Yes	No	Effective	Not effective	Not applicable
Mangrove Swamp	66.2	33.8	62.9	3.5	33.6
Freshwater Swamp	84.3	15.8	76.5	7.9	15.6
Lowland Rainforest	95.1	4.9	92.3	2.9	4.8

Crop rotation which is the practice of growing a series of dissimilar or different types of crops in the same area in sequenced seasons is practiced by many small scale farmers in the Niger Delta region. It is done so that the soil of farms is not used for only one set of nutrients. In general, crop sequences that take advantage of multiple opportunities to suppress and remove weeds from the field are expected to will improve weed management on the farm. Table 6.22 shows that the vast majority of the respondents in the three ecological zones indicated that they are adopting seasonal rotation as a strategy for adapting to climate change in their communities and most of them equally reported that the strategy has been effective.

Table 6.22: Percentage Distribution of Respondents' experience on adopting seasonal rotation as a strategy for adapting to climate change disasters and its effectiveness

Ecological Zones	Yes	No	Effective	Not effective	Not applicable
Mangrove Swamp	56.6	43.4	53.3	4.0	42.8
Freshwater Swamp	65.3	34.7	55.8	9.6	34.6
Lowland Rainforest	73.1	26.9	67.7	5.4	26.9

Another key component of adaptation strategy used by respondents relates to switching from one agricultural activity to another in response to the peculiarities of the locality. Table 6.23 shows that switching from fishing to farming is only significantly practices by respondents in the Mangrove Swamp ecological zone while in the other two zones it is basically not practiced. It shows that the opportunities for farming are being used by those involved in small scale fishing in view of the impact of climate change. It appears that virtually all the respondents in the Freshwater Swamp and Lowland Rainforests do not have the opportunities of switching from fishing to crop farming because most of them are crop famers rather than being involved in fishing. Again Table 6.24 shows that a significant proportion of the respondents (26.8 per cent) in the Mangrove Swamp zone indicated that they have changed from fishing to non-farm activities as a strategy for adapting to climate change compared with the respondents in the Freshwater

Swamp and Lowland Rainforest ecological zones where less than 10 per cent reported switching to non-farm activities. This shows that there is more pressure on farmers and those fishing in the Mangrove Swamp ecological zone compare to those in the two other ecological zones.

Table 6.23: Percentage Distribution of Respondents' experience on adopting changing from fishing to crop farming as a strategy for adapting to climate change disasters and its effectiveness

Ecological Zones	Yes	No	Effective	Not effective	Not applicable
Mangrove Swamp	26.8	73.2	24.3	3.2	72.6
Freshwater Swamp	5.4	94.6	3.6	1.8	94.6
Lowland Rainforest	7.1	92.9	6.3	0.8	92.9

Table 6.24: Percentage Distribution of Respondents' experience on adopting changing from fishing to non-farm activities as a strategy for adapting to climate change disasters and its effectiveness

Ecological Zones	Yes	No	Effective	Not effective	Not applicable
Mangrove Swamp	28.6	71.4	25.2	4.3	70.6
Freshwater Swamp	4.1	95.9	2.8	1.3	95.9
Lowland Rainforest	4.7	95.3	3.9	0.9	95.2

Table 6.25 shows that few respondents reported that they changed from fishing to livestock farming in the three ecological zones which suggests that livestock farming is not a significant agricultural activity which can provide a sustainable livelihood to households except some support is provided to improve the situation. Table 6.26 again differentiates the Mangrove Swamp ecological zone from the other two zones in terms of respondents' adopting hunting for different types of fish as a strategy for adapting to climate change. While over 40 per cent of the respondents in the Mangrove Swamp ecological zone reported that they have adopted hunting for different types of fish as a strategy for adapting to climate change, less than 5 per cent of those in the Freshwater Swamp and Lowland Rainforest ecological zones reported adopting hunting for different types of fish as their response to climate change.

Table 6.25: Percentage Distribution of Respondents' experience on adopting changing from fishing to livestock farming as a strategy for adapting to climate change disasters and its effectiveness

Ecological Zones	Yes	No	Effective	Not effective	Not applicable
Mangrove Swamp	17.9	82.1	14.1	4.3	81.6
Freshwater Swamp	1.7	98.3	1.0	0.7	98.3
Lowland Rainforest	4.1	95.9	4.0	0.2	95.8

Table 6.26: Percentage Distribution of Respondents' experience on adopting hunting for different types of fish as a strategy for adapting to climate change disasters and its effectiveness

Ecological Zones	Yes	No	Effective	Not effective	Not applicable
Mangrove Swamp	40.6	59.4	38.3	2.7	59.1
Freshwater Swamp	4.9	95.1	3.2	1.8	95.0
Lowland Rainforest	11.7	88.3	11.2	0.5	88.3

With climate change and oil exploration having considerable impact on fishing in the rivers and ocean shores of the Niger Deltas region, those involved primarily in fishing have adjusted to the challenges by fishing further ashore as a strategy for adapting to climate change. Table 6.27 shows that this strategy is only relevant in the Mangrove Swamp ecological zone where about 35 per cent of the respondents indicated that they practised fishing further ashore in response to the challenges of climate change compared with less than 5 per cent of the respondents in the other two ecological zones. Again this situation can be explained by the fact that fishing is the dominant activity in the Mangrove Swamp ecological zone compared with those of the Freshwater Swamp and Lowland Rainforest zones where a greater proportion of the households are crop farmers. Furthermore, Table 6.28 shows that adopting relocation to a different fishing ground as a strategy for adaptation to climate change is significant mainly in the Mangrove Swamp ecological zone where about 40 per cent reported as such compared with the two other ecological zones where less than 10 per cent of the respondents are so involved in that strategy.

Table 6.27: Percentage Distribution of Respondents' experience on fishing further ashore as a strategy for adapting to climate change disasters and its effectiveness

Ecological Zones	Yes	No	Effective	Not effective	Not applicable
Mangrove Swamp	34.6	65.4	29.9	4.9	65.2
Freshwater Swamp	3.4	96.6	2.1	1.4	96.5
Lowland Rainforest	4.5	95.5	4.3	0.3	95.4

Table 6.28: Percentage Distribution of Respondents' experience on adopting relocation to a different fishing ground as a strategy for adapting to climate change disasters and its effectiveness

Ecological Zones	Yes	No	Effective	Not effective	Not applicable
Mangrove Swamp	39.7	60.3	37.4	2.7	59.9
Freshwater Swamp	4.3	95.7	2.7	1.8	95.6
Lowland Rainforest	6.5	93.5	5.3	1.3	93.4

Table 6.29: Percentage Distribution of Respondents' experience on adopting combining fishing with crop farming as a strategy for adapting to climate change disasters and its effectiveness

Ecological Zones	Yes	No	Effective	Not effective	Not applicable
Mangrove Swamp	36.4	63.6	33.4	3.0	63.6
Freshwater Swamp	9.0	91.0	7.4	1.9	90.7
Lowland Rainforest	10.2	89.8	9.8	0.6	89.7

Small scale farmers combining fishing with crop farming is a common strategy of adaptation to climate change in the Niger Delta region. The findings of the survey shows that a higher proportion of the respondents that indicated combining fishing with crop farming are in the Mangrove Swamp ecological zone compared with the situation in the Freshwater Swamp and Lowland Rainforest ecological zones where less than 5 per cent of the respondents are so involved. This can again be explained by the fact that it is easier for households in the Mangrove Swamp ecological zone to practice both fishing and farming compared with those in the two other ecological zones because climate change has resulted in most of the rivers and waters in them receding making it difficult for fishing to take place without some support. Finally, in the same vain Tables 6.29 6.30 and 6.31 show that combining the three activities of fishing with livestock farming fishing with crop farming and fishing with livestock farming are only significant in the Mangrove Swamp ecological zone with over 15 per cent of the respondents compared with the two other zones which have less than 10 per cent of the respondents in the same category.

Table 6.30: Percentage Distribution of Respondents' experience on adopting combined fishing with livestock farming as a strategy for adapting to climate change disasters and its effectiveness

Ecological Zones	Yes	No	Effective	Not effective	Not applicable
Mangrove Swamp	18.8	81.3	14.3	4.9	80.8
Freshwater Swamp	3.1	96.9	1.6	1.6	96.8
Lowland Rainforest	4.5	95.5	4.3	0.3	95.4

Table 6.31: Percentage Distribution of Respondents' experience on adopting combined fishing with crop and livestock farming as a strategy for adapting to climate change disasters and its effectiveness

Ecological Zones	Yes	No	Effective	Not effective	Not applicable
Mangrove Swamp	15.6	84.4	11.3	4.8	83.9
Freshwater Swamp	3.2	96.8	1.9	1.4	96.7
Lowland Rainforest	6.1	93.9	5.8	0.5	93.8

Constraints to Adaptation

Considering the magnitude of the impacts of climate change in Delta State, adaptation is expected to be fraught with myriads of challenges. The results of this study identified factors which respondents considered as constraints to the adoption of the various adaptation options identified. Fifteen of these were rated as critical from the perception of the respondents. The most critical was the governments' unresponsiveness to climate risk management. This is not surprising as the Niger delta communities expect governments at all levels to drive the process of adaptation to climate change impacts. The next most critical constraints, in descending order, were: limited availability of land for farming, lack of access to credit facilities, limited income and lack of Government presence among others.

Chapter 7

Empowerment of Women to Play Key Roles on Climate Change Adaptation

The gender question in the Niger Delta region like the larger Nigerian society is historically, a socio-cultural phenomenon which denigrates the female person (whether as a girl-child, or adult woman) as an inferior and weak human-being who is incapable of participating in leadership; while her male counterpart is celebrated as the superior person, imbued with all the potentials for leadership. The Nigerian woman was thus utterly subjugated to the male authority of her father, her brother, and her husband and who, severally dominated her with paternal power. She was so virtually depersonalized that she was categorized into disempowered group. The situation is gradually changing but a lot needs to be done as the data collected during this survey show as presented in this chapter.

Decision Making and the Limited Role of Women

Farming households and their decision-making process are central to the development challenge of alleviating rural poverty as well as responding to the challenges of climate change. On a daily basis, households have to make decisions about the allocation of their labour, land, water and capital resources between the different income earning activities. Decisions are often taken by different household members. An individual's ability to participate in, influence and benefit from decision-making varies within households and between communities. Older men usually take the lead in community decision-making, with women and younger men tending to have a very limited say in decisions, be it within their families or communities. Typically, older men are granted greater authority in community decisions, with men generally having the responsibility for household decision-making. Household dynamics vary, however, and can sometimes contrast with traditional social norms. How these household dynamics are negotiated is difficult to explore but important to address when promoting gender equality and implementing appropriate adaptation activities.

The findings from the household survey and focus group discussions in various communities in the three ecological zones of Delta State show that both men and women reported taking part in key decisions including those entailing actions to adapt to climate change. The issues women had with respect to tradition and culture were expressed in terms of male sexual behaviour (multi-partner relationships, keeping of multiple wives and concubines, and fathering many children). Women also spoke consistently and vehemently about the degrading widow rites to which they were subject. Falling under the rubric of culture (customary law) but viewed as a separate issue by women was women's "inability" to inherit land. Perhaps women's sense of injustice steams from the possibility that women may be allowed to inherit under customary law, but in practice women's rights to inheritance are overridden in favour of the husband's family.

Exclusion from Decision-making by women was expressed in terms of women being marginalized from participation in political structures as well as tribal and community councils. It was also expressed in terms of women not being able to negotiate with the oil companies directly and therefore women felt they were unable to access the community funds and jobs that were

provided in concessions. This was also expressed in terms of traditional leaders appointing women "leaders" who did not represent the needs and interests of women. Women felt there was no authentic voice for positive change for women.

During the focus group discussions, joint decision-making was the most frequent response to most of the intra-household decisions discussed in both groups. Comparing women's and men's perception of joint decision-making, the decisions on 'when to harvest', 'to hire labour' and 'to start a new agricultural practice' were perceived more frequently as joint by men than by women. Women explained that since they were more often in the field, they knew when harvest was ready and thus starting to harvest was a decision they could take individually. In contrast, hiring labour was perceived as a decision taken individually by their male spouses: *'it is men who normally keep our money and savings, so he sees what we have and decides'*. Similarly for the adoption of new practices, women explained that men were normally more mobile and had opportunities to identify new technologies so they were the ones that decided to implement them.

In contrast, decisions regarding 'what and where to plant' and 'to sell land' were more frequently perceived as joint by women than by men. Elaborating why the decision of what to plant was perceived as joint, one woman explained: *'men always dictate, when you come up with your idea, they don't normally accept it if it does not side with theirs'*. This perception of a joint decision implied that a female spouse was able to raise her opinions, although the male spouse was the ultimate decision-maker. For the same type of decision, what to plant, the men explained that since it was their land, they decided*: 'the woman does not know my land, it's me to plan and she should just plant where I show her'*. In this case, we see that while men consider that it is their decision because they tell their wives where to plant, many women perceived this as a joint decision as there is an interaction between spouses in the same physical location.

Finally, the discussions reveal that women were perceived mostly as decision makers conjointly with their spouses but rarely individually, as observed by their partners. Male spouses perceived women having sole decision-making power only for responsibilities of which women are traditionally in charge, namely cooking and weeding. This contrasts with women's perceptions of their own decision-making authority. Women saw themselves more often as having sole decision-making authority in particular for some crop production and land management decisions (for example, clearing the land, leaving land fallow, start planting, hiring labour). These gender differences in perceptions were particularly strong with regard to the decision over when to harvest, with most of the women associating it as their own decision and none of the men perceiving women as sole decision makers.

Climate change effects vary among regions, generations, age, classes, income groups, occupations and gender. There are, however, several ways of promoting women's economic participation while also counteracting climate change. Women in rural areas in Niger Delta region are the principle producers of basic foods and have thus taken action to conserve soil and water. Various examples in different communities in the Niger Delta region exist where women's knowledge and activism have helped to control erosion, prevent flood damage, and improve access to water. Women should be included in decision-making in order to allow their knowledge to benefit entire communities. Knowledge of how women are affected by climate change is essential for their effective involvement in the climate change

response and for harnessing their capacity for appropriate adaptation action. Women also function as change agents in community natural resource management, innovation, farming and care giving and hold the key to adaptation to climate change. Responsibilities in households, communities and as stewards of natural resources position them well to developing strategies for adapting to changing environmental realities. Experience has shown that communities fare better during natural disaster when women play a leadership role in early warning systems and reconstruction. Women tend to share information related to community well being, choose less polluting energy sources, and adapt more easily to environmental changes when their family's survival is at stake.

Ways of Strengthening Economic Empowerment of Rural Women for Climate Change Adaptation

The empowerment of women will significantly enhance the efficiency of adaptation and mitigation efforts at all levels. By significantly increasing the number of women in decision-making, and drawing on their gender-based experiences in the formal and informal workforces, communities, and households, climate responses can be more effective, sustainable, and fair. Investing in women will enormously benefit communities as a whole due to the role that women play in production and reproduction within and outside the household. For these reasons, decision makers and development partners at all levels need to integrate gender perspectives into the planning, financing, implementation, and monitoring and evaluation of climate responses

The survey attempted to gauge the opinions of respondents with respect to their support for women to play key roles in climate change adaptation strategies within their communities. There was a general agreement by both male and females that women can play key roles in climate change adaption activities in their communities. Table 7.1 shows the respondents' identification of the various ways in which women can be involved in promoting community-based climate change adaptation activities. The respondents pointed out that women can play key roles such as women mobilisation, educating other women, acting as change agents in their communities, mentoring other women, awareness creation, climate change advocacy with policy makers and participating in climate change adaptation actions. The vast proportion of the respondents pointed out that the best results of women participation in climate change adaptation would be achieved if all the identified roles are carried out by women simultaneously.

Table 7.1: Percentage Distribution of Respondents' identification of the leadership roles women can play in promoting community-based climate change adaptation and disaster risks reduction

Ecological Zones	Women mobilisation	Educating other women	Act as change agents	Mentoring women	Awareness creation	Climate change advocacy	Getting involved in climate change actions	All the above
Mangrove Swamp	6.3	5.3	0.6	2.0	4.6	0.3	1.2	79.7
Freshwater Swamp	7.5	8.2	0.3	2.1	9.5	0.6	1.2	70.8
Lowland Rainforest	4.5	6.6	0.9	1.5	2.1	0.3	0.8	81.3

Table 7.2 shows respondents' identification of the specific roles which they suggest women can play in the promotion of climate change adaptation in their localities. The table shows that respondents in the three ecological zones identified specific roles which they think women should play in climate change adaptation including household dietary management, proper child care system, augmenting family income, conservation of resources, energy management and creating awareness and advocacy. The vast majority of the respondents pointed out that all the suggested roles have to be played with women before their impact on climate change adaptation can be effective.

Table 7.2: Percentage Distribution of Respondents' identification of specific roles women can play in climate change adaptation and disaster risks reduction

Ecological Zones	Household dietary management	Proper child care system	Augmenting family income	Conservation of resources (water, soil, forest)	Energy management	Creating awareness	Advocacy	All of the above
Mangrove Swamp	3.7	2.5	2.6	2.0	0.8	8.4	0.2	79.8
Freshwater Swamp	3.7	4.9	4.9	2.1	0.8	17.7	0.4	65.7
Lowland Rainforest	2.2	2.5	1.7	3.3	3.2	17.3	0.3	75.9

Table 7.3 indicates that respondents identified some benefits which could accrue to their communities if women are empowered to lead community-based climate change adaptation initiatives. Amongst the benefits identified by the respondents across the three ecological zones are improved household income, reduction of outmigration, disaster preparedness, Conservation of biodiversity, increased awareness of climate change and provision of care. Again the vast majority of the respondents pointed out that a combination of all the identified benefits would be achieved if women are propelled to lead community-based climate change.

Table 7.3: Percentage Distribution of Respondents' identification of perceive benefits of women-led community-based initiatives in climate change adaptation and disaster risks reduction

Ecological Zones	Improved household income	Reduction of out migration	Disaster preparedness	Conservation of biodiversity	Increased awareness of climate change disaster	Provision of care to affected household members	Combination of some of the above
Mangrove Swamp	6.8	1.4	5.0	0.7	3.8	3.0	79.3
Freshwater Swamp	9.8	1.7	3.0	0.5	10.7	1.8	75.8
Lowland Rainforest	7.9	1.3	1.1	0.3	7.2	3.0	78.6

Effective climate information services rely upon locally relevant climate data tailored to farmers' needs. Generally, women's vulnerability and needs with respect to climate change indicates that men and women have different climate information needs. Although women had their own plots to cultivate, their male counterparts tend to control the production inputs. As a result, women tend to plant and harvest much later in the season than men. This explains the fact that the onset date of the rainy season is more important to male farmers and the date of seasonal rainfall cessation more useful to women.

Table 7.4: Percentage Distribution of Respondents' identification of ways of improving women's access to information on climate change adaptation and disaster risks reduction

Ecological Zones	Intensification of agricultural practices	Dissemination of climate change information in local languages	Dissemination of climate change information in electronic media	Participation in community based women activities	Use of town criers	Seminars and workshops	Use of interpersonal communications	Combination of some of the above
Mangrove Swamp	2.2	10.4	3.4	2.9	2.2	5.6	0.7	71.9
Freshwater Swamp	2.3	16.3	2.6	1.7	7.5	10.7	0.9	61.2
Lowland Rainforest	4.6	11.6	1.2	3.5	3.2	1.3	0.8	65.3

It is in this context that Table 7.4 shows the respondents were asked to identify ways of improving women's access to information on climate change adaptation strategies. The findings as reported in the table show that respondents identified a variety of ways including intensification of agricultural practices, dissemination of climate change information in local languages, dissemination of climate change information in electronic media, Participation in community based women activities, Use of town criers, Seminars and workshops and Use of interpersonal communications. Table further shows that the vast majority of the respondents in the three ecological zones belief that a combination of the various ways identified should be used.

An examination of the literature indicates some measures which must be put in place to empower women so that they can play key roles in climate change adaptation in their communities. These are summarised below:

Access to education, training and upgrading: In the context of climate, measures designed for training and continuing education could be particularly significant in the following areas:

- Awareness of the causes and consequences of climate change in order to sensitize rural women on the dangers of climate change and to the possible requirements/mechanisms of adaptation
- Awareness of existing mitigation and adaptation programmes in which rural women can be involved and from which they can benefit.

- Training programmes on adaptation measures with a special focus on the needs of rural women (example, alternative cultivation methods and more resistant crops in agriculture, more efficient domestic and agricultural use of available water resources, alternative sources of domestic energy).
- Training programmes on the use of (new) technologies (example, means of agricultural production, energy-efficient cooking stoves and ovens, renewable energy systems, information and communication technologies).
- Awareness of existing rights and laying claim to these rights in different spheres of life (example, land ownership or land use rights, ownership rights for means of production).

Access to and control over productive resources (**access to land and ownership rights)** This is important because it will help them to:
- own land and be able to use it according to one's own needs and wishes in order to be active in climate mitigation and adaptation.
- procure, own and be able to use the means of production, particularly new technologies, and the related technical know-how.
- obtain, own, and be able to deploy financial capital for one's own undertakings in order to have investments available for the adoption or development of climate-related work.

Access to services
- to have access to (medical) care and child-care services in order to ease the burden on women, reduce time poverty, and gain more time for income-generating activities.
- to have access to the (agricultural) extension services required, for example, to expand agricultural production or nature and resource conservation work.
- to be able to formalise one's own enterprise, which involves neither a great deal of time nor money.

Access to markets (**land, labour, financial and product markets) -** In this context implies:
- to be able to acquire (additional) land or sell it.
- to be able to use one's own labour in the formal and informal labour markets, to have access to loans and funds and, in the context of climate, access to international climate finance mechanisms (e.g., climate funds).
- to be able to access product markets to sell one's own products and so have access to the information required about market prices and trading options.

Table 7.5: Percentage Distribution of Respondents' identification of how women can be empowered to play key roles in climate change adaptation and disaster risks reduction

Ecological Zones	Access to farm inputs	Access to climate information	Access to training	Access to extension services	Access to credit	Freedom from traditional and cultural barriers	Access to farm inputs, climate information and training
Mangrove Swamp	1.3	3.3	5.8	1.8	2.1	1.5	82.4
Freshwater Swamp	1.3	8.4	3.4	0.1	10.6	0.6	61.6
Lowland Rainforest	0.9	2.1	2.7	0.4	6.1	0.8	86.6

It is against this background that Tables 7.5 and 7.6 shows that respondents identified several relevant empowerment actions which need to be put in place to make women play major roles in climate adaption and disaster risks reduction in their communities. The empowerment actions recommended include improved access to farm inputs, access to climate information, access to training, access to extension services, access to credit and freedom from traditional and cultural barriers. Table 7.5 emphasizes the fact that the respondents indicated that a combination of the various actions identified must be provided if women are to play a major role in climate change adaption. In other words, providing one or two of the identified action is not adequate.

Table 7.6: Percentage Distribution of Respondents' identification of ways of building women's capacity to take leadership roles in promoting community-based climate change adaptation and disaster risks reduction

Ecological Zones	Exposure to training	Engaging women as trainers	Encouraging girl child education	Improving access to credit facilities	Combination of some of the above
Mangrove Swamp	10.5	2.3	3.4	0.7	72.7
Freshwater Swamp	3.0	8.0	5.2	3.8	77.2
Lowland Rainforest	6.2	1.5	1.3	0.8	76.9

Chapter 8

Conclusions and Implications for Interventions and Policy

Perspectives on the Findings of this Study

Reasonable proportion of the respondents in the various communities has some rudimental knowledge of climate change, its causes, and impacts. Climatic data analysis of rainfall amount, rainy days and mean air temperature confirm strong signals of evidence of climate change in Delta State. Respondents perceived climate change as unpredictable rainfall patterns, heat stress, late onset of rains and high intensity rainstorms among others.

Climate change hazards/impacts identified in the study area include accelerated gully erosion, landslide, flooding, heat stress, changes in the onset and cessation of rainfall, and windstorm damage among others. Vulnerability of households to the impacts of climate change in the study area is determined by age of household head, access to credit, income of household, dependency ratio, values of farm output, land One important finding of this study is that a large percentage of Delta State population lack science-based knowledge of climate change, although they could finger its impacts. Therefore, rigorous awareness creation using science-based information is suggested as the starting point for policy aimed at effective adaptation by all stakeholders to climate variability. Due to the religious nature of the people, it is suggested that religious institutions be employed, alongside other outlets, to disseminate climate change information as is done with HIV/AIDS, Polio, Immunization and Roll Back Malaria Programmes.

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

ownership status and medical expenses. Men and women are equally vulnerable to the impacts of climate change. The cost of impacts of climate change hazards such as flooding, erosion and heat was higher for women than for men. Also the cost of adaptation to climate change impact was higher for women than for men.

Measures taken by communities to adapt to climate change include economic diversification, dry season farming, late crops planting, agricultural diversification, mixed cropping, planting on ridges and mounds and netting of fish ponds, and construction of gutters and flood reception pits among others.

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

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

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

Implications for Women-led Adaptation Strategies

There are two relevant implications of the knowledge generated in this study for women's participation in climate change adaptation in Niger Delta region.

The first relates to the implications of the findings for the empowerment of women to play key roles in climate change adaptation. Elements of the following strategies need to be followed in the implementation of the intervention component of the project.

1. *Activities that work with women and girls to challenge traditional gender norms as they relate to women*. This type of programming aims to challenge traditional gender norms that limit women's expectations of themselves and their role in the family, the community and their country. Such programming tends to seek to "empower" women and to help women and girls seek alternatives to harmful cultural practices such as early marriage, early first births and traditional roles that circumscribe their full participation in society. This type of programming may assist women by providing "empowerment" including leadership training, public speaking

skills and negotiation skills. Similarly they often work to move women into "non-traditional" roles by providing vocational skills training and business skills.

2. *Activities that work with men and boys to challenge traditional gender norms as they relate to women*. This type of programming was developed in response to the limitations that appeared in programs that only focused on women. This type of programming is designed to help men change their attitudes and expectations of women to promote more gender equitable gender norms. Much of this type of programming tries to encourage men to value women and girls, educate girls, avoid early and forced marriages, "allow" their wives to participate in community development programmes. Many of these programs focus on a specific topic such as working with men to stop gender based violence or to promote the use of family planning services. This type of programming is usually what people refer to as the "constructive engagement of men and boys" in women's empowerment.

3. Activities that work with men and boys and women and girls together to challenge traditional gender norms as they relate to women. This type of programming brings boys and girls together to investigate traditional gender norms as they relate to girls. It reflects a different methodology from the programs described above.

4. Programs that work with men and boys to challenge traditional gender norms as they relate to men. These activities focus on helping men and boys critically reflect upon the socially constructed notions of masculinity and what it means to be a man in a given culture. They are designed to help men understand the negative health and social outcomes of masculinities. To help men and boys acknowledge that there are negative outcomes that are associated with masculinities such as being tough, in control, not seeking help and having multiple sex partners. These activities are often aimed at promote more health seeking behaviours for men and to enable men to create more healthy constructions of manhood.

Secondly the findings have implications for the promotion of relevant and women led adaptation activities. In all the three ecological zones in Delta state, most farmers reported that they had noticed changes in climatic conditions over the last 10 years, with more than 60% reporting increase in temperature and changes in rainfall patterns. However, it is clear that the respondents' perceptions of climate change, regardless of whether these are correct or not, are already causing some of them to change their agricultural practices and have important consequences for their livelihoods. Moreover, farmer perceptions of climate change are important factors driving the adoption of different livelihoods strategies and adaptation measures.

However, while a significant proportion of the respondents in the three ecological zones already perceive the impacts of climate change, only a relatively small proportion have changed their farming systems in response to these changes. The limited uptake of adaptation strategies by farmers is probably due to the high levels of household food insecurity, which make it risky for farmers to adopt new strategies that may affect their agricultural production and food availability. In addition, most farmers in the study area simply lack the resources needed to implement adaptation measures. The fact that the use of adaptation measures was positively correlated with farmer education level, use of diversified agricultural practices, diversified cropping systems and livestock ownership indicate that farmers who are better educated and already have more diversified systems are more likely to be willing to adopt new strategies. Other studies have

similarly highlighted the importance of educational level, wealth, access to credit and information, extension services, safety nets, resources and adequate agricultural inputs and technologies in increasing the probability of uptake of adaptation measures by smallholder farmers

To assist the communities adapt to identified hazards such as flooding, windstorms, drying up of rivers, erosion and sea level rise, early warning system for extreme climate events need to be established at community level. Without this warning system, such events could destroy crops and livestock that people rely on for livelihoods. Emergency evacuation systems should be established al local level to evacuate communities during extreme climate events. Adaptation to climate change at the local level requires capacity development including economic empowerment. Income generation opportunities and income support programmes and capacity building on enterprise development and management are essential as this will enable the farmers and fisher folks to diversify their income sources in order to reduce their vulnerability to climate change.

Certain cultural practices such as hand irrigation, land augment/management with fertilizer, planting on mounds/ridges and planting shade trees need be improved upon and scaled up. Irrigation schemes should be established so that water is available for farming purposes. This requires the preparation and implementation of community-based climate change adaptation plans entailing the participation of the key stakeholders.

Implications for Policy

We suggest four potential areas for policymakers to pursue that could help to increase agricultural productivity and improve livelihoods in the short term. First, there is an urgent need to improve farmer extension services to provide technical information and training on the best management practices for planting, harvesting and crop storage, to facilitate the adoption of new management practices and to encourage farmer-to-farmer learning. Strengthening extension services has been shown to be particularly effective at convincing farmers to change farming practices in response to climate change. Our results show that less than 10% of farmers currently have access to technical support on agriculture and that the adoption of management practices aimed at reducing vulnerability to climate risks is low, despite the prevalence of these risks. These results indicate that there is significant scope for relatively low-cost farmer extension services to improve the uptake of such practices and provide ongoing technical support. For example, changes in crop planting schedules, management practices and varieties used, as well as the diversification of crops planted, are all low-cost options for reducing agricultural risk, which could be widely promoted through extension services and communication campaigns. Careful screening of these strategies and participatory action-oriented research with farmers will be needed to jointly identify and implement adaptation options that are feasible and effective and to ensure that these strategies do not have any negative or unexpected impacts on farmer livelihoods.

The second low-cost opportunity for policymakers is to invest in small-scale infrastructure, such as improved irrigation systems or crop storage facilities, which can help farmers to increase production and better protect their harvests. Smallholder farmers are very keen to build local infrastructure but rarely have the necessary capital to finance these activities. Governments and organizations working in remote areas should seek to further promote such small-scale

infrastructure through the development of small-scale grants and credit to farmers or local farmer associations.

The third option for improving farmer livelihoods is to increase access to credit and safety nets during lean periods and following catastrophic events, such as extreme weather events or disease and pest outbreaks. In these extreme situations, many farmers currently depend on informal support from families and friends, as formal safety nets are lacking. There is a critical need to establish formal safety nets and also strengthen informal safety networks to ensure that farmers can access support when they need it. In addition, more innovative solutions are needed to facilitate access of farmers to financial services in terms of need. New services, such as mobile telephone payment systems that are now available even in remote areas, provide an important new, cheap and secure way for family and friends to exchange money even when they are not physically close to each other. Governments should work with the private sector mobile telephone companies to improve mobile coverage and low cost access to such services. Community savings and loans groups in which members pool resources and lend to members in need are also a low-cost solution that could help to reduce the worst impacts of the lean season or extreme weather events, while creating local funds that farmers can tap into for other development activities.

The final priority for policymakers is to safeguard the natural ecosystems that smallholder farmers use as safety nets. Forests, wetlands, rivers and other natural areas provide critical ecosystem services to the people of the Niger Delta region, including the provision of firewood and charcoal, water, wild yams and materials for house construction, among others. These services are important year-round, but particularly following catastrophic events when farmers turn to the forests for food and materials to rebuild their damaged homes. Efforts that conserve, restore or sustainably manage these natural ecosystems are therefore crucial for sustaining farmer livelihoods.

Conclusion

This study has shown that farmers and fisher folks in the communities of Delta State are already feeling the effects of climate change. Exposure to floods and rainfall variability are only predicted to get worse as the impacts of climate change intensify. The consequences of these hazards on the well-being of the primary producers are severe, inducing intense episodes of food insecurity, which will force them to engage in erosive and unsustainable coping and adaptive strategies. Substantial improvements in the resilience of rural farmers and fisher folks are needed to address the current and increasing vulnerabilities of subsistence farmers and fisher folks in the communities of the region. The most effective way of reducing the vulnerability of farmers and fisher folks is through general adaptation strategies that focus on improving their overall well-being. This suggests the need for place-based studies of adaptive strategies to assess which specific projects will be most effective at reducing farmer or fisher folks' vulnerability under a wide variation of climate hazards.

Despite the promise of some specific adaptation measures, farmers and fisher folks emphasized their desire to remain autonomous in deciding what type of specific adaptation measures they choose to employ. They are looking for support in improving their general well-being so as to be in a better position to use their own resources to adapt to future changes. Although it is important

to recognize the autonomy of farmers and fisher folks in their adaptation choices, it was also clear from discussion with them that they will need and are interested in receiving information and advice on potential adaptation strategies. Future researches are needed to find effective advising strategies that can help farmers and fisher folk access information on, and capital to invest in, specific adaptation strategies.

References

Abotutu A. A. (2012). Vulnerability and Adaptation to Climate Change in the Niger Delta: The case of the Urban Poor in Warri and Environs, Nigeria. *American Journal of Agricultural Economics* 71(5), 1272-1279.

Adebiyi A (2013) Nigeria May Lose $460bn to Climate Change by 2020. This Day Live, September 13, 2014

Adelekan, I. O. (2010). Vulnerability of Poor Urban Coastal Communities to Flooding in Lagos, Nigeria. Environment and Urbanization, 22, 433-450. http://dx.doi.org/10.1177/0956247810380141

Aderogba K. (2012) 'Qualitative Studies of Recent Floods and Sustainable Growth and Development of Cities and Towns in Nigeria', International Journal of Academic Research in Economics and Management SciencesJune2012, Vol. 1, No. 3 http://hrmars.com/admin/pics/968.pdf

Adger, W. N. & Kelly, P. M. (1999). Social Vulnerability to Climate Change and the Architecture of entitlements. Mitigation and Adaptation Strategies for Global Change 4, 253-266.

Adger, W. N, Brooks, N. Kelly, M., Bentham, S. & Eriksen, S. (2004). New Indicators of Vulnerability and Adaptive capacity, Tyndal Centre Technical Report 7. An Economic Perspective. American Journal of Agricultural Economics, 71,1272 – 1279.

Akinro A.O. Opeyemi D.A. and Ologunagba, I.B. (2008) "Climate Change and Environmental Degradation in the Niger Delta Region of Nigeria: Its Vulnerability, Impacts and Possible Mitigations" Journal of Applied Sciences Research 3(3):167-173 https://www.researchgate.net/publication/336830096_Climate_Change_and_Environmental_Degradation_in_the_Niger_Delta_Region_of_Nigeria_Its_Vulnerability_Impacts_and_Possible_Mitigations

Akintola, F. O., & G. O. Ikwuyatum. 2012. Issues in Sustainable Flood Management in Nigeria. In Sustainable Environmental Management in Nigeria, edited by F. A. Ivbijaro and F. O. Akintola, 197–207. Ibadan: Book Builders.

Akpofure R. (2012). Assessing Security Implications of Climate Change in the Niger Delta, Nigeria

Amangabara G. T.and Obenade M. (2015) Flood Vulnerability Assessment of Niger Delta States Relative to 2012 Flood Disaster in Nigeria, *American Journal of Environmental Protection*, 2015, Vol. 3, No. 3, 76-8 3

Anyadike, R.N.C; Madu, I.A and Ajaero, C.K (2010). "Climate Change and the Nigeria Environment". Conference Proceedings. Nsukka: Department of Geography, University of Nigeria

Arndt, C., Asante, F. & Thurlow, J. Implications of climate change for Ghana's economy. *Sustainability* **7**, 7214–7231, https://doi.org/10.3390/su7067214 (2015).

Audu, H.O.; Binbol, N. L; Ekanem, E.M. and Bamayi, E.A. (2012). Effect of Climate Change on Length of Growing Season in Uyo, Akwa Ibom State, Nigeria

Delta State Government (2013) Draft Climate Change Policy, Asaba: Government of Delta State

Chizoba C., G. Abiola-Oloke, C. Jideani (2009) "Energy Resources Management for Sustainable Development in Nigeria Niger Delta Region: Women Issues and the Environment" Environmental Science Published 2009 https://www.semanticscholar.org/paper/Energy-Resources-Management-for-Sustainable-in-and-Chinweze-Abiola-Oloke/39d4b1a203af79a9c312a3701dd75f34b44d0681

Dung Elisha, Bombom, L. and Agusomu, T. (2008) "The effects of gas flaring on crops in the Niger Delta, Nigeria" GeoJournal, Vol. 73, No 4. https://www.researchgate.net/publication/226770764

Efe, S.I (2010). Climate change and food security in Africa: Delta State Nigeria experience. In Anyadike, R.N.C; Madu, I.A and Ajaero, C.K (Eds). Climate Change and the Nigeria Environment. Conference Proceedings. Nsukka: Department of Geography, University of Nigeria, pp.105-126

Ekuase, I.O., Andrew, O and Osarobo, A. (2010). Emerging effects of regional climate changes on socio-economic activities in Benin City: Impacts, Adaptations, and Vulnerability. In Anyadike, R.N.C; Madu, I.A and Ajaero, C.K (Eds). Climate Change and the Nigeria Environment. Conference Proceedings. Nsukka: Department of Geography, University of Nigeria, pp.595-611

Etuonovbe Angela Kesiena (2008) "Sustaining Coastal Management / Adaptation of Climatic Change and Sea Level Rise in the Niger Delta Integrating Generations" FIG Working Week 2008 Stockholm, Sweden 14-19 June 2008 https://www.fig.net/resources/proceedings/fig_proceedings/fig2008/papers/ts03f/ts03f_06_etuonovbe_2753.pdf

Gobo, A.E and Abam T.K.S. (2005) "Flood Prediction and Management in the Niger Delta, Nigeria". Afr. J. Environ. Pollut. Health 4(2): 45–53 http://www.academix.ng/documents/papers/1469191125_8159.pdf

Gobo, A.E. and Abams, T.K.S. (1991), 'The 1988 Flood in the Niger Delta: The Case of Ndoni,' *The Journal of Meteorology* **16**(163), 293–299. https://link.springer.com/article/10.1007/s10669-005-3095-2

Federal Ministry of Environment (FMENV), 2010 "National Environmental, Economic and Development Study (Needs) For Climate Change In Nigeria" Abuja: FMENV, Special Climate Change Unit, https://unfccc.int/files/adaptation/application/pdf/nigerianeeds.pdf

Hewitson, B.C. and Crane, R.G. (2006) "Consensus between GCM Climate Change Projections with Empirical Downscaling: Precipitation Downscaling over South Africa". *International Journal of Climatology*, 26, 1315-1337. https://doi.org/10.1002/joc.1314

Intergovernmental Panel on Climate Change (2001a). Climate Change 2001: Impacts, Adaptation and vulnerability, summary for policy makers, WMO.

IPCC (2001b). Climate change 2001: Impacts, Adaptations and vulnerability. IPCC working group II. Third Assessment Report. McCarthy, J. J., O F. Canziani, N. A. Leary, D. J. Dokken, and K. S. White, (Eds.) Cambridge, UK: Cambridge University Press.

IPCC (2007). Climate change: Impacts, Adaptations and Vulnerability. Contributions of working group II to the fourth assessment report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, UK, for IPCC.

Intergovernmental Panel on Climate Change (2013). *Climate Change 2013: The Physical Science Basis, Summary for Policymakers-PDF. page 3*.

IPCC (2014). *Climate Change 2014: Impacts, Adaptation, and Vulnerability* WGII AR5 Summary for Policymakers. https://ipcc- wg2.gov/AR5/images/uploads/IPCC_WG2AR5_SPM_Approved.pdf. Assessed 25 October, 2014.

Jones, W, R. N. (2001). An Environmental risk assessment/management framework for climate change impact assessments. Nat. Haz. 23: 197-230.

Knox, J., Hess, T., Daccache, A. & Wheeler, T. Climate change impacts on crop productivity in Africa and South Asia. *Environ. Res. Lett.* **7**, 034032, https://doi.org/10.1088/1748-9326/7/3/034032 (2012).

Lukpata, V. I (2013). Revenue Allocation Formulae in Nigeria: A Continuous Search. *International Journal of Public Administration and Management Research 2 (1):32-38.*

Markhan D. (2009).Global Warming Effects and Causes: A Top 10 List. http://planetsave.com/2009/06/07/global-warming-effects-and-causes-a-top-10-list/ (assessed 5/9/2014)

Nabegu, A.B (2010) An Analysis of Municipal Solid Waste Characteristic in Kano Metropolis. Journal of Human Ecology, Vol. 31 No. 2. https://www.google.com/search?biw=1920&bih=966&ei=qrVXXqnHO4ySaPiFhegF&q=Nabegu%2C+A.B+(2010

National Bureau of Statistics (2007). *Statistical Bulletin*. National Bureau of Statistics, Abuja. National Population Commission (NPC) (2006). Population and Housing Census of the Federal Republic of Nigeria, Abuja.
National Bureau of Statistics (2012). *Social Statistics for Nigeria*. Part I: Household And Housing Conditions National Bureau of Statistics, Federal Republic of Nigeria, Abuja.

Nigerian Environmental Study/Action Team (NEST) (2004). *Regional Climate Modeling and Climate Scenarios Development in Support of Vulnerability and Adaptation Studies: Outcome of Regional Climate Modeling Efforts over Nigeria.* Nigerian Environmental Study/Action Team, Ibadan.

Nigerian Environmental Study/Action Team (NEST) (2011) *Reports on Research Projects on Impacts and Adaptation – Climate Change in Nigeria: A Compendium of Reports Commissioned by Building Nigeria's Response to Climate Change (BNRCC) Project* Ibadan, Nigeria

Nhemachena, C. & Hassan, R. (2007). Micro-level Analysis of farmers' Adaptation to climate change in South Africa. International food policy research institute. Discussion paper No. 00714.

NOAA (2006). Nigeria Gas flares. http://commons.wikimedia.org/wiki/File:Nigeria_flares.png. Assessed 3rd Sept. 2014.

Obeta, M. C. (2014) 'Environmental Risk Assessment of Heavy Metal Concentrations in Road Runoff with Absorption Atomic Spectrophotometer(AAS), Imo State, Nigeria'. Journal of Environment and Earth Science, *Vol 4, No 5 2014)*

Odjugo, P. A. O.(2005). An analysis of rainfall pattern in Nigeria. *Global Journal of Environmental Sciences.Vol.4(2):139-146.*

Odjugo, P. A. O. (2007). The Effects of Gas Flaring on Microclimate of Yam and Cassava Production in Erhorike and Environs, Delta State, Nigeria. *Nigeria Geographical Journal.*

Odjugo, P. A. O. and Osemwenkhae (2009). Natural Gas Flaring Affects Microclimate and Reduces Maize (Zea mays L) Yield. *International Journal of Agriculture and Biology* 11:408-412.

Odjugo, P. A. O.(2010). Shift in crops production as a means of adaptation to climate change in the Semi-arid region of Nigeria *Journal of Meteorology and Climate Science, Vol 8 (1):1-6*

Odjugo, P. A. O. (2013). Analysis of Climate Change Awareness in Nigeria. *Journal of Scientific Research and Essays, 8(26):1203-1211.*

Odjugo, P. A. O. (2014). Impact of climate change on migration and possible conflicts in Nigeria. A paper presented at the 3rd Climate Change and Population Conference on Africa, **"**Climate Change, Migration And Security In Africa". Regional Institute For Population Studies (Rips). University of Ghana, Legon - Accra, Ghana. 22nd – 25th July,2014.

Ologunorisa, T.E. (2009) "Strategies for Mitigation of Flood Risk in the Niger Delta, Nigeria" J. Appl. Sci. Environ. Manage. *June*, 2009

Ologunorisa, T.E., Adeyemo, A. Public Perception of Flood Hazard in the Niger Delta, Nigeria. *Environmentalist* **25,** 39–45 (2005). https://doi.org/10.1007/s10669-005-3095-2

Ologunorisa T.E. (2004) 'An Assessment Of Flood Vulnerability Zones In The Niger Delta, Nigeria', International Journal of Environmental Studies, 61:1, 31-38, DOI: 10.1080/0020723032000130061

Olorunfemi, F.B. and Adebimpe R.U. (2008) "Sustainable Disaster Risk Reduction in Nigeria: Lessons for Developing Countries" African Research Review Vol. 2 (2) 2008 pp. 187-217 https://www.semanticscholar.org/paper/Sustainable-Disaster-Risk-Reduction-in-Nigeria%3A-for-Olorunfemi-Adebimpe/1247a38d69ecf7fb18c59a1de4cb6ed541d73dcf

Olujimi J. (2007) "Urbanisation of Peri-Urban Settlements: A Case Study of 'Aba-Oyo' in Akure, Nigeria" The Social Science Vol. 2 No 1 pages 60-69. https://www.researchgate.net/publication/233855640_Urbanisation_of_Peri-Urban_Settlements_A_Case_Study_of_%27Aba-Oyo%27_in_Akure_Nigeria

Priya, S. 2010. Vulnerabilities to climate change in the agriculture sector . Adaptation Knowledge Platform. http://www.climateadapt.asia/upload/events/files/4c8495ae6a07cVulnerabilitiesToClimateChangeInTheAgricultureSector_SatyaPriya.pdf . Assessed 30/9/2014.

Scotland Government (2009). Preparing for a changing climate: Second consultation to inform Scotland's climate change adaptation framework. http://www.scotland.gov.uk/Publications/2009/04/23145206/4. Accessed 4/9/2014.

Sehgal, V. K; Singh, M. R.; Chaudhary, N. J and Pathak, H (2013). Vulnerability of Agriculture to climate change: District level assessment in the Indo-D=Gangetic Plain. Indian Agricultural Research Institute. Indian Council of Agricultural Research New Delhi. Pp 90.

Sperenza, I. C. (2010). Resilient Adaptation to Climate in African Agriculture. German Development Institute. Studies 54.

Sultan, B. & Gaetani, M. Agriculture in West Africa in the twenty-first century: climate change and impacts scenarios, and potential for adaptation. *Frontiers in Plant Science* **7**, art. 1262 [20 p.]. ISSN 1664-462X (2016).

Roudier, P., Sultan, S., Quirion, P. & Berg, A. The impact of future climate change on West African crop yields: what does the recent literature say? *Glob. Environ. Change* **21**, 1073–1083, https://doi.org/10.1016/j.gloenvcha.2011.04.007 (2011).

Terunga, U.C. and Torkwase I.C. (2013) 'Current Issues in Flood Disaster: Challenges and Implications for Science and Technology to Enhance Environmental Education' *Environmental Science* Vol. 2 No 6 http://www.richtmann.org/journal/index.php/ajis/issue/view/12

Ubuoh, E.A; Anyadike, R.N.C ; Akande, S.O; Igbojionu, D.O; Akhionbare, S.M.O and Njoku, J.D (2010). Atmospheric corrosion of corrugated iron roofing sheet in selected parts of Akwa Ibom, Nigeria. In Anyadike, R.N.C; Madu, I.A and Ajaero, C.K (Eds). Climate Change and the Nigeria Environment. Conference Proceedings. Nsukka: Department of Geography, University of Nigeria, pp.489-500

Uchenna, F. O. Wekpe V. and Obafemi A. (2016) "An Overview of Flood Vulnerability Mapping: Strategy for Disaster Risk Reduction in the Niger Delta Region, Nigeria" Nigerian Journal of Hydrological Sciences, Vol. 4, September 2016. https://www.researchgate.net/publication/310202575

Ugochukwu, C. N. C., and J. Ertel, "Negative impacts of oil exploration on biodiversity management in the Niger De area of Nigeria," Impact Assessment and Project Appraisal, 26 (2). 139-147, 2008. http://www.sciepub.com/reference/16419

UNDP/World Bank (2004) "Nigeria Strategic Gas Plan" Washington DC: Energy and Water Department The World Bank Group 1818 H Street, NW Washington, D.C. 20433, U.S.A., https://worldbank.org/curated/en/466291468780949357/pdf/ESM27910paper.pdf

Uyigue, E. & Agbo, M. (2009). Community Adaptation to Climate Change and other Environmental Changes in the Niger Delta Region of Southern Nigeria. *Earth and Environmental Science.* 6(2009), 352041

Uyigue Etiosa and Matthew Agho (2007) "Coping with Climate Change and Environmental Degradation in the Niger Delta of Southern Nigeria" Benin City: Community Research and Development Centre (CREDC) http://priceofoil.org/content/uploads/2007/06/07.06.11%20-%20Climate_Niger_Delta.pdf

Uyigue Etiosa and Matthew Agho (2009) "Community adaptation to climate change and other environmental changes in the Niger Delta region of Southern Nigeria" IOP Conference Series Earth and Environmental Science 6(35) DOI: 10.1088/1755-1307/6/35/352041

World Bank, (2012). Estimated Flared Volumes from Satellite Data, 2007-2011. http://web.worldbank.org/WBSITE/EXTERNAL/TOPICS/EXTOGMC/EXTGGFR/0