Assessing the vulnerability of farmers, fishermen and herdsmen to climate change in Nigeria

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***Abstract*: This research is aimed at assessing the vulnerability of farmers, fishermen and herdsmen to climate change in Nigeria. The study was motivated to examine the underlying causes and assess the degree of vulnerability as well as examines the conflicts between farmers and herdsmen as a result of climate change. This research employed the use of quantitative and qualitative means of data gathering techniques as well as physical observations. Six states (Kebbi, Adamawa, Nasarawa, Osun, Ebonyi, and Akwa Ibom) were selected on the ground that they are key food production areas within the ecological zones of the country and are therefore essential to continual food security in the country. More so, they double as fishing communities in order to aid the comprehensive study of all the effects of climate change on farmers and fishermen alike. The study observed that the level of vulnerability of rural dwellers most specifically farmers, herdsmen and fishermen to climate change is very high due to their socioeconomic, ethnic and historical perspective of their trend. The study therefore recommends that urgent step needs to be put in place to help control natural hazards and manmade disasters. However, serious measures is also needed in order to minimize severe societal, economic and political crises; some of which may either escalate to violent conflicts or could be avoided by efforts of conflict resolution and prevention by the initiation of a process of de-escalation together by applying the best-fit adaptive and mitigation measures to climate change vulnerability in rural communities of Nigeria.**

***Keywords*: Farmers; fishermen; herdsmen; mitigation; vulnerability.**

I. INTRODUCTION

Climatological research over the past decades has proved that the Earth's climate is changing in response to anthropogenic increase of atmospheric greenhouse gases (Onah, Ayuba and Idris, 2020). Thus, global warming can be considered as one of the priority environmental risks generating long-term hazards for society and so there requires efficient political response.

Nigeria is one of the countries expected to be most affected by the impacts of climate change through rising sea level along her coastline, intensified desertification, erosion and flooding disasters and general land degradation. Nigeria is losing huge amount of money worth billions of Naira as a result of the catastrophe while, at least, 80 per cent of the inhabitants of the Niger Delta region of the country will be displaced due to the low level of the region (Medugu, Majid and Leal-Filho 2014). Nigeria is highly vulnerable to the impacts of climate change and the country's fragile economy makes the local ability to respond difficult. Nigeria has a variety of ecosystems, from mangroves and rainforests on the Atlantic coast in the south to the savannah in the north bordering the Sahara. Whether dry or wet, those ecosystems are being battered by global warming. While excessive flooding during the past decade has hurt farming in coastal communities, desertification is ravaging the Sahel (Idris, 2010).

Rainfall in the Sahel has been declining steadily since the 1960s and this has resulted in the loss of farmlands and conflicts between farmers and herdsmen over ever decreasing land (Nasiru, Mohammed and Foziah, 2014). Many different communities, including fishermen, farmers and herdsmen, are now confronted with difficulties arising from climatic change. The livelihoods of people are being harmed, and people who are already poor are becoming even more impoverished. Climate refugees are the result, as the changes make some land unlivable and affect water supplies.

Nigeria is experiencing adverse climate conditions with adverse impacts on the welfare of millions of its population. Persistent droughts and flooding, off season rains and dry spells have sent growing seasons out of orbit, in a country dependent on a rain fed agriculture. Alarm bells are ringing with lakes drying up and a reduction in river flow in the arid and semi-arid region of the country. The result is fewer water supplies for use in agriculture, hydro power generation and other uses (Medugu et. al., 2014).

Apart from human activities, another major suspect for all this havoc is climate change. Climate change has been confirmed following release of the IPCC Assessment report (IPCC, 2007). Africa will be worst hit by the effects of climate change. Droughts are getting worse and climate uncertainty is growing, climate change is an unprecedented threat to food security. Arid and semi-arid areas in northern Nigeria are becoming drier, while the southern part of the country is getting wetter. Global warming means that many dry areas are going to get drier and wet areas are going to get wetter. Many are going to be caught between the devil of drought and the deep blue seas of floods.

The impact of the change will be difficult to handle and it will be potentially very long lasting. The disproportionate impact on Nigeria will be for a combination of reasons. Global warming will be greater over land than over sea because land retains heat more than water. There is also increasing

evidence that it will be particularly hit by the effect of vertical rises and falls in air currents. Climate change often appears very esoteric but in Nigeria, it is real. Currently there is an increasing incidence of disease, declining agricultural productivity, and rising incidences of heat waves (Tarfa, Ayuba, Onyeneke, Idris, Nwajiuba and Igberi 2019). There is glaring evidence that climate change is not only happening but it is changing our lives. Declining rainfall in already desert-prone areas in northern Nigeria is causing increasing desertification, and people in the coastal areas who used to depend on fishing have seen their livelihoods destroyed by the rising waters. Adapting to climate variability and mitigating its impacts is something that we do in our everyday lives, hence, we have to understand what climate change is, that we contribute to it, and how we can adapt and reduce our vulnerabilities.

II. CLIMATE CHANGE IN NIGERIA

Nigeria is located in West Africa and shares land borders with the Republic of Benin in the west, Chad and Cameroon in the east, and Niger in the north. Its coast lies on the Gulf of Guinea, a part of the Atlantic Ocean. The country has a total land area of 923,773 km^2 and consists of about 190 million population based on year 2020 projection and her people consist of over 200 ethnic groups, speaking about 395 languages and dialects (Medugu, Majid and Choji, 2008).

The effects of climate change have become more and more apparent in various forms not only in Nigeria but the whole world. Therefore, an important issue today, is how to address global climate change and its adverse impacts both today and in the future. By virtue of its spatial extent, the country encompasses various climatic regimes and physiographical units that give rise to a wide variety of ecological zones. These zones range from flush forest vegetation in the south to Guinea savanna in the middle belt region, Sudan savanna in the north and Sahelian vegetation in the extreme northern part of the country. In Nigeria, agriculture is the main source of food, and a major source of industrial raw materials, as well as the means of earning foreign exchange. It employs close to 70% of the Nigeria's population (Medugu, Majid and Johar, 2009). Agricultural practice in the country is predominantly rain-fed and therefore particularly vulnerable to the impacts of climate change, and a study report by HBS in 2010 predicted that under a business as-usual scenario, Nigeria's agricultural productivity could decline by between 10-25% by 2080 (Nasiru et. al., 2014). In certain parts, a decline in rain-fed agriculture could be as high as 50%. Exposure to extreme events makes subsistence and small-scale farmers most vulnerable to climate change because of their limited capacity to adapt. Therefore, Nigeria's vulnerability will be in two ways; first, the resulting impacts of climate change and second, the impact of response measures. This is because Nigeria's economy is highly dependent on income generated from the production, processing, export and consumption of fossil fuels and associated energy-intensive products.

2.1 Climate Change and Conflict in Nigeria

Nigeria's climate is likely to see growing shifts in temperature, rainfall, storms, and sea levels throughout the twenty-first century. Poor adaptive responses to these shifts could help fuel violent conflicts in some areas of the country (Odoh and Chilaka, 2012). A basic causal mechanism links climate change with violence in Nigeria. Under it, poor responses to climatic shifts create shortages of resources such as land and water. Shortages are followed by negative secondary impacts, such as more sickness, hunger, and joblessness. Poor responses to these, in turn, open the door to conflict. Drawing lines of causation between climate change and conflict in specific areas of Nigeria calls for caution, however, particularly as the scientific, social, economic, and political implications of the country's changing climate are still poorly understood. Government and private actors also need to ensure that particular adaptive responses do not themselves fuel violence but actively help build peace. Solid engagement on the part of the Nigerian federal government is key to achieving the best outcomes.

2.2 Global Perspective on Climate Change and Matters Arising

The issue of climate change has been placed firmly on local, national and international agendas and in the strategic planning of a growing number of business concerns. The global greenhouse gas emissions are on an accelerating trend and could lead to a 6.4^{o}C (11.5^{o}F) temperature increase by the end of the century exceeding conservative estimates and with an average warming of over 2.5°C, the world would see some very serious changes (Pachauri, 2008). The United Nations IPCC report in 2007 predicts average global temperature rises of 1.1 – 6.4^{o}C by 2100. Pachauri (2008) noted that it could create abrupt and irreversible changes, including the possible extinction of 20-30 per cent of all species and collapse of the Greenland and Antarctic ice sheets, which could create sea-level rise of several meters.

Although concerns related to climate issues are not new, much has happened during the past three decades. Firstly, a world body which evaluates the risks of climate change brought about by humans and which issues periodical reports on the world's climate – the International Panel on Climate Change (IPCC) – was established in 1988 (IPCC, 1996). It was a joint effort of the World Meteorological Organization and the United Nations Environment Programme, which has found since its establishment worldwide acceptance and recognition. Secondly, the United Nations Framework Convention on Climate Change (UNFCCC) was adopted on 9 May 1992 by the Intergovernmental Negotiating Committee established for its negotiation (IPCC. 2000). In early June 1992, the UNFCCC was opened for signature and entered into force on the 21 March 1994 (IPCC, 2003). The UNFCCC has over 200 parties and observer states, which makes it one of the most universally-supported and most influential multilateral environmental agreements (Idris, 2020).

The last twenty six (26) years have shown a particularly intense increase in the degree of emphasis to climate issues as a whole and the level of attention pay to climate change in particular. The Kyoto Protocol, which was adopted at the third Conference of the Parties to the UNFCCC (COP 3) in Kyoto, Japan, on 11 December 1997 and entered into force on 16 February 2005, has provided an extra impulse to the international debate on climate change (IPCC. 2001). Over 180 parties have ratified the treaty to date (Idris, 2020). Since then, UNFCCC Conference of Parties has been meeting every year right from COP 1 in Berlin, Germany since 1995 to the just concluded Conference of Parties (COP) COP 25 talks in Madrid, Spain in 2019 on matters related to climate change. Twenty six years of Climate Change Conference. Is that a talk show? Are there progresses made so far? For how long will the annual event continues?

One might need to wonder what has been happening since the beginning of the 1st COP in Berlin, Germany in 1995 which was tagged Berlin Mandate which was a ruling reached at the first Conference of the Parties to the United Nations Framework Convention on Climate Change (UNFCCC) in March 1995. The importance of this convention is very vital to this study in terms decision that were being taken will definitely establish a process on dealing with matters of climate change especially as African countries are more vulnerable to the impact of climate change which was also confirmed by the United Nations assessment report.

III. RESEARCH METHODOLOGY

This research was designed to employ the use of quantitative and qualitative means of data gathering techniques as well as physical observations to study the underlying causes of vulnerability to climate change and assess the degree of vulnerability of rural farmers, fishermen and herdsmen in Nigeria. The six geo-political and ecological zones in the country are being brought under focus so as to ensure a fair representation of the situation in the country. One state (Kebbi, Adamawa, Nasarawa, Osun, Ebonyi, and Akwa Ibom) each in the various zones of the country was selected as study area as shown in Figure 1. Structured questionnaires were administered in various communities of each state across the selected geo-political zones to elicit information from the rural dwellers, farmers and fishermen while published reports on herdsmen and their activities are being studied and reviewed. The reason for studying the vulnerability of farmers and fishermen was as a result of a study conducted by Medugu et. al., (2014) where the research study observed that farmers and fishermen are more vulnerable to climate change in Nigeria because they survived on rain-fed agriculture and any slightest changes in weather and climate will affect their livelihood. The introduction of herdsmen in the study was to look at the different scenarios for example the dominant role of agriculture in sustaining rural livelihoods which makes it obvious that even minor climate deteriorations can cause devastating socioeconomic consequences. This makes it imperative to assess the level of the country's vulnerability and readiness for adaptability to the climate change phenomena. So in doing that, the study examined the possible conflict that might arise between farmers and herdsmen as a result of decreasing grass land in the study area. However, major food crops of the country were used as yard stick for selection of communities examined. These food crops include beans, rice, maize, yam, cassava and guinea corn. So also, Medugu et. al., (2014) noted that slight changes in climate would greatly affect production of these staple foods.

The reason for adopting the study approach was based on the aspects of some indicator-based approach for vulnerability assessment by Gallopin in 1997. The term vulnerability which refers to the function of three defining factors – exposure, sensitivity and adaptive capacity, which the study further reiterated basically concerns as coupled with human and environmental system.

A total of 1200 semi-structured questionnaires were administered in the six selected states to fishermen and farmers and while an interactive session was conducted with different groups in rural communities of each of the six (6) states identified as presented in Table 1. In each state, 100 farmers and 100 fishermen were sampled for easier reporting and identification thus totaling 200 respondents per each sampled state.

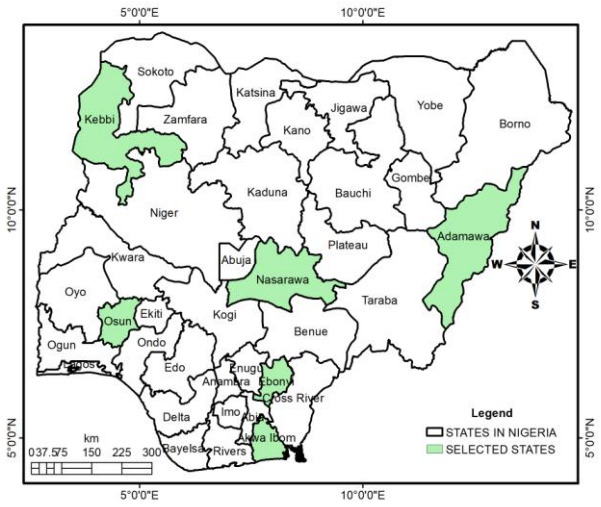

Figure 1: Map of Nigeria showing the 6 selected states as study area

Source: Author

Table 1: Number of respondents interviewed in each of the state

State	Geo-political/ ecological Region	Types of respondent	
		Farmers	Fishermen
		No of respondents	
Adamawa	North east	100	100
Akwa Ibom	South south	100	100
Ebonyi	South east	100	100
Kebbi	North west	100	100
Nasarawa	North central	100	100
Osun	South west	100	100

However, questionnaires were not administered to herdsmen because in Nigeria, herdsmen are Nomadic therefore they were not stationed. Thus, the study examines the possible conflict that might arise between farmers and the herdsmen during the migration/movement of the herdsmen within the farmer's farmland as there were no grazing routes and reserves for them to adhere due to neglect by the government and encroachment by the people (Medugu et. al., 2014). So herdsmen views were not collected but the interaction with communities and farmers within the farmlands gave an overview of what arises as a result of their migration as they are on transit and their herd normally passes through farmer's farmland and which farmers normally resist the encroachment of their lands thus leading to conflict. In a study by Udoh and Chilaka (2012) documented some cases of conflict between pastorals and farmers in northern Nigeria. Their study examines climate change and conflict in Nigeria with emphasis on theoretical and empirical examination of the worsening incidence of conflict between herdsmen and farmers.

IV. PRESENTATION OF RESULTS AND FINDINGS

Table 2 shows the results of this study. The respondents gave their views on the various questions the researcher asked. Regarding whether they have noticed any increase in temperature in recent years, majority of the farmers (97%) and fishermen (83%) have noticed increase in temperature within their immediate environment. From the interaction, farmer's information on temperature increase was based on hash weather condition being experienced and decreased in rainfall as well as report from their extension workers from time to time and thus this is in conformity with the outcome of a study by Onah et. al. (2020) which observed that climate has been changing rapidly in the north central part of Nigeria. Majority of the people interviewed along the riverine areas have confirmed that they have noticed significant changes in the surface water level especially high tides towards the evening period.

As expected, health challenges issues are prevalent in all the study areas as reported by 81% of the farmers and 55% of the fishermen. This is also very true as during the raining season, majority of the rural population especially in the northern part of the country are experiencing serious health challenges as reported by Medugu et al (2014) in their study of climate change vulnerability in Nigeria.

In addition, the results of the responses from the farmers and fishermen on some aspect of agricultural challenges, precipitation pattern, drought and desertification process, crop yield, post harvest losses and possible changes in grazing land as well as crop/livestock production were presented in Table 2 below.

Furthermore, the majority of crop farmers acknowledged to have been noticing the changes for a over 20 years now. This however could be attributable to their years of experience in crop farming as the majority of the crop farmers had been cultivating crops for several years and so have had ample opportunity to observe the trends in climate and acquire relevant information that is required to have their crops thrive. However, it is also worth of note that those who started cultivation within the last few years have also observed changes in climatic trends. This is an indication to the tremendous amount of changes that have occurred within a short period of time, revealing therefore, that climate change is on the increase. This statement is also collaborated by the country's meteorological body during their annual seasonal rainfall prediction and socio-economic implication for Nigeria (NIMET, 2020).

Larger percentage of fishermen have also acknowledged that, they have been noticing changes during the raining season especially rise in rivers and streams waters and also drying up of some ponds and streams during the dry season.

Table 2: Farmers and Fishermen responses

Questions	Farmers		Fishermen	
	Yes	No	Yes	No
Have you noticed increasing temperature in recent years?	97	3	83	17
Have you noticed any changes in water level/sea level and leading to flooding?	79	21	64	36
Are there increases in health challenges recently?	81	19	55	45
Did you experience any increasing agricultural challenges? How are these challenges apportioned to climate change?	85	15	88	22
Was there any change in precipitation pattern in recent years?	35	65	-	-
Are you aware of desertification and drought and their processes?	74	26	80	20
Have you noticed any decrease in quantity and quality of crop yield? Avoid compound questions – what are they saying yes or no to here? Is it for both? How about if there is no linear relationship?	49	51	-	-
Due to diseases, have you noticed any decrease in numbers of livestock and pest infestation? Again, compound question!	41	59	-	-
Any post-harvest lost?	13	87	-	-
Any change in disappearance of grassland for grazing? Crop farmers or herdsmen – who is this question directed to?	50	50	-	-
Have you noticed any increased in cost of crop/livestock? production?	62	38	-	-

However, majorities of the farmers attributed their understanding of climate change to changes in rainfall and temperature patterns. It is quite understandable that this will be the most noticeable attributes they observe since these are the factors that most directly affect the production of crops. Over 90% of the crop farmers acknowledge that they have been experiencing increased temperatures in recent times while 83% of fishermen attributed their changes as a result of temperature and rainfall. Its not clear to me how you are quantifying or assessing climate change vulnerabilities to these socio-economic groups (farmers, herdsmen & fishermen? The study is on climate change vulnerabilities, stay focused on the subject of study.

It was revealed through discussion with the crop farmers that there has been more than 50% reduction in their crop production. The rural fish farmers on the other hand were indifferent as to the effect that climate has had on the volume of production of fish. They however, noted that climate influences their farming seasons. The reference to fishermen statement here was that favourable climatic condition will have significant yield on their output while harsh weather condition and related environmental hazards will significantly affect their production output negatively. Please note that, in most Nigerian rural areas, there are no registered or licensed fishermen recognized by government. Most of their activities are not documented but there are few registered fish farming activities in places like Lagos and Abuja. This study revealed that the people had noticed a variety of changes in climatic conditions especially in rainfall patterns as shown in Figure 2.

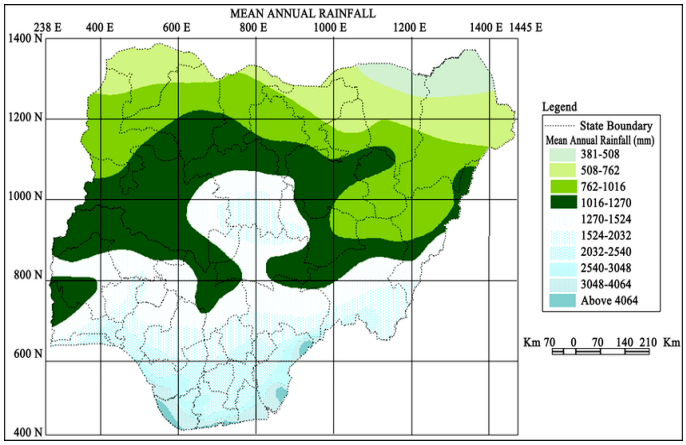

Figure 2: Mean Annual Rainfall Pattern in Nigeria (Ishaku and Majid, 2010)

It also revealed that the respondents had heard of the term climate change but did not however realize that it was a global phenomenon and thought it a local occurrence. It was further revealed that the media had very little to do with the dissemination of information as touching climate change matters as reported by Tarfa et. al., (2019) in their study of climate change perception and adaptation in Nigeria's guinea savanna. Majority of the respondents had access to various means of mass media and therefore, the media need to play a more active role in propagating climate change matters.

Respondents' reported both negative and positive impacts of climate changes on their lives. However, the majority of the reported impacts were negative, chief among which is reduction in the crop and fish production. There has been a tremendous reduction in harvest output but not much change in the fish production. This has led to changes in the standard of living of most of the people because they are dependent on agriculture as their means of livelihood.

The respondents observed of excessively oppressive heat during the dry season. This leads to increased occurrence of pests and diseases which damage their crops and harvests and as well affects the lives of the locals. One major observation was the very low involvement of government authorities in contribution to the knowledge of the people as touching climate change phenomenon and therefore, no clear cut policies or plans that touch the lives of these locals were in place as at the time this study was carried out.

4.1 Climate change vulnerability to farmers in Nigeria

In Nigeria, farmers are exposed to all elements of weather and climate. This exposure affects sensitivity, which means that exposure to higher frequencies and intensities of climate risk highly affects outcome. Exposure is also linked to adaptive capacity. For instance, higher adaptive capacity reduces the potential damage from higher exposure and results to lower sensitivity. Thus, sensitivity and adaptive capacity are also linked and add up to total vulnerability as observed by Medugu et. al. (2014) in their study of assessing the vulnerability of farmers, fishermen and herdsmen to Climate Change in Nigeria.

Several studies for example Tarfa et. al. (2019) and Madu (2016) have predicted climate change to have huge impacts on rural farmers in developing countries like Nigeria, as small-scale farmers are particularly vulnerable to climatic stresses and shocks. Agro-forestry, or the use of trees in the cropping system to improve farm productivity, and this has been put to use as a potential strategy to improve farmers' ability to adapt to future climate changes (Medugu et. al., 2010). However, in Nigeria, the northern part of the country is highly vulnerable when compared to the southern part of the country (Idris, 2010). A study by Madu (2016) on the rurality and climate change vulnerability in Nigeria shows a spatial variation of vulnerability to climate change with states in the north experiencing higher degrees of vulnerability than those in the south. He further observed that the first 13 states which experience high vulnerability are all located in the northern geo-political zones. The pattern authenticates the report by Maplecroft (2014) which shows the northern Nigeria as areas of extreme risk in terms of climate change vulnerability as shown in Figure 3. The pattern of vulnerability therefore results mainly from the dominant of agricultural activities, poor infrastructural development and other socio-economic conditions in rural areas of the country.

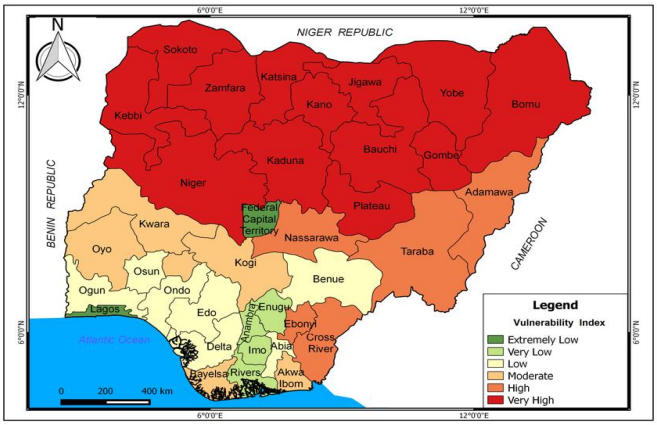

Figure 3: Pattern of Climate Change Vulnerability in Nigeria (Madu, 2016)

4.2 Climate change vulnerability to fishermen

Due to changes in temperature and rainfall patterns, extreme weather events become severe, sea level rises. Therefore, this will affect fishery production with significant impact on food security. Fish reproduction, growth and migration patterns are all affected by temperature, rainfall and hydrology (Ficke et al., 2007). So, changes in these parameters will shift patterns of species abundance and availability. As recently occurs in some part of Nigeria, changes in precipitation influenced seasonal flooding patterns and drives inland fish production in some areas and drier dry? seasons may threaten stocks of both wild and cultured fish. However, extreme weather events could further harm fish production in Nigeria by causing loss of aquaculture stock and destroying fishing and aquaculture infrastructure. The IPCC has examined the implications of projected climate change for fishery production. Overall, it concludes that the sector is vulnerable to and has the potential to be strongly impacted by climate change. Again, this section appears to be literature review rather than results from empirical data.

4.3 Climate change conflict between farmers and herdsmen

The relationship between climate change and conflict in Nigeria is enormous, and a study by Medugu et. al., (2014) shows that the immediate cause of herdsmen and farmer's conflict in northern Nigeria is as a result of natural resource scarcity and worsen conflict between the two especially as farmers' moves from the arid zone savannah of northern Nigeria to the Guinea savannah of central state of the country. Most communal clashes in the country today are actually struggle over either the control of land or mineral resources or both. In the northern and middle parts of the country, the cereal-productive Sudan Savannah ecology is transiting to pure Sahel and the influence of the Sahara is increasing southwards. In the same vein, the root and tuber productive ecology of the Guinea Savannah is giving way to Sudan Savannah grassland. The predominant herdsman of the lower Sahel and Sudan Savannah ecologies is now moving south to the north central states within the Guinea Savannah and Forest belt of the South to find greener pasture for his herds.

4.4 Farmers and fishermen adaptation to climate change

Adaptation to climate change refers to adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm of exploits beneficial opportunities (IPCC, 2001). Common adaptation methods in agriculture include use of new crop varieties and livestock species that are better suited to drier conditions, irrigation, crop diversification, adoption of mixed crop and livestock farming systems, and changing planting dates (Bradshaw et al., 2004; Kurukulasuriya and Mendelson, 2008; Nhemanchena and Hassan, 2007). The locals here however, are burdened under the weight of declining climatic conditions, poor agricultural yield and its effect on their standard of living due to inadequate understanding and conceptualization of the challenges at hand and the measures that can be employed in adapting to them. Building fisher communities' capacity to adapt to these more immediate changes goes hand-in-hand with improving their capacity to adapt to climate change. A far-reaching strategy to improve adaptive capacity and strengthen resilience promises to reduce poverty and enhance food production now and in the years to come. This is literature review.

V. CONCLUSIONS

Climate change has been revealed to have several aspects to it besides physical. There is a social, cultural and economic aspect to climate change. Only the affected people especially the fishermen and farmers can explain how the changes in climate are made manifest. The observations made here can serve as a pointer into other areas that has been overlooked by scientific researchers. So also, the perception of people to climate change influences their response to it. This could also serve as a platform for policies geared towards mitigation to be designed at different levels of government. There is also need for proper enlightenment of the vulnerable people in climate change matters and adaptation measures and improving the development of country farmers' income as one of the most effective ways to reducing their vulnerability to climate change. It has been established that, fishermen and farmers are among the most vulnerable to climate change, therefore, agro-forestry, or the intentional use of trees in the cropping system, is a potential strategy to help farmers reduce their vulnerability to climate-related hazards and sustainable fish farming with adaptive strategies will also minimizes the vulnerability of fishermen to climate disasters. To this end, in order to address climate change vulnerability issues squarely, Nigeria should continue to commit herself to her Nationally Determined Contribution (NDC). This is so important because climate change is affecting our daily life in so many ways and there is evidenced in several dimensions, depending on the region, from drought and desertification in the north, erosion in the east, flooding along the coastal zones and patches of other environmental disasters which are directly or indirectly linked to climate change.

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