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Editorial Board

Editorial Brief

We have in the second volume of IJMGS articles that were peer reviewed by scholars in the field. All, but one, were presented at various times on virtual weekly webinar organized by the Centre. They were then revised and independently reviewed as part of intellectual rigour the Journal editorial is noted for. The coverage is multidisciplinary in contents, and trans-global in analyses. The current world discourse is predicated on three main issues: health and development in the midst of ravaging COVID-19 pandemic; climate change; and food security. The commonality with the three challenges, and scholar's interrogation, is the phenomenal transdisciplinary Migration and its global context. The articles in this volume are rich in contents, informative in analyses; and refreshing in evidence. They are useful in all parameters and will add value to finding solutions to some of the issues raised on all topics.

Hakeem I. Tijani
Editor

Climate Change and the Crisis of Food and Human Security in Nigeria

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Abstract

Climate change continues to pose fundamental challenges to agricultural food production and human security in Nigeria. Since the last four decades, the country, like other countries of the world has been grappling with projected impacts associated with many of the scenarios outlined by the Intergovernmental Panel on Climate Change (IPCC). These include catastrophic shifts in temperature and water supplies, as well as rising river levels and steady decrease in arable land due to intense drought and desert encroachment in the extreme northern part of the country. These and other extreme weather events are having devastating effects on agricultural food production with attendant adverse socio-economic effects on the entire Nigerian citizenry directly or indirectly. Less crop yields and income, poverty, unemployment, lower living standard, rural-urban migration and the like, resulting from the effects of climate change have increased criminality. The southward movement by the Fulani herders for grazing land has resulted in serial violent conflicts with farmers who also want to hold on to their farmland. This development has exacerbated the tensed security situation in the country. The study concludes that though climate change impacts may not cause conflict, it increases its likelihood. It suggests measures to curb potential vectors for climate change-induced conflicts and recommends ways to mitigate its socio-economic effects.

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Comment [b1]: Keywords are not included

Introduction

Climate change can be defined as a change in the state of the climate that can be identified by changes in the means and/or the variability of its properties, and that persists for an extended period typically decades or longer (IPCC, 2007). Making reference to the Intergovernmental Panel on Climate Change (IPCC) report, Odjugo (2010) points out that, the anthropogenic factor in climate change involves human activities which distorts nature directly or indirectly. Such activities either emit large amount of greenhouse gases into the atmosphere that depletes the ozone layer or reduces the amount of carbons absorbed from the atmosphere. The human factors that emit large amounts of greenhouse gases include industrialization, burning of fossil fuel, gas flaring, urbanization and agriculture. Human activities that reduce the amount of carbon sinks are deforestation, alterations in land use, water pollution and agricultural practices. The human factors have been proven to be responsible for the ongoing unequivocal climate change or global warming (IPCC 2007).

Ugwuayin (2017) notes that one of the visible effects of climate change in Nigeria is desertification due to the long effect of drought. She adds that, drought is an insidious hazard of nature that originates from a deficiency of precipitation over a long-extended period of time. Desertification reduces arable land for agricultural purposes with attendant shortfall in food production and imminent food crisis. In Nigeria, food crisis constitutes a major threat to the livelihood of the teeming populace. The northern part of the country, where large percentage of food crops are produced, is most vulnerable to climate change because of its proximity to the Sahara Desert

further north. As Enete and Amusa (2010) aptly put it, the challenge of food security threat posed by climate change is more prominent in Africa. This is because the continent faces steady decline in agricultural products and per capita food production in the face of population growth which will double the demand for food, water and forage in the next three decades.

Food crisis in Nigeria portends great danger to the country such as aggravating the existing socio-economic problems such as hunger and poverty which have bearing with the high level of unemployment in the country. This is in addition to the poor state of the economy which will be aggravated by the global economic recession occasioned by the Covid-19 pandemic. Aside from these challenges, food crisis also encourages migration from one part of the country to the other. On the one hand, the inability of farmers to adapt to climate change is making them to seek for alternative means of income and thereby worsening the rural-urban migration in the country. On the other hand, desert encouragement is compelling a gradual drift from the north to the south for grazing and farming. According to Toulmin (2009), migration as a response to floods and droughts is a well-known means of reacting to climatic stress. For example, communities in some disaster-prone areas have moved to upland areas either with support from government or on their own, using networks and contacts to help them. However, Toulmin noted that, large flows of migrants can generate serious problems in their destinations, given scarce land, water and shelter, from which conflict can develop.

It is against this background that the study focuses on human security challenge on the account of food crisis induced by climate change. Human reaction to food crisis and other effects of climate change is premised on many factors. These can be related to the projected impacts associated with many of

the scenarios outlined by the Intergovernmental Panel on Climate Change (IPCC). These include catastrophic shifts in temperature and water supplies, as well as rising sea levels and a large increase in the incidence of hurricanes, storms and other extreme weather events. According to Toulmin, (2009:109) "these impacts would jeopardize the security of most countries around the world, and especially low-lying small island states, which risk seeing their territory inundated".

Nigerian is a plural state with a long history of ethnic and sectarian conflicts. The serial farmers/herders' clashes in the last two decades is an indication that climate change will generate a greater number, and intensify conflicts in the country. Besides, Nigeria has been portrayed as particularly vulnerable to such a rise in conflict, owing to its high poverty index, high rate of unemployment, weak internal cohesion and poor levels of state organization. The study interrogates security and conflict as it is induced by climate change. It also goes on to examine recent patterns and causes of conflict in Nigeria and assesses the likelihood of their increase as a consequence of climate change. It gives support to the view that, "the evidence shows that, while climate change may not cause conflict, it will increase its likelihood" (Toulmin, 2009: 109). Premised on food crisis and human security challenge, the study analyzes and evaluate these two major factors of climate change as they affect Nigeria.

Climate Change: The Factor of Desertification and Agricultural Food Production in Nigeria

Climate change is different from the generally known terms like climatic fluctuations or climatic variability. These terms denote inherent dynamic nature of climate on various temporal scales. Such temporal scale variations could be monthly, seasonal, annual, decadal, periodic, quasi-periodic or non-periodic. "Climate change is caused by two basic factors, which include natural processes (biogeographical) and human activities (anthropogenic)" (Odjugo, 2010:47).

In terms of biogeographical factor, Nigeria is naturally endowed with rich vegetation and abundant mineral resources, thus making it one of the richest countries in Africa. Due to its large size, four distinct physical regions can be distinguished ranging from the south to the north. Along the coastline is the dense belt of mangrove swamp forest that varies from 18 to 108 kilometres width, which is sparsely populated and little developed. Next is the tropical rain forest belt which is intersected by streams and rivers and varies from 90 to 180 kilometres northward from the east to the west. This is followed by a 480-kilometres-wide belt of open woodland and grass savannah. This zone finally graduates into a vast undulating plateau with intervals of hills until it reaches the southern fringes of the Sahara Desert. The graduation in vegetation and climate is the result of wide variation of rainfall determined by the seasonal inflow of humid air from the South Atlantic (Coleman, 1986). The variation in the climate from the south to the north makes the country to be broadly classified into the hot dry savannah of the north and the damp swampy coastal area of the south. There are two major seasons – the dry season and rainy season that varies from the south to the north. The dry season begins in the north in October and ends in April, while in the south it is of a shorter duration. The dry season is also characterized by the Harmattan –

a dry north-easterly wind which brings along with it a thick haze composed of minute particles from the Sahara Desert. The rainy season has peak periods in July and September. The average temperature varies from 72F to 89F depending on the season (Ezera,1964). This difference in regional climate and vegetation is a major determinant of the soil fertility and the production of the various cash and food crops. Perhaps the most prominent physical feature of Nigeria is the river from which the country derives its name. The River Niger enters the country from the north-west and is joined by its principal tributary, the Benue at Lokoja from where it flows into the Delta area before emptying into the Atlantic Ocean.

This natural climatic pattern has been disrupted over the last three decades as a result of climate change. Nigeria, like most other countries of the world, has experienced unusual rainfall pattern and high temperature level year in year out. The unusual rainfall pattern has resulted in either scarce or excess rainfall where much rain is needed for the production of such crops as millets, sorghum, groundnut, cassava and yam. Due to excessive rainfall, the country has witnessed perennial flood in the last eight years. For example, when the country witnessed the unprecedented flood incidence in 2012, more than twenty out of the 36 states were badly affected. The flood washed away farm lands and affected agricultural produce. Ever since, it has become an annual occurrence, especially in states that the Niger and Benue Rivers (the two major rivers in the country) run through like: Kebbi, Niger, Kwara, Taraba, Benue, Kogi, Anambra, Delta, and the coastal states like Lagos, Bayelsa, Rivers, Cross River. The excessive rainfall resulted in the overflowing of the river boundaries.

Couple with excessive rainfall is high temperature level that the country has also experienced. The year 2014 ranks as Earth's warmest since modern recordkeeping began in 1880, according to two analyses by the U.S. government and another by Japan. The shortfall in rain and high temperature recedes downward from the Sahel region that borders the semi-desert area of the extreme northern part of the country to the Savannah region, down to the rain forest and the Mangrove Swamp of the coastal area of the south. This persistent high temperature and scarce rainfall has resulted in drought in most parts of the extreme northern states –Sokoto, Zamfara, Kano, Katsina, Jigawa, Yobe and Bornu._Ugwuayin (2017) expresses the view that, this usually results in water shortage in the environment when the supply of moisture from precipitation or moisture stored in the soil is insufficient to fulfill the optimum water needs of plants. This, she further explains is relative to some long-term average condition of balance between precipitation and evapo-transpiration (evaporation and transpiration). Drought is also related to the timing and effectiveness of rains from the perspective of principal season of occurrence and delays in the start of rainy season and occurrence of rains in relation to principal crop growth stages. More importantly, rainfall intensity and number of rainfall events are important benchmarks for ascertaining drought in an environment.

Ugwuayin (2017) further observes that, rainfall in the Sahel has been declining steadily since the 1960s which has resulted in steady loss of farmlands and grazing land. Many different communities, including fishermen, farmers and herdsmen are now confronted with difficulties arising from climatic changes. Peoples' livelihoods are being harmed, and already poor people are becoming even more impoverished. Climate refugees are being

created, as climate change makes some land inhabitable and impacts water supplies. Ugwuayin maintains that, most parts of northern Nigeria which falls within the Sudan Savannah is increasingly becoming an arid environment at a very fast receding rate per year occasioned by fast reduction of the amount of surface water, flora and fauna resources on the land. Added to this is the effect of wind erosion that is quite severe in most Sahel States of Sokoto, Zamfara, Kebbi, Katsina, Kano, Jigawa, Borno, Yobe, Kano, Adamawa and Bauchi as a result of drought conditions in the area. The Sahel states are known for the production of major agricultural crops such as groundnut, sorghum, millets, legumes, cassava, yam and vegetables that are among the major staple food in Nigeria.

So severe is the effect of drought that desertification has constituted a major challenge to the agrarian society of the extreme north represented by the states mentioned above. According to Ugwuayin (2017), Nigeria is presently losing about 351,000 square kilometers of its landmass to the desert, which is advancing southward at the rate of 0.6 kilometers annually. She added further that, the consistent reduction in rainfall leads to a reduction in the natural regeneration rate of land resources, which presents a chain of causal reaction that, makes people to exploit more previously undisturbed lands leading to depletion of the forest cover.

Theoretical Framework: The Link between Climate Change, Desertification-Driven Resource Crisis and Human Security

The factor of climate change as it induces food crisis with attendant human security challenge can be conceptualized through the interrogation of these three factors that will be examined in sections.

The Concept of Climate Change and Food Crisis - IMPACT and DSSAT Models

There is a close link between climate change and food crisis as a direct consequence of climate-induced biogeographic and anthropogenic factors. So many models have been adduced to explain this concept. However, this study is combining IMPACT (International Model for Policy Analysis of Agricultural Commodity and Trade) and DSSAT (Decision Support System for Agro-technology Transfer) models to explain the concept because of their interrelationship as presented by Nedumaran et al (2010). The IMPACT model combines a partial equilibrium model that has global coverage with hydrology and water supply and demand model. This is implying that there must be equilibrium in the demand and supply of water either in excess or shortfall as a major determinant of crop production yield. It is also a multi-commodity, multi-country partial equilibrium agricultural model for 40 commodities of crop and livestock, including cereals, soybeans, roots and tubers, meats, milk, eggs, oilseeds, oilcakes/meals, sugar/ sweeteners, and fruits and vegetables. The DSSAT model on the other hand is crop-modelling suite for five crops – rice, wheat, maize, soybeans and groundnuts. The model is techniques of supporting crop growth with an option to include CO2 fertilization effects at different levels of CO2 atmospheric concentration.

According to Easterling et al. (2007), the models have shown positive yield impacts in cooler climates, while decreasing yield levels in lower latitudes where the majority of the developing countries are located. Changes in yield of rain fed crops will be driven by changes in both temperature and precipitation, whereas those of irrigated crops will be driven by changes in precipitation alone. Similarly, Jarvis et al., (2008) contend that, changes in temperature and precipitation regimes are likely to cause the extinction of wild relatives of crops as suitable natural ecosystems would decrease or disappear. Cline (2007) also observes that, owing to global warming, the developing countries face a 9% to 21% decline in overall agricultural productivity, whereas effects on industrialized countries will range from a 6% decline to 8% increase, depending on the offsetting effect the additional atmospheric carbon could have on rates of photosynthesis. Again, Jarvis et al. (2011) maintain that, it is expected that shifts in crop climates to 2050 will result in many countries facing novel climates that are currently not found in their boundaries. The challenges and stresses that face global food production and distribution systems are particularly acute and pressing for sub-Saharan Africa, where persistent levels of food insecurity already exist. Dixon et al., (2001) explain that about 43% of the population lives below the international poverty line. Additionally, the area affected by land degradation within the region is expanding, thereby reducing the yield levels.

Climate change effects on crop production enter into the IMPACT model by altering both crop area and yield. Yields are altered through the intrinsic yield growth coefficient and water availability coefficient for irrigated crops. These yield growth rates depend on crop, management system and location. For most crops, the average of this rate is about 1% per year from effects that are

not modelled. In some countries, however, the growth in yield is assumed to be negative, whereas in others it is as high as 5% per year for some years.

From the African context, the application of these two models is indicative of the reality that Climate change has started to, and will continue to impact negatively on agriculture and food security, especially in tropical and subtropical regions, because greenhouse gas emissions would increase the risk of hunger by additional 80 million people by 2080 in Africa (Odjugo, 2010:47). Similarly, the IPCC 2007 report states that, 'Africa is one of the most vulnerable continents to climate change and climate variability, a situation aggravated by the interaction of multiple stresses attributable to anthropogenic and human factors.

Toulmin (2009), gives an overview of the causes of climate change for a better understanding of the phenomenon. She explains that, the earth's climate is determined by a combination of the energy that comes from the sun and the physical and chemical properties of the earth's surface and atmosphere. Some of the sun's radiation striking the earth is absorbed by the surface, while the rest is reflected, either escaping into space or becoming trapped by gases in the earth's atmosphere. Trapped radiation is then recycled back to earth, adding extra warmth to the surface – a process called the 'greenhouse effect'. This, according to her is a natural phenomenon that ensures that the amount of energy coming in is balanced by that radiated into space, so maintaining a relatively stable temperature at the earth's surface. The concern over global warming focuses on gases in the earth's atmosphere, which have a capacity to absorb the radiation reflected from the earth in order to trap heat. Most greenhouse gases (GHG), such as carbon dioxide (CO2) and

methane (CH4), occur naturally, and are normally present at atmospheric concentrations that effectively regulate the earth's temperature.

In terms of the anthropogenic factor for climate change, Toulmin again explains that, an increase in their concentration has occurred over the last 250 years which however, due to human activities, such as burning carbon-based fuels – an increase which has intensified the greenhouse effect and is leading to global warming. Other greenhouse gases, such as nitrous oxide (N2O), are man-made and are also increasing in concentration. The increase in man-made GHG has also been accompanied by an increase in small particles of dust, soot or sulphur from industrial pollution and soil erosion, which reflect or absorb incoming solar radiation, also leading to cooler or warmer conditions. Volcanic eruptions – even though not experienced in Nigeria, are very important source of such particles and play a part in global cooling (Toulmin, 2009:16-17).

The Concept of Climate Change and Human Security

There is also a close link between human security which is the conditions necessary for survival against the socio-economic problems associated with climate change such as poverty, hunger, unemployment, etc. Hussein et al (2004:8) allude that "human security is a critical component of the global political and development agenda". Against this backdrop, they also observe that two ideas lie at its heart: firstly, the protection of individuals is a strategic concern for national as well as international security; secondly, security conditions for people's development are not bound to traditional matters of national defence, law and order, but rather encompass all political, economic and social issues enabling a life free from risk and fear.

Effects of Climate Change on Food and Human Security in Nigeria

A lot have been written on the environmental effects of climate change. But the effects as it bothers on food crisis and human security in Nigeria is very scanty. Hence, this study is prompted by the relatively less attention given to these two phenomena to interrogate the devastating effects of what has been tagged "the doomsday predictions" (Nwolise, 2013). Again, there is the need to bring into context scholarly views on this.

Expressing view on desertification as a process of climate change, Toulmin (2009) argues that, natural systems are normally resilient to a certain degree of climate variation. In the same manner, plant species have relied on their genetic diversity to help them evolve over many generations. Trees can adapt to long-term changes in environmental conditions by, for example, altering their pattern of growth and the timing of flowering, fruiting and germination, to fit with the new constraints. At the same time, environmental change will also alter the behaviour of other key species, such as pollinators and animals that rely on the tree for food and shelter. But such adaptation takes time, especially in forests where the lifetime of a tree is measured in hundreds of years. Making reference to the opinion of Pernetta (2004), Toulmin further contends that, a wide genetic base can give plants greater tolerance for a variety of environmental conditions. This provides the option of shifting their geographic range, in terms of altitude or latitude, when conditions in one place no longer suit them. Toulmin also draws on the views of Petit et al. (2008) that the adaptation processes have proved reasonably successful in the past, although fossil records show previous extinctions of plant species have occurred, primarily during periods of high climate variability.

On the role of human-induced climate change and gradual process of adaptation, Toulmin also observes that, if climate change is rapid relative to the generational time of the plant, and creates conditions not previously experienced, then the change may push the species to the limits of how fast it can adapt. This will happen even more quickly if the plant species has a limited genetic range. The expectation is that the speed of global climate change over the next 100 years will put 20–30 per cent of plant and animal species at increased risk of extinction, including those within forests. These impacts will stem directly from the changes in rainfall and temperature described earlier, and from a range of other factors, such as the increased frequency and intensity of wildfires, hurricanes, insect and disease outbreaks, flooding and drought. Maintaining a broad genetic range within a given tree species, as well as a high level of biodiversity within forests as a whole, will be important factors in maintaining the resilience and productivity of forests in the face of growing pressures. Toulmin also supports her view with Hansen et al.'s (2003) opinion on forest management, maintaining that, other elements in forest management to reduce vulnerability to climate change include avoiding fragmentation of forest areas, providing buffer zones, protecting mature tree stands, and establishing refuge areas.

Firstly, it is important to look at the vulnerability of agriculture to climate change in a broad perspective. Nedumaran et al (2015) identifies a number of factors that make agriculture vulnerable to climate. They ascribe higher temperatures as a factor because it reduces yields and tend to encourage weed and pest proliferation. According to them, greater variations in precipitation patterns increase the likelihood of short-run crop failures and long-term production declines. They also maintain that, though there might be

gains in some crops in certain regions of the world, the overall impact of climate change on agriculture is expected to be negative, threatening regional food security in many parts of the developing world that are still predominantly agrarian in nature in particular and world over in general.

Even though desertification is blamed on overgrazing practices of the local population, it has been discovered that the real problem is climate change. Ugwuayin (2017) contends that, Nigeria is not a major contributor of greenhouse gas emissions when compared with industrialized countries; but is a major supplier of oil and gas to countries with high greenhouse gas emissions. The exploitation of gas and oil for export from the Niger Delta contributes to global warming and it also destroys the environment and harms communities living near these projects. Oil fields in the Niger Delta of Nigeria contain crude oil mixed with very large amounts of gas. Major oil companies operating in Nigeria separate the oil from its associated gas at flow stations, where the gas is simply burned off, serving no useful purpose and contaminating the air and lands for local communities. The effects of gas flaring on the communities are continuous noise, rise in temperature in communities close to flare sites, acid rain, retarded crop yield, corroded roofs, respiratory diseases and the loss of darkness as with the unnatural illumination from gas flares at night. Gas flared in Nigeria contains high amount of methane and carbon dioxide and is a major contributor to global warming as it produces emissions that is more than the combined emissions of the rest of sub-Saharan Africa (Adegbulugbe and Akinbami,2006). These oil and gas projects do not provide energy to the people who live in the region but only pollute their air and lands from the gas flared by Shell and other major Transnational Corporations. Hydropower generation is the energy

source most likely to be affected by climate change because it is sensitive to the amount, timing, and geographical pattern of precipitation, as well as temperature. Reduced flows in rivers and higher temperatures reduce the capabilities of thermal electric generation. Higher temperatures also reduce transmission capabilities. Excessive drought will lead to higher evapo-transpiration, which adversely affects water volume, and hence reduces hydroelectric capacity. There are glaring pieces of evidence that climate change is not only happening, it is changing the lives of Nigerians, directly or indirectly (ibid).

Extreme events, sea level rise, disruption and damage from floods and storms are also major consideration. A changing climate will also bring a higher level of extreme events, such as storms and floods, causing damage to infrastructure, housing, energy and transport systems. Over time, sea level rise will force some people from their homes and necessitate the relocation of coastal settlements and farming areas. It is reckoned that those areas already adversely affected by weather-related hazards will experience an increase in their intensity and frequency. For conflict to be avoided under this condition will depends on how it is managed with adequate levels of disaster preparedness, whether it triggers a wider sense of grievance, and how far people choose not to politicize such disasters (Toulmin, 2009).

Effects on Food Production

The obvious impact of climate change is in the agricultural sector. The biological effects of climate change on the production of these crops is explained by Nedumaran et al (2015). They contend that biological effects of

climate change on crop yields induces changes in production and prices, which play out through the economic systems as farmers and other market participants adjust autonomously, altering crop mix, input use, food production, food consumption and trade. They contend that, the IMPACT and DSSAT climate models' simulations for the twenty-first century consistently predict increases in precipitation in the higher latitudes (very likely) and parts of the tropics, and decreases in some subtropical region (see Table 2).

Table 1: Climatic Change and Food Security in Nigeria

Production and Yield of Crops in Nigeria in Baseline Scenario, 2010 and 2050

	2010			2050					
				Yield		Area		Production	
Crop	**Yield**	**Area**	**Production**	**Min**	**Max**	**Min**	**Max**	**Min**	**Max**
Sorghum	1.20	8,261.62	9,922.53	1.98	2.01	8,450.37	9,113.37	16,744.01	18,122.02
Millet	1.28	5,680.14	7,298.22	1.97	2.00	7,969.10	8,490.17	15,676.36	17,001.57
Groundnut	0.76	3,262.32	2,223.19	0.84	0.97	2,845.39	3,534.85	2,720.40	3,202.05

Key: Area in '000ha; Production in '000tons; Yield in tons/ha

Source: Adapted from table on Climate Change & Food Security in Asia and Africa: Agricultural, (Nedumaran et al in *Challenges and Adaptations at Farms Level: Case Studies from Asia & Africa)*.

Table 2: Climatic Change and Food Security in Nigeria

Impact of Alternative Climate Scenario on Crop Production in Nigeria

(Percentage derivations from baseline, 2050)

	CSIRO B1			CSIRO A1 B			MIROC B1			MIROC A1B		
Crop	**Yield**	**Area**	**Prod.**	**Yield**	**Area**	**Prod.**	**Yield**	**Area**	**Prod.**	**Yield**	**Area**	**Prod.**
Sorghum	0.59	1.03	1.69	0.44	1.25	1.69	1.52	0,23	1.75	0.14	-6.12	-5.98
Millet	1.61	1.61	2.18	0.62	1.74	2.37	0.51	-0.07	0.43	-1.03	-4.63	-5.61
Groundnut	0.30	7.89	8.22	-6.44	2.67	-3.94	7.82	-6.40	0.92	5.87	-13.15	-8.06

Key: Area in '000ha; Production in '000tons; Yield in tons/ha

Source: Adapted from table on Climate Change & Food Security in Asia and Africa: Agricultural, Nedumaran et al in *Challenges and Adaptations at Farms Level: Case Studies from Asia & Africa*.

As climate change progresses, Nedumaran et al (2015) maintain that, it is increasingly likely that current cropping systems will no longer be viable in many locations. As mentioned above, a number of processes linked to climate change will impact agricultural productivity. This is why Easterling et al., (2007) express the view that, agricultural productivity is expected to decrease in tropical regions. Tables 1 and 2 show how climate change productivity effects are produced by calculating location-specific yields for each of the three selected Nigerian crops (sorghum, millet and groundnut) modified with DSSAT for between the 2010 and 2050 climate. They are crops produced in the northern part of the country where the effect of the climate change is much more obvious. The production and yields of these crops in a baseline scenario. Given a particular climate scenario, Nedumaran et al show that the direction of change is determined through three variables – yield, area and production. Table 1 shows that, the yields, area of cultivation and production output for the three crops is projected to increase minimally or maximally between 2010 and 2050.

A country's wealth and infrastructure will determine, in large part, its ability to tackle and adapt to climate change (Toulmin, 2009). Giving a total of four climate scenarios, Table 2 indicates that, the percentage deviations of the forecast for 2050 from the baseline 2050 values have been reported as they represent the largest of the increases/decreases for the entire time period (2010–2050) for which the IMPACT model makes forecasts. According to Nedumaran et al, the rationale for reporting the percentage deviations rather than the absolute values is that they are indicative of the direction of change from the baseline values. They explain that since the future climate is uncertain, two emission scenarios were considered namely, A1B and B1 for

the purpose of this study. Each of these two emission scenarios are combined with the two most commonly used general circulation models (GCMs), namely MIROC1 and CSIRO. On the one hand, the CSIRO model simulates a situation in which there are no increases in precipitation and small increases in temperature. The MIROC model, on the other hand, simulates a future scenario wherein there are the largest increases in rainfall and temperature. The A1B scenario is a greenhouse gas emissions scenario that assumes fast economic growth, a population that peaks mid-century, and the development of new and efficient technologies, along with a balanced use of energy sources. The B1 scenario is a greenhouse gas emission scenario that assumes a convergent world with the same global population, which peaks in the mid-century and declines thereafter, with rapid changes in the structure of the economy towards a service and information economy, with reductions in material intensity, and the introduction of clean and resource-efficient technologies Nedumaran et al (2015:89). The projected percentage yields, area of cultivation and production of sorghum, millet and groundnut under the four climatic scenarios as indicated above will decrease between 2010 and 2050.

It is indicative from the above analysis that Nigeria will be confronted with serious shortfall in food output by 2050. In other words, given the next thirty years, Nigeria may face food crisis due to effects of climate change. This portends socio-economic challenges for the country. This assertion is supported by Food and Agricultural Organization (FAO)'s recent estimate that, the number of people suffering from chronic hunger has increased from under 800 million in 1996 to more than a billion. Most of the world's hungry are in South Asia and sub-Saharan Africa. The report further indicated that,

these regions have large rural populations, widespread poverty and extensive areas of low agricultural productivity owing to steadily degrading resource bases, weak markets and high climate risks. Farmers and landless labourers dependent on rain-fed agriculture are particularly vulnerable due to seasonal variability in rainfall and endemic poverty that forces them to avoid risks. (Nedumaran et al, 2015). Supporting this view, Vermeulen et al., (2012) remark that, climate change is of particular significance for these countries, which already grapple with global and regional environmental changes and significant inter-annual variability in climate change. Also expressing view on the effect of climate change on food production, Godfray et al. (2010 observe that climate change will bring further difficulties to millions of people for whom achieving food security is already problematic and is perhaps the most pressing human challenge as the goal is to nourish 9 billion people by 2050.

Human Security Challenges

While discussing the vulnerability of agriculture to climate change, it is also pertinent to examine its effects on human security. The link between climate change and human security can be looked at from two perspectives. From the socio-economic perspective, the concern is that climate change will "alter and threaten the living conditions of much of mankind. They may induce large-scale migration and lead to greater competition for the earth's resources" (Toulmin, 2009:114). The second perspective focuses on security risk that climate change-induced conflict engenders. "There may be increased danger of violent conflicts and wars, within and between states" (ibid).

The human socio-economic effects of climate change involve increased poverty, poor standard of living, unemployment, enhanced rural-urban migration. Rosenzweig and Parry (1994); McGuigan et al. (2002), opine that, the impacts of climate change on agricultural activities have been shown to be significant for low input farming systems in developing countries in Africa. Africa has a higher proportion of people living in poverty than any other region of the world. Across the whole region, rural poverty still accounts for 90 percent of total poverty and approximately 80 percent of the poor still depend on agriculture or farm labour for their livelihood (Eneate & Amuas, 2010: 4).

Human security can be defined as the security of the individual with respect to the satisfaction of the basic needs of life. It also encompasses the creation of the social, political, economic, military, environmental and cultural conditions necessary for the survival, livelihood, and dignity of the individual, including the protection of fundamental freedoms, the respect for human rights, good governance, access to education, healthcare, and ensuring that each individual has opportunities and choices to fulfil his/her own potential (African Union Summit, 2004). Viewed from the qualitative and quantitative perspectives (Thomas and Wilkin,1999), human security is about protecting and empowering citizens to obtain vital freedom from want, fear and hunger, as well as freedom to take action on one's own behalf including, among other things, creating the building blocks of human flourishing, peace with dignity and a secure livelihood (Salih, 2008).

If the above definition is anything to go by vis-à-vis the effects of food crisis predicted by the analysis on food production between 2010 and 2050 made above, Nigeria will be confronted by a myriad of social problems. Low

yields in agriculture, resulting from climate change-induced drought/desertification and in some cases destruction of crops and loss of farmland due to flood, many farmers will be gradually out of job. This in turn will increase unemployment and the poverty index of the country. According to the Global Multidimensional Poverty Index of the UN, Nigeria's poverty index was 46% as of 2010. Higher percentage of the unemployed will imply lower standard of living and encourage rural urban migration for means of livelihood. This will in turn put pressure on the country's urban centres, increasing the rate of crime, emergence of slums, and pressure on government's ability to provide social amenities for the teeming population.

However, the obvious and most challenging national question in Nigeria today is the security of lives and property which climate change-induced conflict engenders. To this end, Toulmin (2009) expresses the view that, climate extremes and uncertainty will add to existing tensions in already volatile regions of the world and Africa will be one of the regions hardest hit by climate change. This is implies that, while Nigeria is grappling with the socio-economic induced problems, it also has to guarantee its citizens freedom from violence – physical hurt, injury, abuse or the threat thereof that constitutes the core of security risk. In the last few years, the country has witnessed serial farmers/herders' clashes over the diminishing arable land due to drought, desert encroachment and flood.

The Farmers/Herders' Conflict

It is envisaged that climate change and environmental degradation will lead to major conflicts and struggle over ever scarcer resources, such as water and good land in Africa (Homer-Dixon, 2009). The tendency to resort to conflict is

linked to poverty and weak institutional development that characterized most modern African states (Toulmin, 2009). Although, Africa is a conflictual continent owing to multifaceted factors, there is direct link between resource scarcity and violence caused by climate change.

The farmers/herder's conflict has become a national question because of the ethno-religious nature of the problem. The herders, identified as the Fulani nomads (cattle Fulani), an extraction of the Fulani ethnic group have been in violent confrontation with various local farming communities in the country over grazing land for their cattle. Apart from the northern part of the country where they are predominant, the need for grazing land has compelled some of these Fulani herders to settle in different parts of the country for several decades. However, as the effect of drought and desert encroachment continues to reduce grazing land and arable land in the northern part of Nigeria, the need to remain in business has compelled southward movement of more Fulani herders. This southward surge has led to violent confrontation with the local farming communities. In order to understand the root cause of the incessant violent confrontation, the study interviewed a local farmer, a Fulani herder and relation of a victim of the violent confrontations that have almost degenerated into inter-ethnic and religious confrontation. They expressed different views on the reasons for the confrontation.

In an interview with Alhaji Jauro Ado, a Fulani herder in Baddiko, near Jengre, Plateau State, central Nigeria, he claimed that his grandfather, Baba Buki had migrated and settled in the place several decades ago. According to Ado, the land was on free lease from one Rakahama, an indigene of Baddiko. Initially, he said that they were not paying royalty for the land but that they started paying a token of N10,000 every five years to the Rakahma family. He

maintained that, they had lived peacefully as good neighbours in the past until the face-off began. He attributed the face-off to the use of fertilizer and other chemical by farmers as affecting good pasture for their herds. He also attributed the violent clashes to reprisal action which often occurred when there was loss of life from either side.

Also in an interview with Manchido Ayuba Abarishi, a farmer in Aweh, Nassarawa State, central Nigeria, he attributed the farmers/herders clash to intentional grazing on farmland, an action he considered as vagrant disregard of the farmers' means of livelihood. According to him, the act of leaving the grazing land for the farmland was an indication that their action was intentional. But rather than ascribe it to the effect of climate change, Manchido saw it as an age-long religious rivalry between the Muslim Hausa/Fulani and the indigenous Christian farming communities. He maintained that, this religious rivalry had its root in the inability of the Fulani to establish political control over the minority ethnic groups in today's "Middle Belt states" (Taraba, Benue, Plateau, Kaduna, Niger, Kwara and Kogi States).

Another interviewee who expressed his view was Pastor David Rakaham Boyi, an indigene of Baddiko near Jengre, Plateau State. As a relation of the victim of farmers/herders' conflict, Pastor Boyi presents the opinion of those who are directly or indirectly affected by the farmers/herders' conflict. Pastor Boyi whose sister was a victim of the farmers/herders' clash in Baddiko said that his grandfather leased their family land to Alhaji Ado's grandfather for herding some decades ago. Giving reasons for the conflict, Pastor Boyi expressed the view that, climate change is a trigger to the underlying factors. To him, the conflict had religious motive. According to him, the Fulani herders never had problem with land for grazing. To him, the underlying reason was

to Islamize Nigeria. He buttressed this point with the claim that the Fulani herders had assumed the role of landlords on these leased lands to the extent that some of the indigenous people had become tenants on their own lands. The bid to carry out this Fulani agenda had always led to vindictive and vengeance mission.

These three categories of interviewees represent the views of the wider Nigerian populace going by the endemic nature of the conflict. The opinions expressed here is indicative of the fact that as much as there may be some underlying reasons for the farmers/herders' conflict, the effects of climate change have exacerbated these factors. In other words, the effects of climate change cannot be wished away from the interface between these warring parties because land is a major factor for their livelihood. Moreover, the farmers/herders' conflict has spread from the northern to the southern part of the country. Between 2015 and 2019, the country recorded not less than 16 clashes (see Table 3).

Table 3: Newspaper and agency reports between 2015 and 2020 of some incidences of farmers/herders' violence in Nigeria

Date	Newspaper/Agency	Place of Conflict	State	Incidence
Sept. 16, 2015	This Day	Ibi, Ibi LGA	Taraba	9 persons killed
December 10, 2015	The Punch	Kwata, Jos South LGA	Plateau	22 persons killed
February 12, 2016	The Punch	Agatu	Benue	300 persons

				killed
February 21, 2016	New York Times	Godogodo Village	Kaduna	Burning of buildings
September 8, 2017	Premium Times	Ancha	Plateau	19 persons killed
February 4, 2018	Daily Post	25 Villages	Nasarawa	Houses burnt down
February 4, 2018	World Watch Monitor	Shiuba and Shinure	Adamawa	30 people killed
May 28, 2018	Premium Times	Jalingo	Taraba	1 person killed
June 17, 2018	The Telegraph	Meye Village	Kaduna	71 persons killed
June 25, 2018	New York Times	Several villages	Benue	21 persons killed
August 10. 2018	EU RIR	Benin City	Edo	Several schools burnt down
February 10, 2019	New York Times	Ungwar Barde	Kaduna	60 persons killed
February 21, 2019	New York Times	Kutura	Kaduna	4 persons killed
February 13, 2020	Premium Times	Aywon, Uwheru	Delta	2 persons killed

February 14, 2020	Niger Delta Weekly	Ughelli	Delta	10 persons killed
February 15, 2020	Premium Times	Agadama	Delta	7 persons killed

Source: Compiled from the newspaper and agency reports.

The above Table is a compilation of a few national newspapers and agency reports on farmers/ herders' violence in Nigeria between 2015 and 2020. It shows that not less than 556 people were killed within this space of five years with unquantifiable value of property destroyed. This is excluding several other incidences that were not included in the compilation. And as Krista Mahr, a special correspondent with *New York Times* in a report quoted the Amnesty International to have recorded nearly 3,500 deaths in more than 20 of Nigeria's 36 states within the space of three years. The Table shows that the country witnessed the highest incidences of farmers/herders' violence with not less than 123 fatalities in addition to the destruction of unquantifiable value of property in six states alone.

Potentials Vectors for Climate Change-induced Conflict in Nigeria

Nigeria is an entity within the West African sub-region that share so many common features and effects of climate change. Consequently, there are several trends of potential tensions that will arise because of changes to resource availability and where investment in better governance and institutions would help both strengthen resilience to adverse change and reduce risks of conflict (Toulmin,2009).

Development of Hydroelectric Power and Water Management – Nigeria is contending with developing its electric power need and to effectively manage the various River Basins for agricultural purposes. The construction of hydroelectric dams along so many rivers like Niger, Shiroro and Mambilla amidst the effects of climate change will cut water flow downstream and further put pressure on the availability of water for agricultural purposes in the various river basins.

Migration of People Facing Crop Failure – Climate change could lead many people to migrate to areas with better conditions. Apart from creating environmental refugees as a result of drought and other changes to weather systems, it has also engendered rural-urban migration. The ability of the government to keep impoverished rural people on the land, in their villages or camps. (like in Ethiopia), is to avoid a growing landless population seeking shelter in the cities, since riots by a large and hungry urban mass can threaten and topple an unpopular government (Toulmin, 2009).

Inflation in Food and Fuel Prices – Food insecurity is another factor leading to climate change-induced conflict. The vulnerability of food systems in many parts of Africa is associated with changes in supply and demand. This is based not only on the rapid increase in prices but also on the high level of uncertainty as regards food availability. Going by the food crisis in most African countries in recent times (like Ethiopia in the early 1970s and Niger in late 1980s), the fear of the Buhari administration on the consequences of food shortages in the big cities is founded. This is because a hungry mob constitutes a very powerful threat to its political future.

Suggestions to Mitigate Food Crisis and Human Security Challenges

On accepting his Nobel Peace Prize, Al Gore called on the nations of the world to mobilize to address climate change 'with a sense of urgency and shared resolve that has previously been seen only when nations have mobilized for war' (Toulmin,2009 :114). From the above discussion, it is obvious that climate change is affecting food production in Nigeria with non-availability of land for farming and grazing as a major challenge to farmers and herders. This in turn has created human security challenge that has gone beyond the livelihood of farmers and herders but has led to violent confrontation between the two sides. As a way forward, the study is making the following suggestions and recommendations.

Stronger Agricultural Policy: The government has been advised to strengthen its policy on agriculture in Nigeria. Machido Abarishi, wants farming to be encouraged so that agriculture resumes its preeminence as it was before the country's independence in 1960. He also advised that, there should also be legislation to protect local farmers from the marauding herders whose activities is creating setback for agricultural food production in Nigeria.

Ruga Settlement as a Solution? - The government is contemplating establishing Ruga Settlements or ranches as solution for the incessant farmers/herders' conflict. The problem to grapple with is the land to use for such Ruga settlements. While a Fulani herder, Alhaji Jauro Ado saw the idea of Ruga settlement as a welcome development, a local farmer, Machido Abarishi was against it. Sharing the same view, Pastor David Boyi was of the opinion that Ruga settlement would amount to snatching land from local farmers for Fulani herders. On Abarishi's part, the move would reduce the farmland for

agricultural purposes in States like Nassarawa, Benue and Taraba, considered as the food basket of Nigeria. He also believed that, the idea of Ruga settlement would not work because herders cannot be restricted to a particular place.

Reduction in Gas Flaring: Gas flaring as a contributing factor for greenhouse gases, constitute a major environmental problem in Nigeria. The reduction in gas flaring must be intensified. The ongoing projects aimed at reducing gas flaring, such as the World bank-financed Escravos Flared Gas Reduction Project combined with a tax incentive package for all projects aimed at reducing gas flaring under the Associated Gas Framework Agreement (AGFA) will go a long way in considerably reducing gas flaring in the country (Adegbulugbe and Akinbami, 2006). The promotion of less environmentally offensive energy resources such as solar, wind, small hydro, biogas, should be encouraged. These will help alleviate the burden on the environment through the exploitation of fossil fuels (ibid).

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Interviewees

1. Alhaji Jauro Ado (56 old), Fulani herder. Interviewed at a his settlement in Baddiko near Jengre, Plateau State, Nigeria on January 5, 2020.

2. Pastor David Rakahma Boyi, (54 old), Baddiko near Jengre, Plateau State, Nigeria. Relation of a victim of farmers/herders confrontation. Interviewed at his house at Baddiko on November 29, 2019.

3. Manchido, Ayuba Abarishi, (44 old), farmer in Aweh, Nassarawa State, Nigeria. Interviewed at his house at Aweh on November 26, 2019.