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CLIMATE CHANGE AND FOOD SECURITY IN NIGERIA: THE DEMAND AND SUPPLY PERSPECTIVE

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ABSTRACT: ***This paper evaluated the relationship between climate change and food security in Nigeria from 1980 to 2018. Data on monthly average rainfall and temperature of five years intervals were used to represent climate change with maximum and minimum events evaluated alongside computed averages and variances. Climate variables and their outcomes were used to corroborate food availability proxies (domestic food supply and imported food supply) and food accessibility proxies (per capita income growth rate and consumer price index for food). The results showed maximum variance temperature in Nigeria of 1.09ºC while the minimum variance temperature was 1.28ºC. These values though less than the danger benchmark of 2ºC, were considered alarming. Growth rate of imported food was seen to be the highest compared to domestic production. Consequently, consumer price index for food increased at an increasing rate over the two based period compared to per capita income growth rate. Finally, growth rate of total food supply was seen to exceed per capita income for all the years except in 1985 and 2004. The paper thus recommended the establishment of a national climate change commission to oversee the planning and implementation of climate change programmes at all levels of government.***

Keywords*: *climate change, food security, entitlement approach and descriptive analysis.

INTRODUCTION

Climate change is unarguably the biggest environmental problem of today that is threatening the existence of mankind and his environment. It is a major threat to agricultural system and food security in many countries of the world especially in sub-Saharan Africa including Nigeria. It is a broad array of alterations in climatic and weather conditions characterized by shifts in average conditions and in the frequency and severity of extreme conditions. According to Okoli and Ifeakor (2014) climate change relates to all changes in climate as a result of natural variations and human activities. Natural variation is due to increase in the concentration of carbon dioxide and other

heat trapping gases (such as methane, ozone, nitrous oxide, carbon monoxide and water vapour) in the atmosphere. These heat trapping gases are known as Green House Gases (GHG) and occur naturally in the troposphere. The greenhouse gases prevent the direct heat of the sun from heating the surface of the earth but allow sufficient heat to keep the earth warm enough for survival of life. The increased emission of carbon dioxide into the atmosphere results in the depletion of the ozone layer and this leads to increase in the earth's surface temperature due to direct heating of the earth's surface by the ultra-violet radiation of the sun. Climate change is also caused by human activities such as large scale deforestation, wide-spread use of land, overpopulation, reduced reliance on organic fuels and accelerated uptake of fossil fuels.

According to Intergovernmental Panel on Climate Change (IPCC) (2008), most countries in sub-Saharan Africa (including Nigeria) are likely to suffer the effects of climate change more than other countries in the world. This is due to their geographical location, low income, low institutional capacity as well as their greater reliance on climate sensitive renewable resources. Nigeria like other countries in Sub-Sahara Africa is highly vulnerable to the impacts of climate change. Many towns and villages in Nigeria lie along the coastal, littoral region of the south as well as the North close to the Atlantic Ocean with virtually small terrestrial habitations almost equal the sea level. These communities are exposed to climate variability or extremes such as shift in temperature, rainfall, storms and rise in sea levels. These changes in weather patterns impact negatively on agricultural activities and food security. The six geopolitical zones in Nigeria are vulnerable to climate change. The degree of vulnerability to climate change in the six geopolitical zones in Nigeria varies from zone to zone.

The South-South and South-West geopolitical zones are mainly affected by sea level rise, flooding and deforestation-induced change, for instance, in the Niger Delta region and some other parts of Nigeria, the devastating effects of the 2012 flooding were pronounced. Farm lands were destroyed and thousands displaced from their homes. the South-East zone is affected mainly by erosion, flooding and land degradation, the North-Central is affected by changes due to deforestation and over-grazing, the North-East by drought, desertification and heat-stress and the North-West is also affected by drought, desertification and heat stress (Okoli & Ifeakor, 2014). Climate change is a serious threat to agricultural production and food security.

Food security on the other hand refers to the availability and accessibility to enough food by all people at all times for an active and healthy life. A country is considered food secured when its population do not live in hunger or fear of starvation. Food security is important in any consideration of wealth and economic sustainability of a nation. The economy of Nigeria depended heavily on the agricultural sector in the 1960s, however, recent figures from the National Bureau of Statistics (2017) revealed that the share of agriculture to GDP dropped to 21.06% from a high of 69% in the 1960s. This drop in agricultural GDP was as a result of neglect of the sector. In a bid to mitigate the neglect of the agricultural sector in Nigeria, the government had established a number of programmes beginning from the 1970s. These programmes thus included: Operation Feed the Nation (1976), Green Revolution (1979), Agricultural Development Programmes (1976), River Basin (1976), Agricultural Credit Guarantee Scheme (1977), Green revolution (1980), Directorate for Food, Roads and Rural Infrastructure (1986), National Special Programme on Food Security (NSPFS) (2000), Community-Based Agricultural and Rural Development Schemes (2003), Root and Tuber Expansion Programme (RTEP) (2004), Fadama Development Projects (2008), and Nigerian Agricultural Transformation

Agenda (NATA) (2012). These policies and programmes with regard to agricultural production were hastily put together with little or no participation from those who are engaged in agricultural productivity. Moreover, none of these policies considered the growing threat of climate change to the already neglected sector that was being mitigated, for the purpose of food security in Nigeria. Unfortunately, climate variability and extremes impact more on the agricultural sector than any other sector. These impacts are manifested in changes in frequency and intensity of rainfall, droughts, floods, changes in soil moisture and nutrient, increase in pests and diseases of crops and livestock, desertification, land degradation, heat stress, rise in sea level and erosions. These adverse weather events constitute important challenges to crop and livestock production, fish farming and hunting in Nigeria.

According to the Food and Agricultural Organization of the United Nations (FAO), International Fund for Agricultural Development (IFAD) and World Food Programme (WFP) (2013), Nigeria has an energy intake of 1730Kcal and an average protein supply of 64g capita per day far below the 2500 – 3400Kcal minimum recommended daily intake per day. This shows that Nigeria is facing the challenge of unbalanced diet leading to various deficiency symptoms. Also among the 109 countries assessed by Global Food Security Index (GFSI) (2015), Nigeria was 91st with 37.1 score based on indices of affordability, availability, quality and safety.

The above reports from both local and international institutions of reputable standings on the dwindling fortunes of agriculture and food security in Nigeria coupled with the increasing and persistent threat of climate change that was never considered in any of the agricultural policies despite the country's vulnerability to climate change, called for the urgency of this research paper. Several studies including those of Okoli and Ifeakor (2014); Okolo and Obidigbo (2015); and Metu, Okeyika and Maduka (2016) were all carried out in Nigeria with regards to climate change and food security. However, none of these studies advocated for climate change policy in agricultural programmes to ensure food availability and the role of access to food as key to food security in Nigeria which this study seeks to achieve. The specific objectives of this study thus are: (i) to examine the relationship between climate change and food availability in Nigeria, and (ii) to evaluate the relationship between climate change and access to food in Nigeria between 1981 and 2017. This paper is presented in five sections. Section II summarized the literature reviewed and presented a theoretical framework, while methodology and data sources follows in Section III. Presentation and Discussion of results is presented in Section IV and conclusion/recommendations are presented in Section V.

LITERATURE REVIEW

There are several works done in the area of climate change and food security. Some of the foreign works found in the literature include but not limited to the works by (Sinha and Swaminathan, 1991; Lal *et al.*, 1998; Saseendran *et al.*, 2000; Aggarwal & Mall, 2002; Mall *et al.*, 2006; Kalra *et al.*, 2007; World Bank, 2006; Aggarwal, 2009). All of these studies attempted in one way or the other to investigate the impact of climate change on food security. In Nigeria, such studies as Obioha (2009), Okoli and Ifeakor (2014), Tersoo and Ogochukwu (2014), Ethan (2015), Islam & Wong (2017) and Ojunderie and Ogunsola (2017) also made the list. Some of these studies admitted to the negative impact of climate change on food security while others deny this relationship. Besides, most of the studies in this area were based on the sound understanding of agronomic science thus these studies ignored adaptations that farmers follow to minimize the harmful effects of climate change. Theoretically, economists have estimated

the climate change impacts on agriculture using Ricardian theory of land rent (Mendelsohn *et al*., 1994; Sanghi *et al.*, 1998; Sanghi and Mendelsohn, 2008; Kumar and Parikh, 2001) assuming that farmers maximize profits by allocating land to different crops in a declining order of fertility and climate, and everything else remaining constant, the regional differences in land value or productivity are due to differences in the climatic conditions. In most of these studies land value or net revenue per unit of land from a cross-section of heterogeneous units, has been regressed on climate normal. Again, a major criticism of this approach is the assumption of no variation in the crop choices and production technology over time, regardless of the climate change. Some economists have also adopted the Malthus population framework as one of the earliest thesis on the relationship between population growth and food security. However, this theoretical framework was broad and can only help in the framing of specific theories that can evaluate fewer cases.

Theoretical Framework

Following the controversies associated with empirical studies on climate change and food security, differences in land fertility theory as propounded by Ricardo and the broad nature of the Malthus population thesis, this paper adopts Amatya (1981) Entitlement's Approach as its theoretical framework. This theory stressed that people suffer from food insecurity as a result of their inability to have access to food irrespective of food availability (Devereux, 2001). That people suffer from hunger do not imply that there is not enough food to go round. Entitlement approach is based on three conceptual categories: (1) The endowment set (2) The entitlement set and (3) The entitlement mapping. The endowment set is the combination of all those legally owned resources by a person conforming to established norms and practices. This may include tangible assets like land, equipment etc. and intangible assets like labor power, knowledge and skill and membership of a particular community. The entitlement is the set of all possible combination of goods and services that a person can legally obtain by using the resources of his endowment set. This use of resources to obtain final goods and services may be in form of production, exchange or transfer.

The entitlement mapping, sometimes called the E-mapping is the rate at which resources of endowment set can be converted into goods and services included in the entitlement set. From the above it could be seen that since entitlement set is derived from endowment passing through applying E-mapping, it is only through changes in either endowment or E-mapping that food insecurity can occur, and that situation is called entitlement failure (Kumar and Parikh, 1998). Therefore, an entitlement failure can occur only through adverse changes in either endowment set or E-mapping or both. E-mapping consists of three different kinds of relationship: production, exchange and transfer. One can therefore identify four distinct sources of entitlement failure such as: (i) Endowment loss- When capital is lost. May be in form of property or income. (ii) Production failure-Business failure or poor harvest (iii) Exchange failure- high inflation or exchange rate that reduces the currency value thereby lowering purchasing power and (iv) Transfer failure. That is, unavailability of welfare package or safety net. Climate change unarguably and significantly influences entitlement failure in all four sources. Inadequate food production or what is generally called food availability decline (FAD) plays a role in food insecurity mainly by worsening the entitlement set through unfavorable E-mapping as a result of rise in price caused by low supply which among other factors can be brought about by negative weather events. The situation however is not

different in the event of production failure or poor harvest. Extreme weather events such as excessive temperature can lead to excessive rainfall and flooding and or draught affecting agricultural production and harvest. Exchange failure. Either through poor harvest or agricultural production failure endowment can be constrained leading to lesser units of entitlement. This brings to fore the importance of climate change in food insecurity. Not only climate change but also the whole macroeconomics variables- per capita income, inflation, exchange rate and consumer price index. Thus, this paper examines (i) changes in weather variables, viz. temperature and rainfall, and (ii) implications of climate change for food security.

METHODOLOGY

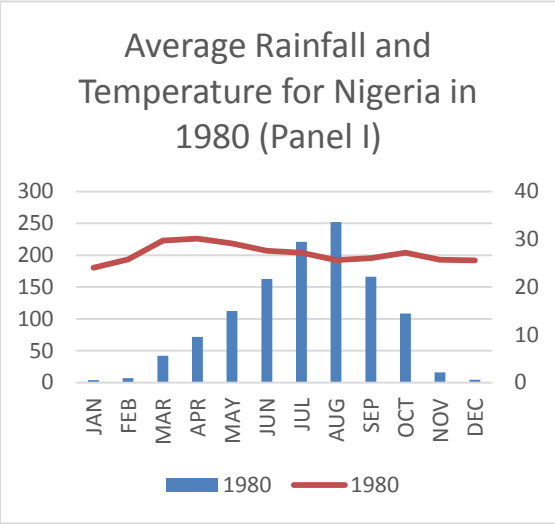
This study employed simple descriptive and graphical analysis, using time series data for Nigeria. Food availability was measured using aggregate domestic production [Crop production, livestock and fishing share of gross domestic product] and value of import of food and life animals. Food accessibility on the other hands was measures using per capita income growth rate (PCIGR) and annual average consumer price index for food (CPIF).

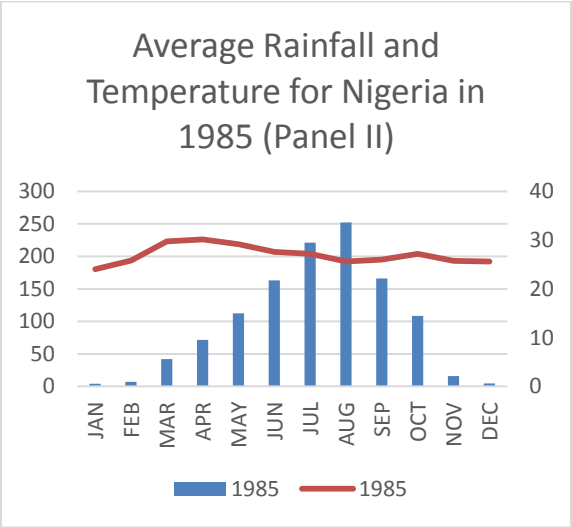
Climate change is expected to affect food accessibility through most or all of the entitlement failures as postulated by the Amatya's Entitlement Approach. Thus, the combination of PCIGR, and CPIF represent the demand side. Put differently, food accessibility represents the demand for food by Nigerian. Also, monthly average rainfall and temperature spaced for five years intervals from 1980 to 2015 and their graphical trends in Nigeria were used to corroborate availability and accessibility to food to evaluate how climate change affects the demand and supply of food in Nigeria.

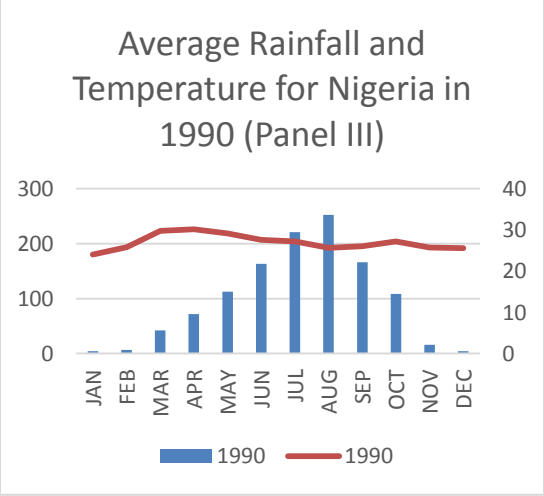
Data were sourced from Climate Change Knowledge Portal of the World Bank Group, Central Bank of Nigeria (CBN) Statistical Bulletin and World Development Index. Specifically, Population statistics of Nigeria and Per Capita GDP were sourced from World Development Index, Average Rainfall and Temperature were sourced from the World Bank Portal while the rest were sourced from the Central Bank of Nigeria (CBN).

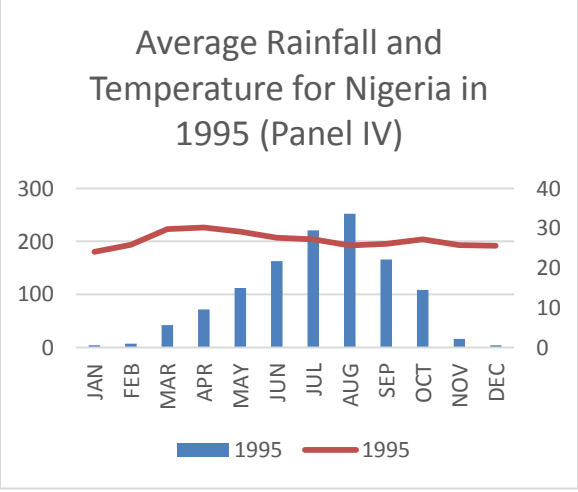
PRESENTATION AND DISCUSSION OF RESULTS

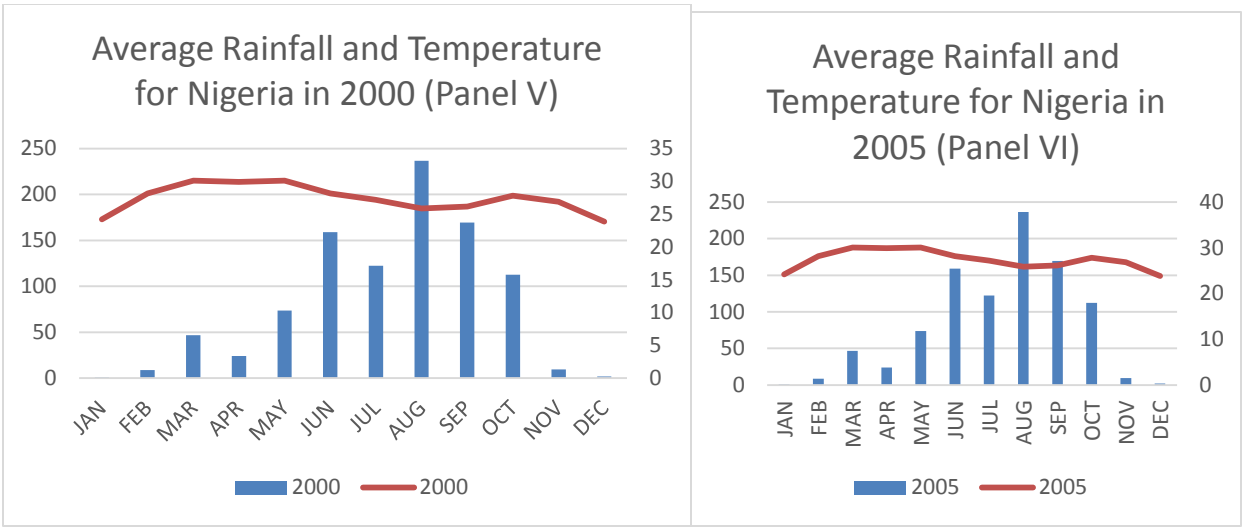
Graphical trends in climate change are presented in figure 4a panels (i) – (viii) using monthly average rainfall and temperature with intervals of five years in Nigeria from 1980 to 2015. This was followed by descriptive analysis in tables 4.1 and 4.2. Thereafter, graphical trends in domestic and imported growth rates of food supply representing food availability or supply were presented on figure 4b, followed by trends in per capita income growth rate and consumer price index for food accessibility or demand for food. Then, trend in growth rates of total food supply and per capita income were presented graphically to corroborate the relationship between climate change and food security with a demand and supply perspective.

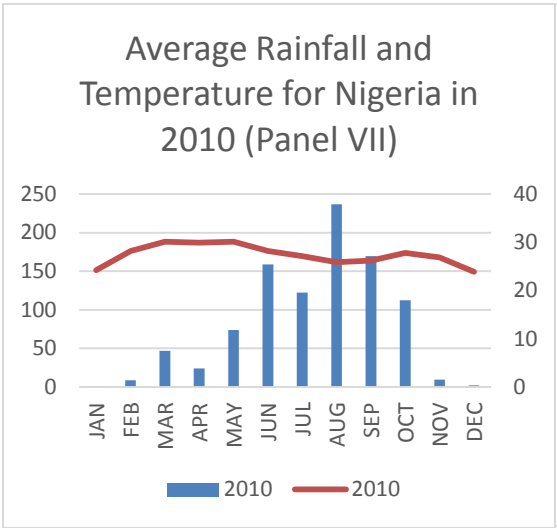












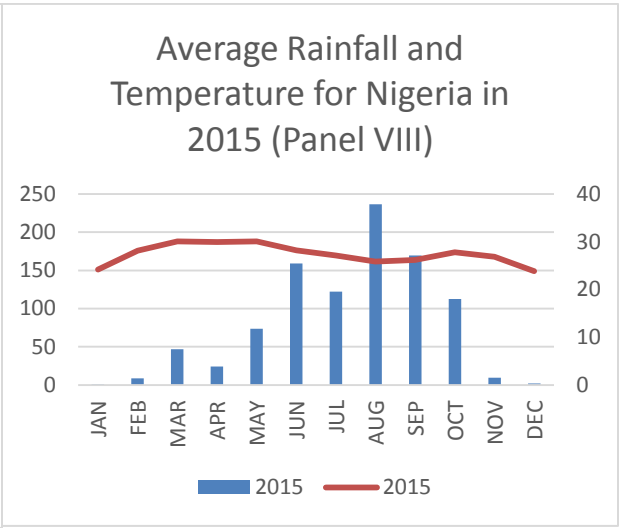


Figure 4a; Panels I – VIII: Monthly Average Rainfall and Temperature for Nigeria with 5years intervals from 1980 to 2015.

Figure 4a, panels A through H, showed monthly average rainfall in Millimeters (mm) on the vertical left hand side, while monthly average temperature is presented in Degree Celsius (ºC) on the vertical right hand side of the graphs. Though these variables were collected as monthly averages, their variances are important in our analysis. For the period under review, maximum and minimum rainfall alongside their average maximum, maximum variance, average minimum and minimum variance were computed and are shown as seen in table 4.1 below.

Table 4.1 Maximum and Minimum Rainfall in Nigeria from 1980 to 2015

Year	Maximum Rainfall (mm) & Month	Minimum Rainfall (mm) & Month
1980	August (271.29mm)	December (0.76mm)
1985	July (212.62)	December (0.86mm)
1990	July (252.59)	February (3.87mm)
1995	August (252.09mm)	January (3.99mm)
2000	August (246.81mm)	February (0.73mm)
2005	September (198.96mm)	January (1.35mm)
2010	July (295.42mm)	January (1.72mm)
2015	August (263.50mm)	January (0.70mm)
Average Maximum Rainfall	249.16mm	Average Minimum Rainfall = 1.75mm
Maximum Variance Rainfall	46.26mm	Minimum Variance Rainfall = 2.24mm

Source: Authors' computation using World Bank Data (2017).

Table 4.2 Maximum and Minimum Temperature in Nigeria from 1980 to 2015

Year	Maximum Temperature (ºC) & Month	Minimum Temperature (ºC) & Month
1980	April (30.16ºC)	December (23.49ºC)
1985	March (29.94ºC)	December (23.93ºC)
1990	April (30.57ºC)	July (25.76ºC)
1995	April (30.16ºC)	January (24.05ºC)
2000	April (30.36ºC)	December (24.42ºC)
2005	March (30.96ºC)	January (27.72ºC)
2010	April (31.57ºC)	December (25.48ºC)
2015	May (30.09ºC)	December (23.86ºC)
Average Maximum Temperature	30.48ºC	Average Minimum Temperature = 24.46ºC
Maximum Variance Temperature	1.09ºC	Minimum Variance Temperature = 1.28ºC

Source: Authors' computation using World Bank Data (2017).

From table 4.1 and 4.2 it is shown that the heavy and light rainy seasons maintained the peak and low periods of three months in July to September and December to February respectively, while temperature showed high degrees between March and April and lower degrees distributed unevenly. The tables also revealed that maximum variance rainfall increased between 1980 and 2015 by 46.26mm with a corresponding maximum variance temperature increased in Nigeria by 1.09ºC. This value though below the intergovernmental panel on climate change warning benchmark of 2ºC is indicative of progression to the benchmark and hence, calls for concern. The minimum variance rainfall on the other hand portrayed a value of 2.24mm for the same period with a corresponding minimum variance temperature of 1.28ºC. This variance which is higher than the maximum variance temperature of 1.09ºC is a more realistic indication of the increasing weather temperature in Nigeria over the period under study. To corroborate the information on changing climate, food availability or supply trend is presented as seen on the following graph below.

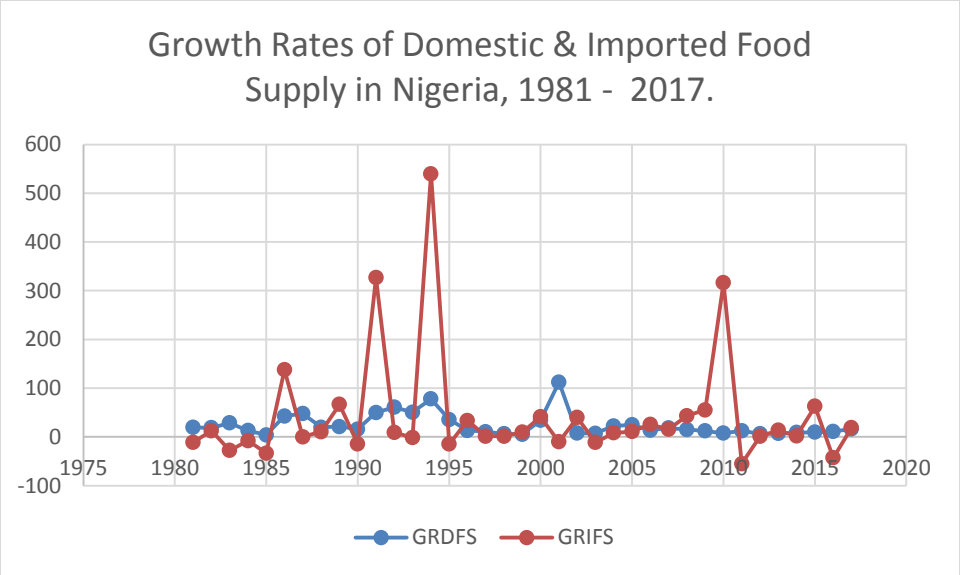


Figure 4b: Growth rate of Domestic and Imported Food supply in Nigeria, 1981 - 2017.

Figure 4b shows two line graphs, where the blue line represents growth rate of domestic food supply in Nigeria, derived from three components of agricultural gross domestic income comprising crop production, fishing and livestock. The orange line represents growth rate in food imported into Nigeria also measured in billions of Nigerian naira. The blue line representing growth rate of domestic food supply shows a relatively stable trend of positive food supply in the country with some peak cases rising up to between 40% and 80% and single highest case of 112.31% in 2001. The lowest growth rate in domestic food supply occurred in 1985 with a growth rate of 4.15%. These values revealed that even the least growth rate of food exceeded the population growth rate of 2.8% up to 2006 and the projected population growth rate of 3.2% from 2006 to date. The orange line representing the growth rate of imported food in Nigeria on the other hand can be analyzed in three ways: First, that 11 years of the total period of 36 years under study amounting to 31%, had negative growth rate of imported food supply in Nigeria. Second, that 10 years of the same period, about 27% of the period had peak positive growth rate. Of these peak positive periods, 2010 had extreme weather events both in maximum rainfall and temperature that coincided with high growth rate of imported food supply. There was also the case 2005 with peak minimum variance temperature though this did not coincide with high growth rate of imported food supply, thus implying that there were other factors and variables that influenced food availability aside from climate change. Third, the rest of the 15 years representing 42% of the period, growth rate of imported food supply was below the domestic growth rate.

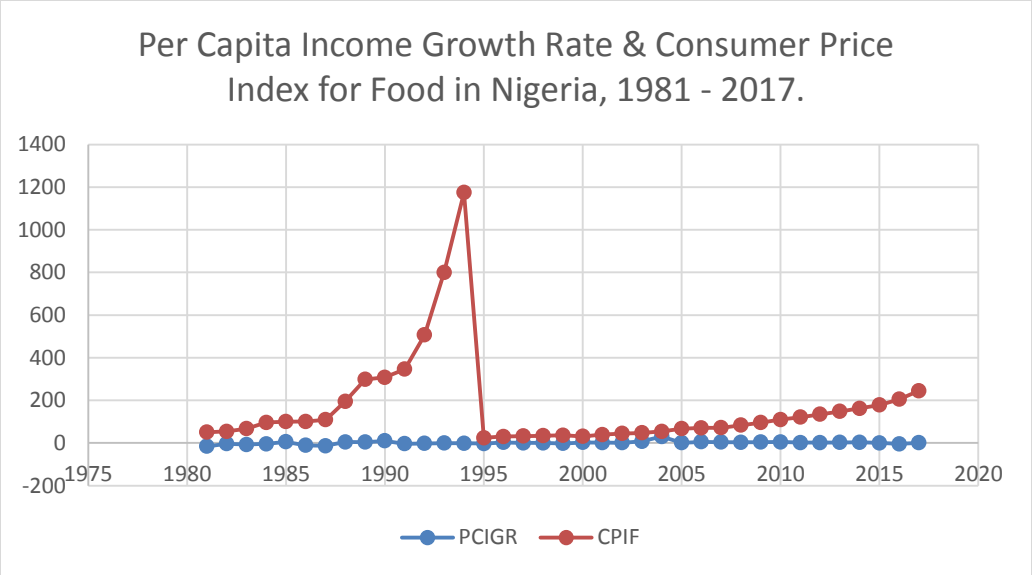


Figure 4c: Per capita income growth rate and consumer price index for food (CPIF) in Nigeria with a rebased CPIF in 1995.

Figure 4c also presents two line graphs showing the relationship between per capita income growth rate (PCIGR) and consumer price index for food (CPIF) in Nigeria between 1981 and 2017. The blue line shows the trend in per capita income growth rate which reveals a mixture of negative and positive growth rates. The PCIGR was derived by dividing GDP by population and computing the growth rate thereof. The PCIGR is taken as a macroeconomic measure of the purchasing power of Nigerians that grants them real access to food. It represents the demand side to food security haven had a look at the supply side which is food availability. PCIGR was negative between 1981 to 1984, 1986 and 1987, 1991 to 1995, 1999, 2015 and 2016. This period of 14years represents 38.9% of the period under study. The CPIF on the other hand measures by what amount a representative basket of food items commonly consumed by Nigerians increase in price over and above the base year benchmark of 100. From figure 4c, the orange line represents the CPIF. There were two base years in the CPIF measurement by the Central Bank of Nigeria and as presented in the graph. First, is the 1985 base year which measured prices of food from 1970 to 1994 (25years) and second is the 1995 base from 1995 to date. The CPIF line showed growth rate at an increasing rate up to a peak of 1,174.6% in 1994 before it was rebased in 1995 to conform with the realities of inflation in the country. After the CPIF rebase in 1995 which unrealistically brought it close to the PCIGR, the CPIF had since then grown above the PCIGR. This is the unbalanced relationship between PCIGR and CPIF representing accessibility to food in Nigeria.

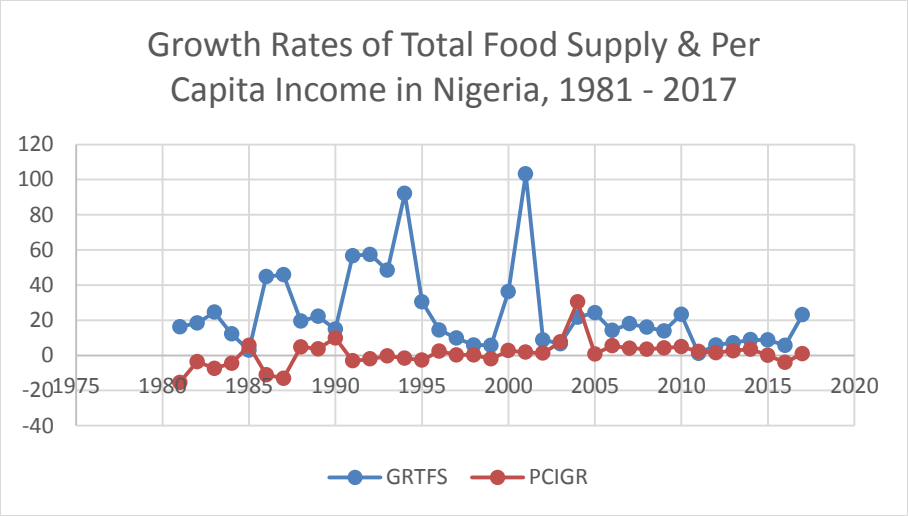


Figure 4d: Growth rate of total food supply and per capita income in Nigeria, 1981 – 2017.

Figure 4d above shows the relationship between growth rates of total food supply (GRTFS) and per capita income (PCIGR) in Nigeria using line graphs. The blue line represents trend in GRTFS, while the orange line portrayed the trend in PCIGR. With exception of 1985 and 2004 GRTFS showed higher growth trend than PCIGR.

CONCLUSION

This paper evaluated the relationship between climate change and food security in Nigeria from 1981 to 2018. Specifically, it examined the link between climate change and food availability as well as food accessibility. The theoretical framework used in this paper was the Amatya's entitlement approach which stressed that people suffer from food insecurity as a result of their inability to have access to food irrespective of food availability. Data on monthly average rainfall and temperature of five year intervals were used to represent climate change with maximum and minimum events evaluated alongside computed averages and variances. These climate variables and their outcomes were then used to corroborated food availability proxies - domestic food supply (gross domestic income on crop production, fishing and livestock) and imported food supply on the one hand and food accessibility proxies - per capita income growth rate and consumer price index for food. The results showed that maximum variance temperature in Nigeria was 1.09ºC while the minimum variance temperature was 1.28ºC. These values though less than the danger benchmark of 2ºC, were considered alarming. Growth rate of imported food was seen to be the highest compared to domestic production. Consequently, consumer price index for food increased at an increasing rate over the two based period compared to per capita growth rate. Finally, growth rate of total food supply was seen to exceed per capita income for all the years except in 1985 and 2004. This implies that climate change increased the demand for imported food and thus the consumer price index for food and worsened per capita income growth rate in Nigeria.

RECOMMENDATION FOR POLICY

Given the conclusions of this paper, we recommend that the following climate change mitigation and adaptation policies be considered alongside a special commission established at the national level that oversees the climate change concerns at the state and local government levels:

1. Government should incorporate climate change issues such as climate change causes and adaptation strategies into the curricula at the various levels of our education system to enable students gain knowledge and understanding about climate change. This, it is hoped will enable learners avoid acts that promote climate change in Nigeria.
2. The national climate change commission should be saddled with the responsibility of ensuring the following:

(a) Stabilize gullies and erosion site through better methods of erosion control at all levels of government.

(b) Employ climate change experts at all levels to ensure smooth planning and implementation of climate change issues as the National Emergency Management Agency of Nigeria is saddled with too many task.

3. Government should provide financial support in the form of soft loans and agricultural insurance to farmers affected by disasters caused by climate change to enable them start off again.
4. Government should improve the monitoring and evaluation of agricultural activities with realistic and measurable indicators to enhance food security in Nigeria.
5. Farmers should be encouraged to engage in other businesses other than farming so that incase of disaster, they will still have something else to fall back on.

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