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## CLIMATE CHANGE AND FOOD SECURITY IN NIGERIA

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### Abstract

*This paper starts with painting a gloomy picture of African agriculture, which can be worsened by climate change. Against the conceptual bases of climate change and food security, it explores the causes of climate change, its reality, evidence and manifestation in Nigeria. It explores the available strategies for mitigating climate change impacts in Nigeria. This reveals gross inadequacies in terms of governance, absence of a national adaptation programme of action, national climate change policy and strategy and action plan on climate change. The policy implications of these were discussed including massive deforestation, galloping urbanization, management of wetlands, widening governance space, the role of the media and vulnerability assessment. The message of the paper is that too little is being done and too late.*

**Keywords:** Climate change, agriculture, greenhouse gasses, national strategies, adaptation, mitigation strategies

### INTRODUCTION

Over the years in the 20<sup>th</sup> century, agricultural productivity has faced severe stress, especially in sub-Saharan Africa, which is the world's poorest and most rainfall-dependent farming region. Across this region, agricultural producers have operated with limited resources in fragile ecosystems, sensitive even to minor shifts in temperature and rainfall patterns. In dry land areas sophisticated intercropping systems – maize and beans, cowpea and sorghum, millet and groundnut have been developed to manage risk and sustain livelihoods. An added threat is the expansion into areas vulnerable to drought. As projected by the Hadley Centre for Climate Change, arid and semi-arid areas will increase by 60 – 90 million hectares. By 2090 some places will face extreme danger. Southern African rain fed agriculture would be reduced by up to 50% between 2000 and 2020 (Fisher, et al, 2005). Even in regions in Africa where rainfall is adequate, threats of flooding, deforestation exist; and in some mineral and fossil fuel production areas agricultural productivity will face stress.

Developing countries, including Nigeria cannot feed themselves. For example, Index Mundi (2019) reported that Nigeria is the second largest importer of rice in the world. As of today, Nigeria expends between \$6 billion and \$8 billion to import food annually (Stephen, 2019). As far back as 1995, Lofchie (1995) painted a horrendous picture of African agriculture. Since the 1970s many African countries cannot feed themselves. Domestic food production has been

inadequate to supply minimal needs of growing population, while per capita earnings cannot support enough food importation. As a result, starving children are symptoms of deepening economic deterioration. By 1995, African countries imported 10 million tonnes of grain/year. Africa's population growth rate stands at 3.5% per year (the highest in all of developing world), while food production increase is 1.5%. In 1980, per capita food production was only 80% of the 1970 level. As far back as 1984, The World Bank Report observed that 20% of total sub-Saharan Africa received less than the minimum amount of food to sustain health and in 1995, 100 million people were malnourished. By the end of the 1970s Africa's marketed volumes of key agricultural exports were at the level of the 1950s. Food aid once considered a palliative to momentary episodic events, such as droughts or political upheaval, became permanent. Short of money to finance food import, African countries fall back on social services, especially education and health.

What has been said with respect of sub-Saharan Africa is exactly true of Nigeria. Although other factors such as external factors of international economic system (e.g. terms of trade, low demand elasticities of Africa's key agricultural commodities, introduction of synthetic products, increase in the price of energy sources, impact of multinational corporations, protectionism), have aided the decline, the factors internal to Africa, such as poor agricultural policies, effects of currency over-valuation, role of parastatals and poor industrial policies vis-a-vis agricultural industry play a major role.

This sordid and gloomy picture may be worsened, among other causes, by climate change which is the subject of this discourse. The rest of the paper consists of seven parts. In the next section, the conceptual basis of this paper: food security and climate change, is interrogated. The third section (3.0) focuses on the causes of climate change, while section 4.0 discusses the reality of climate change-globally. Section 5.0 looks at evidence of climate change in Nigeria. In section 6.0, current national institutional governance strategies for addressing climate change in our country is examined, while section 7.0 focuses on adaptation and mitigation strategies for climate variability and change. Section 8.0 wraps up the discussion.

## **FOOD SECURITY AND CLIMATE CHANGE**

### **Food Security**

Food security can be defined as access by all people at all times to the food they require (Von Braun, 1991; Eicher, 1985). Ukoha (Reutlinger, 1987) asserts that food security refers to the accessibility of all people to enough food, at all times for an active and healthy life. In the attainment of food security, there is need to ensure that food is adequately supplied in quantitative and qualitative terms to avoid under nourishment and malnutrition. Food security demands two essential determinants: availability and access. While availability of food does not ensure access, access to food is contingent on availability (Egbuna, 2001). But regional access to food depends on factors of production and distribution, which are factors of consumer prices of food, government policies and inflation rate inter alia. Household food availability is a function of food availability at national or even regional markets and this is conditioned by market operations. Food availability at any level (local, national, regional or global) does not guarantee food security. Regional or national food availability does not put food on everybody's table in the right quantity and quality. Food price structure may deny people access to food. By the same

token, national regional food availability may be constrained by distributional inequity (Schoeberger, 2001). Egbuna (2001) identified four elements of food security; entitlement, sufficiency, access and security. He argues that the interplay of these factors determines whether a nation, state, household or individual is food secure or not.

Segynola (2005) adds another dimension of food security – food procurement, as a process of attaining food security. He advances four aspects of procurement:

- (i) Adequate domestic production of food items by people for whom food security is being sought. In this dimension we can talk of small scale food producers both in arable and livestock sub-sectors;
- (ii) The issue of transferability of food products from areas of surplus to food deficit areas. This has national and international dimensions. At the national level, the internal transportation systems are expected to be efficient. This is the bugbear in Nigeria due to transport infrastructure collapse. At the international level, food importation is governed by availability of foreign exchange and domestic policies.
- (iii) Issue of exercising effective demand for food, which is a factor of purchasing power to procure the required food. The critical factors here are gainful employment and adequate per capital income. A major impediment here is mass poverty in Nigeria, where 130 million people are living below poverty level, not to talk of mass unemployment and underemployment.
- (iv) Adequate nutritional knowledge so that people can procure the right combination of food items needed to ensure a balanced diet. Segynola argues that in the absence of these four elements, food insecurity is the resultant, with implications for health, unhealthy labour force, low productivity, labour lock-out and civil unrest.

There is another peculiar problem inhibiting food security in Nigeria and that is the general personal and group insecurity in the country which makes residence and travel from one part of the country to another hazardous. This is due to the menace of armed Fulani herdsmen, armed robbery, kidnapping, ethnic dissent and gross spatial, group and individual inequality. Adequate domestic food production is also inhibited by small holder scheme agriculture, its rural-based nature and conflict between Fulani herdsmen and resident crop farmers. Domestic terrorism has led to the displacement of real farmers who have become Internally Displaced People (IDPs). Transferability is equally inhibited by poor road infrastructure and terrorism on these rickety roads. Purchasing food is worsened by mass unemployment and crippling relative and absolute poverty.

Food security in Nigeria is essentially ecological, educational, cultural, economic and political. It can be stated that in the spirit and philosophy self-reliance, food importation portends chronic food insecurity, while acute food insecurity cannot be managed without external aid. Finally, food security refers to the need to prevent loss of access to food over an extended period of time and that is where climate change and variability pose a monumental danger to food security.

### **Concept of Climate**

The study of atmospheric sciences has been conventionally divided into two main subject areas; meteorology and climatology. Meteorology seeks to analyse, explain and ultimately predict atmospheric processes and their behaviour overtime. As Musk (1988) argues, it is the science of

the atmosphere and thus the science of weather. On the other hand, climatology, which is dependent on its parent science of meteorology documents, analyses and explains the spatial variation of meteorological processes on a number of time-scales, as related to the human environment. The climate of a particular place is a concept; it is a statistical generalization, rather an actual reality.

The climate of a place is not its average weather (Musk, 1988). The average weather is rarely the weather experienced at any given time. The weather systems which determine the climate of a locality are governed by many interactions and complex feedback processes involving the underlying surface of land, sea, snow, ice, mountains, forests, cities and the overlying atmosphere with its variable winds and clouds. All these elements and their interactions vary over time. In this way climate variability over time about the average state is to be expected as the very essence of climate.

Climate is therefore the integration of the spectrum of weather likely to be experienced over time, usually 30-35 years at a particular place (Musk, 1988; Ayoade, 1993). It is the characteristic condition of the atmosphere deduced from repeated observations over a long period of time. It includes more than the average weather conditions over a given area. It includes considerations of departures from averages (variabilities), extreme conditions and probabilities of frequencies of occurrences of given weather conditions. Hence climate is a generalization, whereas weather deals with specific events (Ayoade, 1993). In short, climate is what we expect, while weather is what we get (University Corporation for Atmospheric Research, 1997).

### **What is Climate Change?**

Weather changes both rapidly and slowly. For example, the passage of a thunderstorm can change a bright sunny day into a dark windy, rainy one in less than an hour (University Corporation for Atmospheric Research, 1997). Farmers know that in one year the amount and timing of rainfall can be nearly ideal for growing crops, while next year might bring drought or floods. In many cases variations in weather are random. The atmosphere, in isolation, has only short term memory and so acting alone, it cannot produce long term enduring variations. But the climate is determined by the workings of the climate system composed of the atmosphere, biosphere, hydrosphere (oceans), lithosphere, cryosphere, human society, structure and interactions among these (Anyadike, n.d.). Since the oceans have a large capacity to store and release heat, it gives the climate systems a long memory that can result in variations lasting from seasons to centuries. The number of hurricanes in the Atlantic Ocean varies from year to year in synchrony with subtle shift in Sea Surface Temperature (SST) and seasonal wind patterns. At the same time long-term effects can result from changes in the biology and chemistry of the climate system. Understandably, life in the sea controls the flux of carbon from the atmosphere and CO<sub>2</sub> into ocean sediments.

Since weather varies over long intervals, climate variability varies from weather variability. Mostly, random variations in weather from year to year usually balance each other in these averages and do not affect the mean climate.

Often abnormal temperature or rainfall persists for a few years or even a decade, such as the great West African Sudano-Sahelian drought of the 1970s and 1980s. These slow shifts in weather are called climate fluctuations, anomalies or changes. These are pronounced swings up and down

from mean climatic conditions. Climate variations occur on different time-scales; year to year, decade to decade and on longer time-scales of centuries or longer. Great continental ice sheets have appeared and disappeared again and again in the last several millions of years. Climate variability or fluctuation refers to variations in the mean state and other statistics of the climate on spatial and temporal scales beyond that of individual weather events (Okpokwasili, 2011). IPCC (2007) defines climate change as a change in the state of the climate identifiable by changes in the mean and the variability of its properties that persists for an extended period, typically decades or longer. It is a long term shift in the statistics of the weather (including averages). Or simply climate change can be defined as any significant change in measures of climate, such as temperature, precipitation, wind, and other weather patterns, that lasts for decades or longer. Climate change is attributed to both natural and anthropogenic factors. To these causes the discussion in Section 3.0 is averted.

## **CAUSES OF CLIMATE CHANGE**

For convenience of discussion, the causes of climate change can be classified into three: astronomical causes, earth-based causes and anthropogenically induced causes.

### **Astronomical Causes**

#### *Milankovitch's Postulation*

In 1924 the Serbian mathematician, Milutin Milankovitch put up a theory on the advances and retreats of ice sheets. According to him a major factor in determining ice sheet growth is the amount of solar insolation reaching high latitudes of the Northern Hemisphere in summer. Ice sheets would grow when solar insolation reaching the high latitude continents was less than normal during summer, since this would allow snow cover to last through the melting season and gradually accumulate over the centuries.

He showed that variations of insolation result from subtle variations in Earth's orbit. Today the Earth's orbit of rotation is tilted about  $23.5^{\circ}$  relative to the plane of the Earth's orbit about the sun, and this tilt gives marked seasons in middle and high latitudes. The tilt angle varies between  $22^{\circ}$  and  $24.5^{\circ}$  within a period of about 41,000 years. The amount by which the Earth's orbit deviates from a perfect circle also varies with periods around 100,000 and 400,000 years. The day on which the earth is closest to the sun, currently January 3<sup>rd</sup> varies on a 23 year cycle. The effects of these orbital variations are largest in the middle and high latitudes, where colder temperatures make the development of large ice sheets possible.

Milankovitch's theory has been confirmed by modern scientists using modern techniques, who estimate the amounts of land ice based on information contained in layered ocean sediments. These have shown that for the last several million years, the ice sheets have varied with the same rhythm as the Earth's orbit. In confirmation of Milankovitch's theory, global ice volume was highest when summertime insolation at high latitudes dipped. The period of rapid ice melting, about 10,000 years ago, occurred when greater summertime insolation was reaching the high latitude continents of the Northern Hemisphere.

### *Climate System response to Earth's Orbital Changes (Cryosphere)*

Although external shifts in insolation appears to be the pacemaker of ice ages, the nature and magnitude of the resulting climate changes are still determined by processes that take place within the Earth's climate system. For climate to swing from ice age to warmer conditions, the climate system must amplify the response to Earth's orbital changes. Climate change can be amplified through albedo feedback. Albedo measures how much insolation the Earth reflects back to space. Snow and ice reflect far more effectively than unfrozen ocean or ice free land. As the ice expands, less solar energy is absorbed which tends to cool the climate further and leads to further expansion of the ice cover. The ice albedo feedback process can make the climate more sensitive to outside influences, such as shifting insolation.

To determine how climate can get cold enough to sustain summertime snows, scientists can measure CO<sub>2</sub> gas. Ancient content of CO<sub>2</sub> has been determined by measuring the air in bubbles inside cores of ice from the Greenland and Antarctic's ice sheets. These cores show that the atmosphere contained 40% less CO<sub>2</sub> when the ice reached its maximum extent 20,000 years ago, than it did just before the industrial revolution in the 18<sup>th</sup> century (University Corporation for Atmospheric Research, 1997). Estimates suggest that the reduced CO<sub>2</sub> may account for nearly 50% of the approximately 5<sup>o</sup>C global cooling during this glacial maximum.

Over the longer time spans required for major glacial cycles, the atmospheric CO<sub>2</sub> content is closely tied to the amount of CO<sub>2</sub> in the ocean, while the amount of CO<sub>2</sub> in the ocean depends on marine organisms that use the CO<sub>2</sub>, sunlight and nutrients in their photosynthetic processes, Lowered atmospheric CO<sub>2</sub> may be caused by increased productivity of these marine organisms during the ice ages.

### *Changes in Energy Out-put of the Sun*

The climatic state at any given time is determined by three crucial factors: the amount of energy received by a climate system from the sun, the manner in which the energy is distributed and absorbed over the earth surface and the nature of interaction processes between the various components of the climate system (Ayoade, 1993:165). Observations taken over the last few decades, show that output of the sun is about 0.1% greater when the number of dark spots on the sun is at its maximum, (roughly every 11 years) than when it is at a minimum. Although this change in solar energy output is negligible to cause significant climate variation, yet the sun's output may vary on longer time scales. Some evidence suggests that low solar energy output may have helped to produce the little Ice Age of 1350-1850 AD. At that period cold spells were more common and temperatures were a few degrees colder than now in the middle latitudes.

## **Terrestrial Causes**

This group of theories tries to link changes in climate variations to terrestrial conditions. These include distribution of land and oceans, which brings about change in energy distribution and so general atmospheric circulation and climate because of the well-known differences in the thermal characteristics of land and water surfaces. Examples of such theories include those of polar wandering and continental drift. Shifts in the locations of continents and oceans would mean

some areas being located nearer or farther away from the poles or the equator with attendant changes in climate.

Changes in the topography of the continents and oceans, especially the former, constitute another group of theories. Orogenesis or mountain building processes influence climate in two ways. Change in topography exerts influence on air flow, insolation, temperature and precipitation. Orogenesis may come with volcanic activity, which would provide aerosols and other pollutants that would affect the transparency of the atmosphere and so the amount of energy reaching/leaving the Earth's surface. In Al Gore's book, *Earth in a Balance: Ecology and the Human Spirit* (1992), Chapter 3 *Climate and Civilization: a Short History*, he demonstrated the catastrophic effect of volcanoes in changing global climate and rubbishing accumulated civilization. For example, the series of eruptions of the Tambora volcano on the island of Sumbawa, Indonesia in the spring of 1815, killed 10,000 people initially and 82,000 more died of starvation and disease in subsequent months. In 1816 the dust ejected into the sky had spread throughout the atmosphere and began to reduce dramatically the amount of solar insolation reaching the Earth's surface and to force temperature down. In New England there was widespread snow in June, 1816 and frost throughout the summer. From England to the Baltics, precipitation was continuous from May to October, 1816. The disruption of reliable climate patterns caused grave social consequences: failed harvests, food riots, and near collapse of society throughout the British Isles and Europe, which Post (1977) termed *The Last Great Subsistence Crisis* in the western world. Climate changes precipitating the crisis last for only 3 years, because much of what is blown into the atmosphere by volcanoes falls back out of the atmosphere in a relatively short period of time. That is why the eruption of Mount Pinatubo in the Philippines in 1991 had a significant, but brief global impact-cooling the earth and temporarily masking the much more powerful warming caused by human civilization and temporarily accelerating ozone depletion.

Al Gore summarized the effects of great volcanic eruptions before the coming of Christ as decimation of huge numbers of human population, long periods of snows and frost (which killed cereal crops), non-maturation of some fibres, heavy precipitation, frigid temperatures (which caused temporary cessation of agriculture), harvest failures, great famine in which humans ate themselves and skyrocketing of food prices by more than 1,000%.

### **Anthropogenic Causes**

The rising global human population needs to be sustained in the rising standard of living. To meet this objective, man employs natural resources and technologies that were unknown in the Ice Age.

#### *Anthropogenic or Human Causes:*

In order to satisfy the needs of rising human population, man employs natural resources and technologies that were not known in the Ice Age. Hence human activities lead to a build-up of certain trace gases in the earth's atmosphere – CO<sub>2</sub> (carbon dioxide), CH<sub>4</sub> (methane), N<sub>2</sub>O, (nitrous oxide), O<sub>3</sub> (tropospheric ozone). Measurements show that CO<sub>2</sub> has increased by about 30% since late 1700s (beginning of industrial revolution) when use of coal as energy began. Burning coal, petroleum and gas release CO<sub>2</sub> into the atmosphere. These fuels are used in

electricity generating plants, automobiles, home-heating, etc. Also CO<sub>2</sub> escapes to the atmosphere in the process of cement manufacture and as a result of deforestation and bush burning.

Atmospheric CO<sub>2</sub> concentration which has been rising more rapidly in recent times is expected to rise higher in the 21<sup>st</sup> century because of growth in human population and per capita energy use. Since 1750 CO<sub>2</sub> atmospheric build up was 275ppm by 1996. It has risen to 377.1ppm in 2004 superseding pre-industrial era by 35%. CH<sub>4</sub> has increased by about 200% since the industrial revolution and comes from rice paddies, domestic animals, leakage from coal, petroleum and natural gas mining. Methane concentrations stood at 1783ppb in 2004 and N<sub>2</sub>O at 318.6ppb. The increase of CO<sub>2</sub>, CH<sub>4</sub> and N<sub>2</sub>O in 2004 to the values of 377.1ppm, 1783ppb and 318.6ppb respectively represent increases of 35%, 155% and 18% respectively over the values 100 years ago when the increase stood at 19ppm, 37ppb and 8ppb in absolute amounts.

These three gases are the most crucial and long-lived greenhouse gases and contribute most to global warming. CO<sub>2</sub> just added to the atmosphere takes 100-400 years to strike a new balance compared to water vapour which lasts for several weeks. CH<sub>4</sub> has atmospheric residency of over 100 years. Other gases, halocarbons and water vapour add to global warming, but not as much as CO<sub>2</sub> and CH<sub>4</sub>. Today 5.5bn tons of CO<sub>2</sub> is added to the atmosphere every year. Of the 37bn tones of gas flared globally, Nigeria accounts for 50% even though gas flaring has been reduced to 40% in 2006 through internal utilization, export of LNG and gas re-injection. Deforestation and bush burning add 1.5bn tonnes of CO<sub>2</sub> yearly. These releases increased CO<sub>2</sub> emission into the atmosphere by about 0.5% per year. Halo carbons – a family of industrial gases manufactured for use in refrigeration units as clearing solvents and production of insulating foams were first produced in the 1940s. Their residence in the atmosphere is over 100 years.

As of now Nigeria is a major contributor to climate change by not only deforestation and bush burning, but mostly through gas flaring. As of 2007, 37 billion tonnes of gas was flared worldwide with Nigeria being responsible for 50%. An estimated 755 million people could be given electricity with gas flared in Nigeria. Because of the low combustion efficiency of Nigerian flares (80%), a large proportion of the gas is vented mainly as CH<sub>4</sub>, as a result of which 12 million tonnes of methane are released into the atmosphere per year in Rivers, Bayelsa and Delta States in addition to CO<sub>2</sub>. Because of the higher global warming potential of methane over CO<sub>2</sub> (64:1), the significance of Nigeria's gas flare is considerable. Gas flare is implicated in soil acidification. Although the former Petroleum Minister (State), Dr. Kachikwu announced that gas flaring would stop in 2019, this is a tall expectation given the hindsight of previous efforts.

These gases cause increase in Antarctic ozone hole. Near the earth's surface ozone amounts have been increasing because of human activities. The effect of these gases especially CO<sub>2</sub> and CH<sub>4</sub> is that people living at the turn of the 22<sup>nd</sup> century will still battle with the effects of today's emissions, just as we are battling with the consequences of emissions since the industrial revolution. The warmer the atmosphere the more energy there is for evapotranspiration, hence more rain and more flooding. The warmer the atmosphere, (especially in latitudes 40 – 70°N), the quicker the thawing of permafrost areas and so the greater the rise in ocean sea-level and so the greater the submergence of coastal areas, settlements and small island states.

## **CLIMATE CHANGE: THE REALITY**

In this section the reality of climate change globally is examined. This is done in 3 categories - 2006, 2007 and 2009/2010.

### **2006**

Records show that the first 10 years in the 21<sup>st</sup> century, including 2006 were the warmest 10 years since 1850 (when instrumental recording started). Global surface mean temperatures for 2006 ranged from 0.42<sup>o</sup>C – 0.54<sup>o</sup>C, higher than 1961 – 1990 annual average. 2006 was the 6<sup>th</sup> warmest year on record with December as the warmest since global surface temperature (T<sup>o</sup>) records were instituted (WMO, 2006). The largest T<sup>o</sup> anomalies were observed throughout the high latitude regions of North America, Scandinavia, China and Africa, where Ts<sup>o</sup> were 2<sup>o</sup> – 4<sup>o</sup>C above the 30 year mean. Areas of negative anomalies include central parts of Russian Federation.

### **2007**

The year 2007 ranked as the warmest year with mean surface T<sup>o</sup>s averaging 0.62<sup>o</sup>C for the northern hemisphere above the 30 year 0.18<sup>o</sup>C mean (WMO, 2007). Since the beginning of the 20<sup>th</sup> century, global surface T<sup>o</sup> has risen by 0.74<sup>o</sup>, though not continuously. Linear warming trend over the past 50 years (0.13<sup>o</sup>C/decade) was nearly twice that for the last 100 years. Warmer than average T<sup>o</sup>s affect almost all areas of the world, except cooler-than-average anomalies in South America. Higher-than-average largest warming anomalies affected high latitude regions of North America, Europe and Asia, reaching 2-4<sup>o</sup>C above 1901 — 1990 average for the Northern Hemisphere. In all, 2007 was the warmest in 150 years of hydro meteorological measurements with North Atlantic being significantly warm. Extreme high T<sup>o</sup> was recorded in much of Western Australia (January – March) with February T<sup>o</sup> warmer by 5<sup>o</sup>C above average.

### **2009/2010**

The years 2000 – 2010 was the warmest decade on record since the beginning of modern instrumental recording in 1850. 2009 was the 5<sup>th</sup> warmest year on record since 1850. 2000 – 2009 was warmer than 1999 – 1899, which in turn was warmer than the 1980 (1980 – 89). Global surface T<sup>o</sup> anomaly was between +0.34<sup>o</sup>C and +0.56<sup>o</sup>C. December 2009 – February 2010 showed extreme conditions. Strong negative T<sup>o</sup> anomalies and heavy, prolonged snow conditions occurred over Europe, Russian Federation and parts of North America, especially in the USA and Asia. This made 2009 cold winters the harshest. Some places in the Northern Hemisphere had above normal T<sup>o</sup>s for the season, especially in Arctic region and Canada with T<sup>o</sup>s of +6<sup>o</sup>C above long term average in some places. Combined land and ocean surface T<sup>o</sup>s over Northern Hemisphere were estimated at 0.5<sup>o</sup>C above seasonal long term average of +8.6<sup>o</sup>C (WMO, 2010). Global surface T<sup>o</sup>s has been on a steady increase. The National Oceanic and Atmospheric Administration and the National Aeronautics and Space Administration of the USA reported that the Earth's surface temperatures for 2016 were the warmest since modern instrumental recording started in 1880, thus setting a record in the years 2014, 2015 and 2016.

In concluding, the trend survey of anomalies is not continuous; global warming is continuing; there is regional variation in anomalies caused by local characteristics; effects are more pronounced in the Northern Hemisphere because of extensive land masses. Australia, South America and South Africa showed extremes because of the sea and the accompanying El Nino/El

Nina events. Antarctic ice sheets are melting and will continue to melt. In addition, it is noteworthy that the effects of global warming are uneven, however, some are highlighted. A metre rise in sea-level will displace 10 million people in Egypt's Nile, 13 million in Bangladesh and 72 million people in China (Young, 2006). Other impacts that will continue are frequent heat rashes, heat strokes, meningitis, seasonal flash floods, river floods, coastal flooding, beach erosion, incessant droughts, desertification, frequent and more severe cyclones e.g. thunderstorms, violent hurricanes, and tornadoes. The Sahara desert is expanding in all directions at a rate of 10 metres per annum (Odjugo & Ikhuoria, 2003).

The chilling new report on Global Warming by the Intergovernmental Panel on Climate Change (IPCC) issued in Incheon, Republic of Korea on 6<sup>th</sup> October, 2018 is that global warming is already in the region of 1<sup>0</sup>C. The Paris Agreement set a long term goal of holding global average temperature to well below 2<sup>0</sup>C above pre-industrial levels and pursuing efforts to limit temperature to 1.5<sup>0</sup>C (Nullis, 2018). IPCC warned that at 1<sup>0</sup>C, the consequences have been manifest-increased extreme weather events, rising sea levels, diminishing Arctic sea ice, among others. Limiting global warming to 1.5<sup>0</sup>C, IPCC insists, is technically possible, but would entail global emissions of CO<sub>2</sub> declining by about 45% from 2010 levels by 2030 to zero by 2050. IPCC reported that at current rate of emissions, the world will reach 1.5<sup>0</sup>C warming between 2030 and 2050 and is on track for more than 3<sup>0</sup>C to 4<sup>0</sup>C warming by 2100. Exceeding 1.5<sup>0</sup>C would trigger instabilities in the Greenland and Arctic ice sheets, resulting in multi-metre rise in sea level over hundreds and thousands of years. IPCC warns that an Arctic region being free of ice will occur once in 100 years at 1.5<sup>0</sup>C regime as against once in 10 years at 2<sup>0</sup>C regime.

At less than 1.5<sup>0</sup>C, increases in ocean temperature and acidity and decreases in ocean oxygen levels would reduce risks to marine biodiversity, fisheries and ecosystem. At 1.5<sup>0</sup>C thousands of species will be lost through extinction: 6% of insects, 8% of plants and 4% of vertebrates will lose over 50% of their climatically geographic range, compared with 18% of insects, 16% of plants and 8% of vertebrates at 2<sup>0</sup>C regime, especially in the northern hemisphere. Increase in extreme weather events include hot extremes (increasing number of days of more than 3<sup>0</sup>C) in most inhabited regions, increased frequencies, intensity and amount of heavy precipitation in several regions, and increased intensity and frequency of droughts and precipitation deficits in some regions, especially in high risk regions of the Mediterranean, sub-Saharan Africa and small island states.

## **CLIMATE CHANGE IN NIGERIA**

In Nigeria, an estimated 60% of the population living in the rural areas are engaged in agricultural activities and are likely to be affected severely by climate change. They live off natural resources e.g. hunting, animal rearing, fishing, forestry and logging and crop farming. Studies show that Nigeria is already getting its fair share of climate change impacts (Odjugo, 2009; Ekpo & Nsa, 2011; Adefolalu, 2007). In a study spanning 105 years and involving 30 meteorological stations, Odjugo (2010) showed that mean temperature (T<sup>0</sup>) for Nigeria since 1901 remained steady until late 1960s when it started a gradual rise up till today. In his study of rainfall trend, he discovered that rainfall experienced a decline of 81mm from 1901 – 2005. A study by Ekpo and Nsa (2011) showed that rainfall for Sokoto from 1968 – 2008 declined by

8.8% of the long term mean from 1915 – 2008. The same study revealed late onset, early cessation and long breaks within the rainy seasons.

Rainfall varied in total amount for all regions and was quite erratic. This pattern poses real problem to planning and adaptation. Studies by Odjugo (2010) and Baudi and Ahmed, (2006) showed that rainstorm killed 199 people and destroyed property worth N85.03m between 1992 and 2007. Other studies showed the number of rainy days in Northern Nigeria in the last 30 years have dropped by 53% in the north east, while the coastal areas have noticed a drop of 14%. The double rainfall maxima have shifted southward, while the “little dry season” usually experienced in August is usually experienced now in July (Odjugo, 2010; Ekpo, 2009).

The Lake Chad region, (a region of intense evapotranspiration) has seen drastic reduction in rainfall from 800mm to 400mm (a 50% decrease) in the last forty years, resulting in incessant drought. Rivers and streams feeding into the Lake Chad have all been drying up. A reed, *Typha australis* (known locally as “Kachalla”) has been covering the River Komadugu-Yobe fertile place since the completion of the Tiga Dam. In addition, “Kachalla” has been an ideal habitat for the destructive quelea birds, which destroy crops. As a result of the ecological condition of the Lake Chad, there has been 60% decline in fish production. Degradation of pasturelands has led to shortage of dry matter estimated at 46.5% as far back as 2006, reduction in livestock population and threat to biodiversity (The Nation, Saturday, June 1, 2019, pp. 13-16). Economic estimate of fish sold in the region is put at N350 million weekly or N1.4bn a month. 50,000 metric tonnes annual loss is sustained in fresh water fish supply as a result of the drying up of the Lake Chad, 55% estimated loss in pasture land due to desertification, (posing a challenge to beef production), 95% drop in quantity of milk product per cow as a result of poor cattle nutrition and massive reduction in crop yield in the past 20 years (45% in tomato and 55% in wheat) (Kenechukwu, 2016).

Climate change, deforestation, high rainfall, weak unconsolidated soil and slope incidence have accelerated sheet and gully erosion. While sheet erosion is fairly widespread, gully erosion presents catastrophic spectacle. Although gully erosion afflicts only 0.1% of the total land area of Nigeria, the number of gullies is dauntingly large and sizes of some of them astonishingly large. Areas most ravaged are the South East geopolitical zone, South-South zone (Cross River), Edo (Auchi), Ondo state (Efon Alaye), Benue (Ankpa) and Gombe State. In a public policy forum titled *Desertification and Deforestation* held at Shehu Musa Yar’Adua Centre on Friday, October 25, 2016, the Minister of Environment, Hajia Amina Mohammed and Chairman, Senate Committee on Environment, Senator Oluremi Tinubu stated that 1.5 million trees were being felled daily and about 351,000 hectares lost to desertification annually (Daily Sun, Friday, Nov. 4, 2016, p. 14). The impact of Climate Change and Environmental Degradation on Food Security in Nigeria is also benumbing. \$1bn is posted as annual loss in non-timber forest products due to rapid deforestation, 90% permanent loss is sustained in the natural habitat of pollinators critical to agricultural production.

The effects of climate change in Nigeria can be summarized as follows:

There is a connection between climate change (which became pronounced in the 1970s) and decline in Africa’s agricultural productivity. Concern for climate change became serious in the late 1960s and early 1970s. This period is significant in Nigeria and West Africa and has intensified as shown in the 1970s and 1980s in the great Sudano-Sahelian drought. The dimension of Lake Chad straddling the borders of Nigeria, Chad, Niger and Cameroon decreased

from 25,000km<sup>2</sup> (9,650sq miles) in 1963 to just 1,350km<sup>2</sup> or 521sq miles today, due to dams constructed on the upper reaches of the rivers draining into it, as well as intense evapotranspiration. Periodic flooding episodes culminating in the horrendous flooding episode of 2012 which affected 27 states, in which over 600 lives were lost and estimated to cost over N11 trillion naira by the Federal Government in property and assets. Earlier were the Ojiranmi flood disasters, Gusau, Sokoto, etc floods. In 2017, flooding affected Benue, Kogi and Kebbi States destroying settlements and farms. Sea surges in coastal belt of Nigeria, especially in Victoria Island, Port Harcourt and Yenagoa destroy transport infrastructure. There have been variable rainfall patterns in the form of late arrival of rainfall, and premature cessation. There have been heavier rainfalls in the deep South (about 3000 mm) and near drought condition in extreme north (between 200mm and 750mm) (Nnodu, 2011).

A broad reduction in rainfall is noticeable in the range of 5% to 10% in Nigeria's Sudano-Sahelian zone characterized by drought and floods. There have been increased desertification, soil and gully erosion, due to decreased rainfall and increased rainfall respectively. Increased southward movement of Fulani herdsmen resulting in bloody clashes and fatalities between crop farmers and pastoralists is partly a result of decreased grazing land consequent on decreasing rainfall and cultural habits. Periodic infestation of pests, locusts, quelea birds and associated diseases in the North, are the consequences of biodiversity loss. Heat waves in Northern Nigeria accompanied by severe bouts of meningitis can be traced to decreased rainfall and prolonged hot season in addition to overcrowding. In Nigeria NIMeT records show that average surface T<sup>0</sup> ranged from 0.4<sup>0</sup>C to 1.5<sup>0</sup>C above long term average, while mean T<sup>0</sup> increase in the rain forest area was between 0.2<sup>0</sup>C and 0.3<sup>0</sup>C per decade (Ewa, 2011). The NEMA 2009 Report shows that 165 incidents of flooding, rain and windstorm affected about 55,286 people. On July 10, 2011 – 17 hours of rainfall in Lagos caused extensive flooding in which 20 people died. Roads, bridges, vehicles, schools and homes were destroyed, and thousands of people rendered homeless. In August, 2011 severe flooding in Ibadan, led to a loss of 102 lives and millions of naira worth of property destroyed.

Climate change will affect Nigerian agriculture because a large proportion of agriculture is rain fed. For example from 2002 – 2005 only 0.8% of crop land was irrigated (UNDP, 2009), the same as in 2001 – 2003 (The World Bank, 2007). Intense and heavy rainfall in Southern Nigeria is increasing the range of gully erosion because of increase in overland flows in fragile sandstone dominated environment. Heavy rains and flooding affecting the Niger and Benue rivers' flood plains cause severe displacement of settlements, grain losses and infrastructure damage, especially roads, bridges and culverts. Shortfall in rainfall leads to grain and livestock losses. The uncertainty created by delayed onset of rainy season, or early cessation subjects farmers to indecision as to when to commence farming and this affects gross productivity.

The decrease in forested area also aggravates climate change because of slash and burn practice by farmer families. This increases CO<sub>2</sub> concentration in the atmosphere, as well as decreases atmospheric humidity. It also aggravates overland run-off and diminishes infiltration potentials. In 1990, 172,000km<sup>2</sup> of land was forested. In 2005 it remained only 111,000km<sup>2</sup> with average deforestation rates of 2.7% from 1990 – 2000 and 3.3% from 2000 – 2005 (UNDP, 2009). It is not therefore surprising that in 2004 – 2005 the values of agricultural export and importation were \$623 million and \$2,285 million respectively. For food, respective figures were \$548 and \$2,024 million (The World Bank, 2007). The serious problems of land degradation and desertification are likely to be exacerbated by climate change through accelerated erosion,

fertility depletion, salinization and acidification. Subsistence farming, characterized by low productivity and extractive farming is extremely vulnerable to climate change. This constrained food production targets and the achievement of the Millennium Development Goals (MGDs) and will continue to constrain the Sustainable Development Goals (2016 – 2030).

It is clear therefore that an authentic link can be established between climate change and agriculture. Unless appropriate actions are taken, Nigeria will always be taken unawares and be helpless as happened in 2012. There is, therefore, the need to develop a rich and varied baggage of strategies not only to minimize agricultural decline and food insecurity, but also to ensure that an entire human development is not nullified. We therefore go on to discuss possible responses, bearing in mind that agriculture involves fishing, forestry, crop farming, animal rearing, market gardening, etc. It has to be borne in mind that some climate-related events, such as flooding and water resources depletion intimately affect agriculture and food security.

## **CURRENT NATIONAL STRATEGIES FOR CLIMATE CHANGE**

### **Institutional Structure**

At present the following institutional provisions exist:

- i. Special Climate Change Unit (Federal Ministry of Environment) (SCCU)
- ii. National Emergency Management Agency (NEMA) and their state counterparts
- iii. Climate Centre, Federal University of Technology, Minna
- iv. The Nigerian Meteorological Agency (NIMET),
- v. The Energy Centres: Usman Danfodio University, Sokoto; University of Nigeria Nsukka; and Obafemi Awolowo University, Ile-Ife
- vi. National Space Research and Development Agency (NARSDA)

A recent study shows that the SCCU in the Federal Ministry of Environment lacks both capacity and resources to drive and coordinate national climate change response. There are very few experts there and facilities are grossly inadequate, in addition to poor funding (Oladipo, 2011). All crises, such as the 2012 flooding were handled by emergency bodies to provide food (some of which was imported), water and blankets at emergency camps. Such emergencies have no research or learning memories. Lacking a learning platform, no accumulated knowledge exists to respond to a reoccurrence. Impacted people and communities become hopelessly affected with fear, misery and poverty, especially the very poor, wiping off any accumulated MDG achievement. Poverty remains a great problem in adaptation to climate change emergencies. Going by research, Olofin (2011) has shown that 126 million Nigerians are branded poor and these can never adapt and cope with a major crisis. Over the years farmers have had strategies to cope with climate emergencies, including mixed cropping, relay cropping, traditional raising of quick-maturing and drought-resistant cultivars, wide spacing cultivars, traditional agro-forestry and shelter belt establishment.

Although there is a skeletal governance structure in the Federal Ministry of Environment, it is limited in scope and operation. Such a governance structure should include the Ministries of Environment, Agriculture, Water Resources, Transport, Women Affairs and Youth Development, Tourism, Energy and Power, Petroleum, Education, Health, Defence, Aviation, Housing and Urban Development, etc each developing areas where it can play significant role in climate-related hazards and disasters, but all of them in a synergy. The need for such an over-arching governance infrastructure is to avoid duplication of functions and waste of expensive and scarce resources. Such structure should have research and development, operational, educational, and technological units. This structure should also aim at limiting Green House Gases (GHGs) emissions, through adoption of green development strategies.

In terms of food security, the crucial role of NIMeT, the various Climate Centres, River Basin and Rural Development Agencies, Forestry Departments, Survey Departments, Nigerian Inland Waterways Department, National Orientation Agency, Fisheries Department, Agriculture and Rural Management Institute and Agencies responsible for dams in developing early warning systems in relation to climate change disasters is pivotal. These, however, are missing a collegiate synergistic umbrella because of poor funding and poor knowledge of environmental pin-ups in their daily operations, possibly with the exception of NIMET. This umbrella body would naturally be the NEMA and it should have the necessary psychological preparedness and operational efficiency to respond to disasters and tackle underlying causes.

However, NARSDA has done a few things as follows:

Nigeriasat-1 has been used locally to detect land cover/land use change in Enugu and Niger Delta regions between 1986 and 2003; developing predictive models for desertification early warning; studying impact of gully erosion and soil loss in South-eastern part of Nigeria; mapping flood vulnerability around Lake Chad, along Kaduna River and Shiroro Dam; assessing deforestation in south-western part of Nigeria. Nigeriasat-2 is capable of assessing CO<sub>2</sub> sequestration through land use cover mapping; estimating urban GHG emissions from motorized vehicles; assessing flood vulnerability through mapping in flood prone areas in Nigeria and monitoring drought and desertification (Ewa, 2011).

Although Nigeria is a signatory to the United Nations Framework Convention on Climate Change (UNFCCC) and has ratified the Kyoto Protocol, nothing positive is happening beyond this. It has not prepared a National Adaptation Programme of Action (NAPA) or the National Climate Change Response Strategy (NCCRS) (Madzwamuse, 2010). Nigeria has no National Climate Change Policy and Strategy that should guide present and future efforts in addressing climate change vulnerability and adaptation (Faturoti, 2011); has no action plan on climate change and is yet to adopt any adaptation or mitigation strategies for combating the menace of climate change (Ewa, 2011). Lack of appropriate policy and legislative frameworks, apart from being barriers to implementation of adaptation responses and so increasing societal vulnerability, prevents Nigeria from accessing Adaptation Funds because of lack of an instrument to ensure efficient utilization of funds and transparency. The SCCU operates only in the Ministry of Environment and so has no governance structure with sensitive ministries, such as agriculture, water resources, energy, health, transport, oil and gas, sports and tourism that are vulnerable sectors to climate change (Ekpo, 2011).

At the moment environmental education, not to talk of climate change education, is not reflected in school curriculum and there is pervading environmental illiteracy, even among the elite and

governing class (Muoghalu, 1998). Although Nigeria has scheme of service for officials in the Environment Ministries, some states have not adopted it. Local Government Departments of Environmental Health have no qualified personnel and so Local Governments are bereft of all they should know and do about the environment, short of sanitary inspection.

### **ADAPTATION AND MITIGATING STRATEGIES: THE POLICY IMPLICATIONS**

The above considerations are germane to adaptation and mitigation of climate change disasters related to the agricultural sector. In this section we will be more specific on measures relating to agriculture. There are international and local perspectives. It is a truism that in order to reduce GHGs a high degree of international cooperation and funding is needed, especially from the developed, industrialized nations, who are the main precipitants of global warming. In this case, Nigeria has to take concrete action that will convince the world that she is serious about combating climate change. She will adopt a governance structure that will guarantee this credibility: produce a National Climate Change Policy and Strategy, a National Adaptation Programme of Action (NAPA) and the National Climate Change Response (NCCRS) and open the space for involvement of the wider society. Nigeria has to show seriousness in reducing deforestation and develop structures, administrative, managerial and financial very much like Japan in making forestry a viable agricultural sector. Traditional strategies that work should be strengthened such as agroforestry. Areas that are prone to land degradation should be converted to parks and their use should be regulated with affected communities as major stakeholders. A situation where the Federal Government has no more responsibility for forests should be reversed. State Forestry Laws should be updated and enforced with local governments having strong stakes (Muoghalu, 2018). Gas flaring should stop entirely. The rate of urbanization of our land space should be reduced and regulated to make land available for agriculture. The large lot zoning in our urban centres should be re-examined as it amounts to a dole out to the rich. In this regard, the total area taken up by urban centres for example, in Anambra State has to be reconsidered. The three towns of Awka, Onitsha and Nnewi for which HABITAT prepared structure plans would on execution take up 1,325km<sup>2</sup> or 27.34% of total state land. Added to the other 18 local government headquarters with 5km radius of planning area, total state land devoted to urbanization is 2,739.25km<sup>2</sup>, out of 4,865km<sup>2</sup> or 56.3 1% of total state land area (Muoghalu, 2013). There is need to enforce Anambra State Physical Planning Board stipulation of a minimum of three trees and a catchment pit within the compound to create green townscape.

Weather and climate information should be made available to real farmers who need this information so as to know when to start and end all farm operations. In this, focal farmers have to be identified and fed with information. Same goes with when to expect drought, below average rainfall or flood, or pest infestation, time to weed and apply fertilizers. Crop varieties that are not only resilient to adapt to climate variability, but can also mature relatively quickly should be available to farmers. In this, all Universities of Agriculture, Colleges of Agriculture, faculties of agriculture and research institutes have a great role to play. The federal government should ensure that our weather record instruments are the automatic ones that make records acceptable to World Meteorological Organization (WMO) and should benefit from the 5000 meteorological stations being installed all over Africa by a consortium (WMO, 2009).

The need for afforestation and re-afforestation is dire. In 2011 Nigeria raised 36 million tree seedlings for planting in all states and Abuja. This should not be a once-for-all effort, but should

be sustained. As Munasinghe and Shearer (1995) emphasized any tropical landscape devoid of trees should be a warning signal that the landscape is degraded. It must be recalled that deforestation accounts for 20% of global warming. Crop genetic diversity will help farmers to adopt crops that are suited to their local environment, food production systems and practices. It also serves as a risk adjustment measure thereby helping farmers to be very prepared to achieve food security in their diverse ecological regions by reducing their vulnerability to climate shocks and fluctuations in crop production (Sulphey, 2013:197). It is cheering news that Nigeria has now 55 rice species that address different ecological conditions through maturing in different time intervals. The maintenance of Nigeria's wetlands (estimated at 3m hectares) is of utmost importance, since wetlands provide an incredible range of ecological services. They harbour biodiversity, provide agricultural, timber and medicinal products, sustain fish stocks, buffer coastal and riverside areas from storms and flood and protect human settlements from sea surges (Finlayson & Spiers, 2000). Unfortunately, the coastal wetlands are being ravaged by the oil and gas industry, but the non-saline wetlands of the Niger – Benue troughs and their distributaries, Hadeija-Nguru, Komadugu-Yobe, Kainji Lake, Adiani-Nguru, Margadu/kabak, Kirisama-Nguru, Sokoto-Rima, Ogun, Oshun, Katsina-Ala, Gongola, Anambra-Imo basin and Cross River plains need to be preserved at all cost since they support dry season gardens, bananas, sugar cane, early maize and paddy rice plantains, oil palm, coconuts and cassava (Muoghalu, 2010).

Engaging agrometeorologists who will serve as extension officers to real time farmers particularly in flood-prone southern Nigeria and drought-ridden northern Nigeria is a crying necessity. In the dissemination of agricultural meteorological information, the local media, radio and television stations have a role to play, as well as the print media, who may operate in both English and the native languages. Education focused on the dangers of slash and burn and the need for agroforestry and wiser use of water, should be of national concern. Where irrigated agriculture is practiced, attempt should be made to regulate the release of water to avoid excessive flooding from the dams. The dams should be monitored for sediment yield on the lakeward side of the dam to avoid dam failure and collapse as happened with the Tiga Dam in Kano and the one on Goronya Dam in the Republic of Camerouns in 2012. The Chad Basin Commission should incorporate this flash spot disaster area.

Where farmers locate near rivers liable to annual floods, there is need for dredging to deepen the river thalweg to minimize dangerous flooding that can ruin crops. The so-called River Niger dredging was a rouse. In addition to dredging, the river output should be continuously gauged in order to advise farmers on flooding and in order to decide on steps to take such as canalization, channeling, etc. Allied to flood management for agricultural activities, sea level rise means inundation of settled areas. This demands that farmers in such locations should be settled on upland areas, while they farm the flood plains where flood deposits plenty of alluvium.

The same should apply to the Niger Delta. The anticipated sea-level rise of 1 meter/100 year as predicted by IPCC (2007) would flood 10,000 km<sup>2</sup> or 2% of Nigeria's land area along the coast and would disrupt economic activities in the Niger Delta, including oil and gas production, agriculture, fisheries and force 80% of the Niger Delta population to migrate to higher grounds, while property damage estimated at \$9bn would result (Nicholas et al, 1993).

Nigeria should undertake a detailed Vulnerability Assessment of various crop zones in the country. This will identify the areas most vulnerable to climate change-induced disasters and risks. Climate change has to be integrated into National Development Plans to ensure sustainable

funding. The governance space for climate change operations should be widened to include academic institutions, research institutes, NGOs, CBOs, FBOs, Civil Society Organizations and foreign donors and agencies for an all-inclusive active participation that will fast-track adaptation and risk management. These will help to conduct the advocacy and sensitization of the citizenry.

Again the media has a crucial role to play. Programmes should be instituted on radio, television and in print media to educate and interact with farmers continuously. Media people need to undergo training on climate change and environment generally. The use of cell phones in educating and reaching rural farmers should be explored as is being done in some developing countries. Multidisciplinary research centres on crop resilience, better hybridized crops that can thrive with minimum water supply in case of drought should be set up. Faster maturing crop varieties should be produced through biotechnology engineering. Such centres should have crop scientists, bird farmers, animal rearers, meteorologists/climatologists, soil scientists, foresters/botanists, agricultural engineers, aquaculturists, pests and disease experts. Management of real hazard includes pre-hazard, during hazard, post hazard phases. These deal with real cost of hazard, in people, infrastructure, property and economy. The last phase is rehabilitation in settlement and livelihood, which has been absent in Nigeria.

## CONCLUSION

Climate change is a serious development brought about by humans and nature. The part due to humans should be brought under check in order to sustain existence on our planet earth. The prime drivers of climate change are our consumption behaviour of all resources, high population growth rate that is devastating natural resource capital stock, massive pervading poverty and bad resource management practices, industrialization, technology and deforestation, all of which, unless checked through international cooperation and national programmes of action, will make life miserable on earth, especially for the very poor, the aged and children, a higher proportion of whom live in developing countries. The answer lies in behaviour change and the willingness of the developed world and indeed all nations to act together to salvage mankind from precarious existence. Any attempts made to protect agriculture from the ravages of climate change and variability will ensure food security and meaningful livelihood.

The following are reminiscences from Al Gore:

*Massive clearing of tropical rain forest is an ecological catastrophe of the first magnitude. Huge population increases cause vulnerability to extreme climate changes, pressure of population on the environment causes deforestation, accelerating water-driven soil erosion, carrying enormous quantity of top soil downslope and enhancing flooding, turning our rivers brown with the soil that should have been growing crops and silting up rivers. Climate change marks a reversal of "where civilization once feared Nature's whim, the Earth must now suffer ours".*

Al Gore ruminates that just as the

*Year without a summer in 1816 produced massive famines and helped stimulate the emergence of the administrative state, global warming will produce a new world bureaucracy to manage the unimaginable problems caused by massive social and political upheavals, mass migrations and the continuing damage to the global environment by civilization itself. In the lifetimes of people now living, we may experience a "year without winter."*

That world bureaucracy is here already, manifested in the United Nation's numerous climate summits, the existence of UNEP, the emergence of the Ministries of Environment, numerous NGOs, refugee institutions and WMO, among others. These result in too much talk and too little action.

In conclusion, Sa'adatu Madaki, a scientific officer in SCCU of the Federal Ministry of Environment in an address to a Youth Climate Innovation Hub in Kano on 30<sup>th</sup> August, 2019, warned that unless government and other stakeholders work hard, climate change would rob Nigeria of her \$411bn GDP to the tune of 11% by 2020 without appropriate adaptation and mitigation strategies. She warned that even though climate change is affecting all economic sectors, it will cause loss of agriculture and increase water scarcity. The time to act is now (Madaki, 2019).

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