

General Overview of Climate Change Impacts in Nigeria

Peter Akpodiogaga-a Ovuoyovwiroye Odjugo

*Department of Geography and Regional Planning, University of Benin, Benin City,
Edo State, Nigeria*

Telephone: +23408023718654, E-mail: paodjugo@yahoo.com

KEYWORDS Greenhouse Gases. Temperature. Rainfall. Crops. Desertification. Coastal Inundation. Rainstorms and Windstorms

ABSTRACT Although no region of the world will be entirely spared, the negative impacts are likely to fall most heavily on poor nations in the tropical region. While data on the global impacts of climate change is available, those at regional levels are scanty and scattered. This prompted this study that took a general overview of climate change impacts in Nigeria. Mean annual and monthly temperature and rainfall data were collected from the Nigerian Meteorological Agency and some States' airports for a period of 105 years (1901-2005). Published data from different sources as acknowledged in the text were also used. Histogram, trendline and time series were the statistical tools employed to analyse the data. The results show that while temperature increased by 1.1°C for the 105 years, rainfall decreased by 81 mm. Desert encroachment, coastal inundations, drying up of surface waters and shift in crops cultivated over time were also noticed. Greenhouse gas reduction and adaptive measures were recommended.

INTRODUCTION

IPCC (2007) defines climate change as a change in the state of the climate that can be identified (e.g., by using statistical tests) by changes in the mean and /or the variability of its properties, and that persists for an extended period typically decades or longer. Although the length of time it takes the changes to manifest matters, the level of deviation from the normal and its impacts on the ecology are most paramount. This prompted Ayoade (2003) to state that secular variations in climate occurring over a period of 100 to 150 years may not qualify as a climate change if conditions will quickly reverse later, but a change in climate usually takes place over a long period of time of at least 150 years with clear and permanent impacts on the ecosystem. Climate change is different from the generally known terms like climatic fluctuations or climatic variability. These terms denote inherent dynamic nature of climate on various temporal scales. Such temporal scale variations could be monthly, seasonal, annual, decadal, periodic, quasi-periodic or non-periodic.

Climate change is caused by two basic factors, which include natural processes (biogeographical) and human activities (anthropogenic). The natural processes are the astronomical and the extraterrestrial factors. The astronomical factors include the changes in the eccentricity of the earth's orbit, changes in the obliquity of the plane of ecliptic and changes in orbital procession while

the extra-terrestrial factors are solar radiation quantity and quality among others. On the other hand, the anthropogenic factor in climate change involves human activities that either emit large amount of greenhouse gases into the atmosphere that depletes the ozone layer or activities that reduce the amount of carbons absorbed from the atmosphere. The human factors that emit large amounts of greenhouse gases include industrialization, burning of fossil fuel, gas flaring, urbanization and agriculture. On the other hand, human activities that reduce the amount of carbon sinks are deforestation, alterations in land use, water pollution and agricultural practices. The human factors have been proven to be responsible for the ongoing unequivocal climate change or global warming (IPCC 2007).

The emitted greenhouse gases are carbon dioxide (CO₂), chlorofluorocarbons (CFCs), Methane (CH₄) and nitrous oxide (N₂O) among others. As shown in Figure 1, CO₂ currently contributes the highest rate of the greenhouse gases followed by CH₄, CFCs N₂O and others (like halons, tropospheric ozone, sulphuric hexafluoride (SF₆) among others). Although CO₂ has the highest contribution to greenhouse gases, its potency is far lower. For instance, a gram of CH₄ is about 23 times higher than the effects of the same volume of CO₂ and a gram of sulphuric hexafluoride (SF₆) released into the atmosphere is about 22,000 times that of CO₂ with respect to tropospheric zone depletion. The life time of CO₂ in the atmosphere varies, but

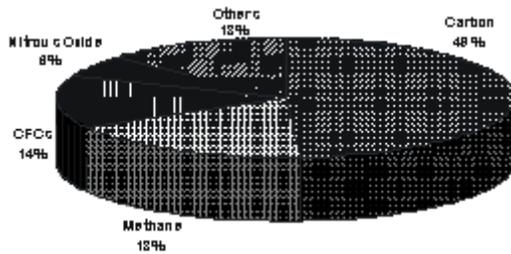


Fig 1. Current contribution of greenhouse gases to the atmosphere

obviously less than ten years, while that of CH_4 , N_2O , CFCs and SF_6 are 12.2, 120, 50-1700 and 3200 years respectively (Smith 1994; Msumba 2006). While a molecule of CO_2 could cause damage to stratospheric ozone just for a few years, other greenhouse gases could cause ozone layer damage for between decades to thousands of years. Although the potency of CO_2 released into the atmosphere through human activities may be significantly lower than many other greenhouse gases, the much greater volume of its emissions still makes it the most important influence in humans' enhancement of the natural greenhouse effect.

Available evidences show that climate change will be global, likewise its impacts, but the biting effects will be felt more by the developing countries, especially those in Africa, due to their low level of coping capabilities (Nwafor 2007; Jagtap 2007). Nigeria is one of such developing countries. Researches have shown that Nigeria is already being plagued with diverse ecological problems, which have been directly linked to the on-going climate change (Odjugo 2001a; 2005; Odjugo and Ikhuoria 2003; NEST 2003; Chindu and Nyelong 2005; Mshelia 2005; Ayuba et al. 2007). While Odjugo (2001a, 2005) observes erratic pattern of weather elements in Nigeria, Odjugo and Ikhuoria (2003) show that climate change has started impacting on desertification and Ayuba et al. (2007) show that climate change is impacting negatively on plant species composition in Northeastern Nigeria. These may not be the only impacts of climate change in Nigeria. It is on this premise that this study took an overview of the impacts of climate change in Nigeria with the aim of compiling and synthesizing them holistically.

MATERIALS AND METHODS

Both primary and secondary data were used

in this study. The primary data used were the mean annual and monthly rainfall and temperature collected from 30 Nigerian Meteorological Stations and some States' Airports for a period of 105 years (1901-2005). The time series was used to analyse the trend of rainfall and temperature. The pattern of rainfall was depicted using the histogram while trend lines were used to depict the slope of the rainfall and temperature. The secondary data were derived from various published data as shown against the figures. The information from these sources was displayed for analysis using flow and pie charts and time series among others.

RESULTS AND DISCUSSION

Climatic Variation

The temperature trend in Nigerian since 1901 shows increasing pattern (Fig 2). The increase was gradual until the late 1960s and this gave way to a sharp rise in air temperatures from the early 1970s, which continued till date (Fig 2). The mean air temperature in Nigeria between 1901 and 2005 was 26.6°C while the temperature increase for the 105 years was 1.1°C . This is obviously higher than the global mean temperature increase of 0.74°C recorded since 1860 when actual scientific temperature measurement started (Spore 2008; IPCC 2007). Should this trend continue unabated, Nigeria may experience between the middle (2.5°C) and high (4.5°C) risk temperature increase by the year 2100.

Rainfall trend in Nigeria between 1901 and 2005 shows a general decline (Fig 3). Within the 105 years, rainfall amount in Nigeria dropped by 81mm. The declining rainfall became worst from the early 1970s, and the pattern has continued till date. This period of drastic rainfall decline corresponds with the period of sharp temperature rise (Fig 2). Although there is a general decrease in rainfall in Nigeria, the coastal areas of Nigeria like Warri, Brass and Calabar are observed to be experiencing slightly increasing rainfall in recent times (Odjugo 2005, 2007). This is a clear evidence of climate change because a notable impact of climate change is, increasing rainfall in most coastal areas and decreasing rains in the continental interiors (IPCC 1996; NEST 2003). Odjugo (2005, 2007) observe that the number of rain days dropped by 53% in the north-eastern Nigeria and 14% in the Niger-Delta Coastal areas. These studies also

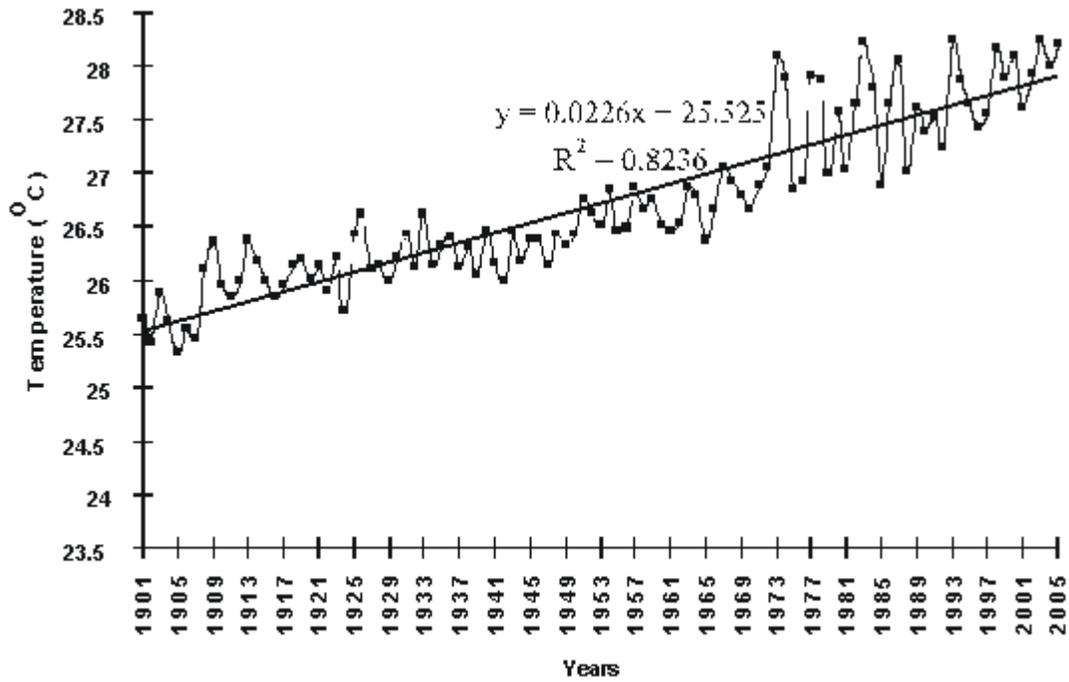


Fig. 2. Air temperature distribution in Nigeria between 1901 and 2005

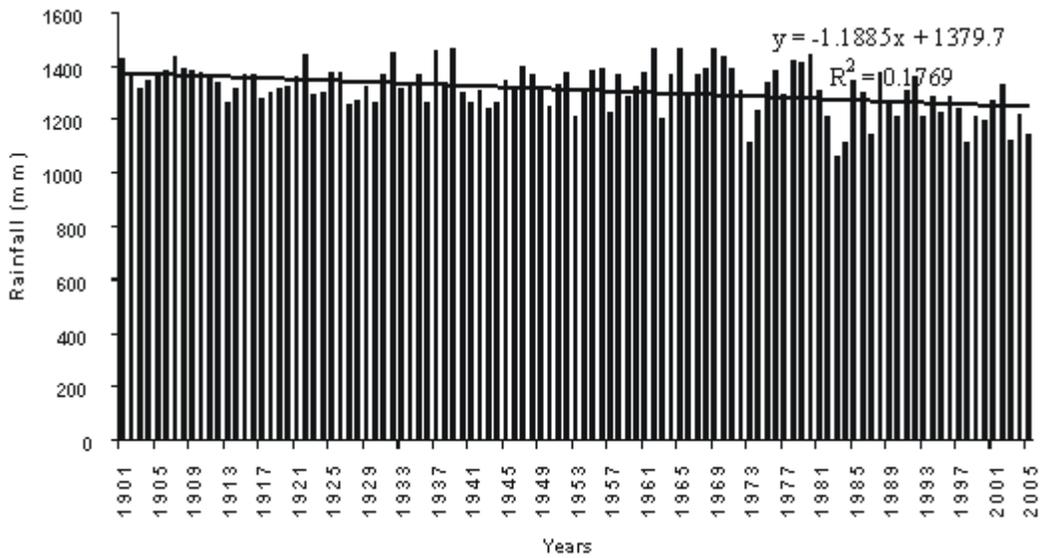


Fig. 3. Rainfall distribution in Nigeria between 1901 and 2005

showed that while the areas experiencing double rainfall maximal is shifting southward, the short dry season (August Break) is being experienced more in July as against its normal occurrence in the month of August prior to the 1970s. These are major disruptions in climatic patterns of Nigeria showing evidences of a changing climate. The computed $R^2=0.82$ and $R^2=0.18$ in temperature (Fig 2) and rainfall (Fig 3) respectively shows that within the past 105 years the temperature increase (warming) in Nigeria is statistically significant while the rainfall decline is not. This is a pointer that Nigeria is going to be hardly hit by global warming in the nearest future while the declining and shifts in rainfall pattern are becoming a worrisome development.

Ecological Implications of Climate Change

Increasing temperature (global warming) and decreasing precipitation in most parts of the world are the greatest impacts of climate change. These bring about either negative or positive ecological impacts in different parts of the world. The increasing temperature has led to increased land-based ice instability and its melting. The thawing of the Arctic, cool and cold temperate ice, the increasing rainfall in some parts of the world and expansion of the oceans as water warms has started impacting on sea level rise, coastal inundation and erosion. The current global estimate of sea level rise is 0.2 m and it is projected to increase to 1 m by the year 2100 (Hengeveld et al. 2002; Hengeveld et al. 2005). The implication is that the present 0.2 m sea level rise has inundated 3,400 km² of the coastal region of Nigeria, and if the sea level rise attains the projected 1m on or before 2100 then 18,400 km² of the coastal region may be inundated (NEST 2003). Coastal settlements like Bonny, Forcados, Lagos, Port Harcourt, Warri and Calabar among others that are less than 10 m above the sea-level would be seriously threatened by a metre rise of sea-level.

The sea incursion due to sea-level rise means salt-water intrusion into the fresh water, invasion and destruction of mangrove ecosystems, coastal wetlands and coastal beaches. The worst impact is population displacement, which may result in communal crisis. The coastal inundation and erosion with their associated population displacement are currently major environmental problems in Nembe, Eket and other coastal settlements in Bayelsa, Delta, Cross River, Rivers,

and Lagos States of Nigeria. It is estimated that a metre rise in sea level will displace about 14 million people from the coastal areas of Nigeria (Abu 2007). Young (2006) also observes that sea-level rise up to a metre will displace 10, 13 and 72 million people in the coastal areas of Egypt, Bangladesh and China respectively.

The increasing temperature and decreasing rainfall have led to frequent drought and desertification. The Sahara desert is observed to be expanding to all directions trying to engulf the Sahelian region of Africa with annual expansion of 1-10 km (Odjugo and Ikhuoria 2003; Yaqub 2007). Odjugo and Ikhuoria (2003) also observe that Nigeria north of 12°N is under severe threat of desert encroachment and sand dunes are now common features of desertification in states like Yobe, Borno, Sokoto, Jigawa and Katsina. The migrating sand dunes have buried large expanse of arable lands, thus reducing viable agricultural lands and crops' production. This has prompted massive emigration and resettlement of people to areas less threatened by desertification. Such emigration gives rise to social effects like loss of dignity and social values. It often results in increasing spate of communal clashes among herdsmen and farmers and such clashes resulted in the death of 186 people in six northern states of Nigeria between 1998 and 2006 (Yugunda 2002; Yaqub 2007). Akonga (2001) also shows that most of the destitute that emigrated as a result of drought and desertification usually move to nearby urban areas to beg for alms thereby compounding the already tense urbanization problems.

Climate change will alter all aspects of the hydrological cycle ranging from evaporation through precipitation, run off and discharge (Mcguire et al. 2002). The global warming and decreasing rainfall together with the erratic pattern of rainfall produce a minimal recharge of groundwater resources, wells, lakes and rivers in most parts of the world especially in Africa thereby creating water crisis. In Nigeria, many rivers have been reported to have dried up or are becoming more seasonally navigable while Lake Chad shrunk in area from 22,902 km² in 1963 to a mere 1304 km² in 2000. This shows that what is left of Lake Chad in the year 2000 is just 5.7% of 1963 (Odjugo 2007). Awake (2009) also confirms the fact that Lake Chad has shrunk by 95% since the 1960s and Aral Sea in Central Asia was the fourth-largest lake in the planet in 1960, but by 2007 it

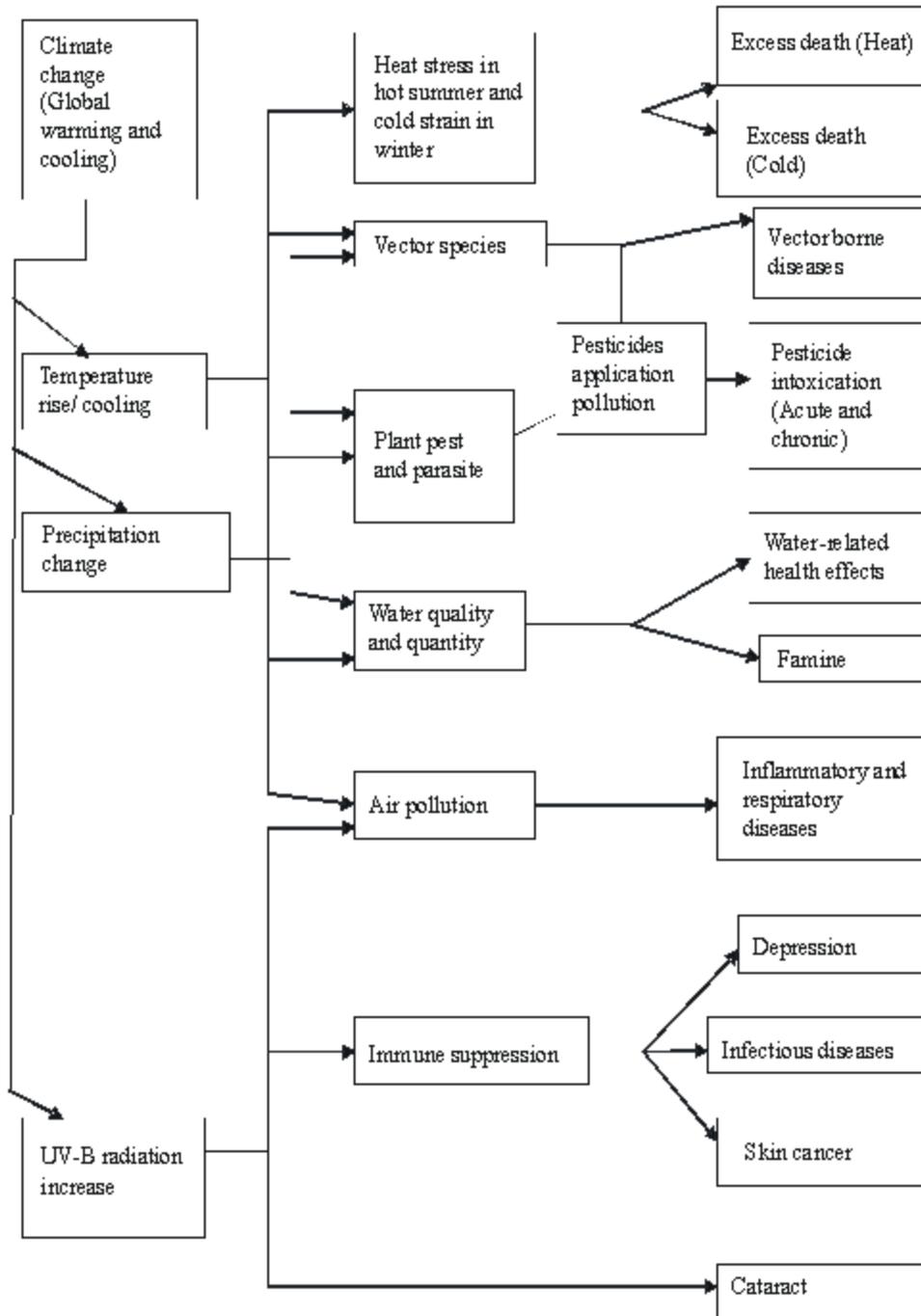


Fig. 4. Impacts of climate change on human health

Source: Author

had shrunk to 10% of its original size. Lake Chad and so many rivers in Nigeria, especially in Northern Nigeria, are in the danger of disappearing. The water scarcity will create the tendency for concentration of users around the remaining limited sources of water. Under such circumstances, there is increased possibility of additional contamination of the limited sources of water and transmission of water borne diseases like cholera, typhoid fever, guinea worm infection and river blindness. Odjugo (2000) and DeWeerd (2007) note that the increasing temperature will mean northward migration of mosquitoes and malaria fever which will extend from the tropical region to warm temperate region while the sporogony of the protozoa causing the malaria accelerates from 25 days at 10°C to 8 days at 32°C. This paper also conceptualizes the relationship between climate change and human health (Fig 4). As shown in figure 4, the excessive heat, increasing water stress, air pollution and suppressed immune system occasioned by climate change will result in increasing incidence of excessive death due to heat exhaustion, famine, water related diseases (diarrhoea, cholera and skin diseases), inflammatory and respiratory diseases (cough, and asthma), depression, skin cancer and cataract.

One of the greatest impacts of climate change is the worsening condition of extreme weather events like drought, flood, rainstorms, windstorms, thunderstorms, landslides, avalanches and tsunamis, among others (Odjugo 1999, 2001b; Changnon 2001). Odjugo (2008) notes that the frequency and magnitude of wind and rainstorms did not only increase, they also killed 199 people and destroyed property worth ₦85.03 billion in Nigeria between 1992 and 2007. Buadi and Ahmed (2006) had similar result when they reported that rainstorms claimed 42 lives in southern Cameroon between 2000 and 2005. Between 1950 and 2000, the increasing frequency and intensity of rainstorms have created enormous damages estimated at \$87 billion in property losses, \$19 billion in crop losses and losses of over 12,000 human lives in the United States of America alone (Changnon 2001).

Climate change has started to, and will continue to impact negatively on agriculture and food security especially in tropical and subtropical regions because greenhouse gas emissions would increase the risk of hunger by additional 80 million people by 2080 in Africa and southern Asia

(Odjugo 2001a; DFID 2006; Nwafor 2006, 2007; DeWeerd 2007). Odjugo (2008) shows that climate change has led to a shift in crops cultivated in northern Nigeria. The paper (Odjugo 2008) quoting Ahmed (1978) reveals that as at 1978, the preferred crops the farmers cultivated were guinea corn followed by groundnut and maize, but due to increasing temperature and decreasing rainfall amount and duration occasioned by climate change, the farmers as a means of adaptation in 2007 shifted to the production of millet followed by maize and beans. Another major problem to agriculture in Nigeria due to climate change is the reduction of arable lands. While the sea incursion is reducing the arable land of the coastal plains, the desert encroachment with its associated sand dunes is depriving farmers of their agricultural farmlands and grazing rangelands. Moreover, the frequent droughts and lesser rains have started shortening the growing season thereby causing crops failure and food shortage. It has been shown that drought, desert encroachment and coastal inundation have started affecting the country's ecosystem leading to ecological destabilization due to climate change impact in the semi-arid region of Northern Nigeria (Odjugo and Ikhuria 2003; Ayuba et al. 2007).

Planning Implications

Singer and Avery (2007) show that it is impossible for man to stop the natural causes of climate change but much can be achieved in either to stop or drastically reduce the human causes of climate change. If human activities that deplete the ozone layer are to a very large extent reduced and the carbon sinks are well-managed and protected, then the on-going global warming will seriously decline. To reduce the emission of greenhouse gases, clean and environment friendly technologies are needed. Industrial productions should convert to machines that emit limited or no greenhouse gases. Automobiles and industrial machines should be improved upon to use only ethanol, solar engines, electric engines or hybrid electric engines. Gas flaring especially in the Niger Delta region of Nigeria should be reduced to the barest minimum.

Nigeria should encourage the use of renewable energy sources such as photovoltaic cells in a small scale. Moreover the use of fuel cells that convert hydrogen fuel directly into electricity without first burning it to produce heat should

be encouraged. Policy-makers should encourage energy efficiency and other climate-friendly trends in both the supply and consumption of energy. Efficiency can also be improved upon by providing appropriate economic and regulatory framework for consumers and investors. A “Clean Development Mechanisms” is needed from the developed countries. This will enable the developed nations to finance emission-avoiding projects in developing countries. Promoting such clean technologies will bring credit to the industrialized nations rather than transferring non-environment friendly technologies to developing world like Nigeria.

The protection, sustainable management and enhancement of terrestrial and marine ecosystems, which act as carbon sinks and reservoirs to greenhouse gases are also very important. This means deforestation should be reduced to the barest minimum and afforestation highly encouraged. Protection of the forest requires improved agricultural practices through the use of fertilizer rather than the current dependence on the natural fertility of the forest soils as mostly practised in Nigeria. The widespread use of low-cost solar energy cookers instead of wood-burning devices will also limit the current pressure on the Nigeria forest for firewood. Moreover, bush burning either for hunting, farm clearing or by herdsmen to facilitate the sprouting of fresh grasses for their animals to graze on should be stopped. Oil spillage in the creeks and coastal areas of Nigeria should be guarded against in order to enhance carbon sink in the coastal waters. Changes are needed in building and furniture materials in Nigeria. Roofing materials, doors and furniture in most buildings, in Nigeria, are made of wood. Odjugo and Ikhuoria (2003) note that average of 320 sticks was used to support the decking of a three-bed-room flat building, plus the plywoods used for the floor of the decking. They also stated that these supporting sticks and plywoods are hardly used twice since they are sold as fuel wood immediately they are removed as support. One could therefore appreciate the number of trees destroyed annually with the current vertical growth of Nigerian cities. The deforestation processes can be reversed if iron and steel and aluminium are used for construction of our buildings and household furniture.

Ultra-violet rays due to ozone layer depletion result in increasing occurrence of skin cancer and

cataracts. To reduce the effects of skin cancer and eye cataracts, appropriate clothing that covers most part of the body should be worn, especially by albinos and those fair-skinned and to be accompanied by hat and sunshade glasses while under the sun. It is therefore advisable that those with black skins should avoid toning their skins because such act will make them highly susceptible to skin cancer.

For the developing nations like Nigeria to survive the effects of climate change, serious adaptation measures are needed. There is the need to establish better-equipped weather stations as against the scanty and ill-equipped ones we currently have in Nigeria. With these, accurate weather forecast and predictions will be possible and this will help to prevent weather-related disasters through early warning and effective response system. For example, a violent tropical cyclone in Central and North America in 1970 killed 30000 people whereas similar cyclones in 1992 and 1994 caused only 13000 and 200 deaths respectively as a result of improved forecast and early warning (Adefolalu 2007). Another important factor is the establishment of disaster mitigation plans in a more formal setting and the upgrading of all systems based on advance in science and technology, with emphasis on space science. With the decreasing rainfall amount and duration, frequent drought and desertification, drought resistant and short duration high yielding crops should be developed and made available to farmers. Nigeria should start to invest heavily on irrigation farming rather than relying more on rain-fed agriculture that is highly unreliable and becoming more unpredictable. Investment on improved agricultural technology, which should include the manufacturing and establishment of storage facilities, are very necessary. This will help to store excess agricultural produce for future use. The on-going plan to supply water to the disappearing Lake Chad from the Congo Basin should be intensified and brought into fruition within the shortest possible time. Another area that the governments sharing the lake should look into is the transportation of water from the Atlantic Ocean to the Lake Chad through pipelines after desalination. If crude and refined oil can be transported through pipelines from the coastal region of the Atlantic Ocean to Northern Nigeria, then that of water will not be too difficult a task to achieve. Such water transfer will definitely increase the volume and also the area coverage

of the Lake. This means more water for irrigation farming, fishing, domestic and industrial usage.

CONCLUSION

The study reveals increasing temperature and decreasing rainfall amount and duration in Nigeria between 1901 and 2005. Temperature increase of 1.1°C was observed in Nigeria for the 105 years while rainfall amount dropped by 81mm. While rainfall amount is generally decreasing in Nigeria, the coastal region of the country has been experiencing slightly increasing rainfall since the early 1970s. The short-dry-season popularly known as August break is currently being experienced more in the month of July as against August. Sea-level rise is observed to have inundated 3400km² of Nigeria coastal region while desert encroachment is reducing arable lands from the northern part of the country by 1-10km a year. A shift in crops cultivated by farmers from long to short duration is also noticed. While the choice crops produced by 1978 were guinea corn, groundnut and maize, they were millet, maize and bean by 2007. Surface water bodies were also observed to be drying up, for example, Lake Chad is currently 5.7% of its size in 1960. Wind and rainstorms were observed to kill 199 people and destroyed property worth N85.03 billion in Nigeria between 1997 and 2007.

While the activities of the developed nations are mostly responsible for the changing climate, the developing nations are those suffering more of the impacts due to inability to cope as a result of poverty and low technological development. If the developed world can immediately implement deep emission cuts and reduce their rate of water pollution while the developing countries practice clean technology and reduce their rate of deforestation and enhance their afforestation programmes, then the rate of carbon sinks will be improved and ozone layer depletion will decline. With cleaner atmosphere which will lead to self-sustaining ozone layer rebuilding, the current rate of global warming will be drastically reduced and its effects on humans and the ecosystem will with time be a thing of the past.

REFERENCES

- Abu B 2007. Sea level rise and the Niger Delta of Nigeria. *Journal of Wetland*, 3(1): 44-52.
- Adefolalu DOA 2007. Climate change and economic sustainability in Nigeria. *Paper presented at the International conference on climate change, Nnamdi Azikiwe University, Awka* 12-14 June 2007.
- Ahmed HA 1978. The pattern of farming systems and crops production in Borno State, Nigeria. *Journal of Agricultural Science*, 2(1): 9-16.
- Akong A 2001. The causes and impacts of drought. *ANIS Monograph No. 3*, pp. 1-16
- Awake 2009. Are we running out of water? *Awake!* January 2009, pp. 3-7.
- Ayoade JO 2004. *Climate Change*. Ibadan. Vantage Publishers, pp. 45-66.
- Ayuba HK, Maryah UM, Gwary DM 2007. Climate change impact on plant species composition in six semi-arid rangelands of Northern Nigeria. *Nigerian Geographical Journal* 5(1): 35-42.
- Buadi PV, Ahmed AN 2006. The impacts of wind related hazards in Southern Cameroon. *Journal of Physical Sciences*, 3(2): 82-88.
- Changnon SA 2001. *Thunderstorms Across the nation*. Mahomet, Illinois: Changnon Climatologist, pp. 59-76.
- Chindo A, Nyelong PN 2004. Lake Chad: From Megalake to Minilake. *Arid Wetland Bulletin No. 6*: 24 – 27.
- Department for International Development (DFID) 2006. How climate change threatens the world's poor. *Development Issues*, 25: 8-9.
- DeWeerd S 2007. Climate change coming home: Global warming effect on populations. *World Watch*, 2(3): 6-13.
- Hengeveld GH, Bush E, Edwards P 2002. *Frequently Asked Questions About Climate Change Science*. Canada: Environment Canada.
- Hengeveld H, Whitewood B 2005. Understanding climate change 2005: A synthesis of climate change science. Canada. Environment Canada. pp. 31-35.
- Intergovernmental Panel on Climate (IPCC) 2007. Climate change 2007. The fourth assessment report (AR4). Synthesis report for policymakers http://www.ipcc.ch/pdf/assessment-report/ar4/syr/ar4_syr_spm.pdf. (Access 10th August, 2009).
- Jagtap S 2007. Managing vulnerability to extreme weather and climate events: Implications for agriculture and food security in Africa. *Proceedings of the International Conference on Climate Change and Economic Sustainability held at Nnamdi Azikiwe University, Enugu, Nigeria*. 12-14 June 2007.
- Mcquire B, Mason I, Kilburn C 2002. *Natural Hazards and Environmental Change*. London: Arnold, pp. 53-63.
- Mshelia AD 2005. Adaptation strategies to climate change. *Journal of Energy and Environment*, 18 (3): 74-81.
- Msumba A Global 2006. climate change and sustainable human development. *Journal of Arid Environment*, 5(1): 18-24.
- Nigerian Environmental Study/Action Team (NEST) 2003. *Climate Change in Nigeria. A Communication Guide for Reporters and Educators*. Ibadan: NEST pp. 5-16.
- Nwafor, JC 2006. *Environmental Impact Assessment for Sustainable Development: The Nigerian perspective*. Enugu: EL 'DEMAK pubs, pp. 359-394.
- Nwafor JC 2007. Global climate change: The driver of multiple causes of flood intensity in Sub-Saharan Africa. *Paper presented at the International Confe-*

- rence on Climate Change and Economic Sustainability held at Nnamdi Azikiwe University, Enugu, Nigeria, 12-14 June 2007.
- Odjugo PAO 1999. Climatological implications of environmental degradation on sustainable human development. *GeoResearch*, 3: 52-60.
- Odjugo PAO 2000. Global warming and human health: Current and projected effects. *Environmental Analar*, 4(2): 49-60.
- Odjugo PAO 2001a. Global warming and food production: A global and regional analysis. *African Journal of Environmental Studies*, 2(2): 85-91.
- Odjugo PAO 2001b. The impacts of global warming on climate change and extreme weather conditions: Global and regional evidences. *Asia Pacific Journal on Environment and Development*, 7: 53-70.
- Odjugo PAO, Ikhuoria AI 2003. The impact of climate change and anthropogenic factors on desertification in the semi-arid region of Nigeria. *Global Journal of Environmental Science*, 2(2): 118-126.
- Odjugo PAO 2005. An analysis of rainfall pattern in Nigeria. *Global Journal of Environmental Science*, 4(2): 139-145.
- Odjugo PAO 2007. The impact of climate change on water resources: global and regional analysis. *The Indonesian Journal of Geography*, 39: 23-41.
- Odjugo PAO 2008. Quantifying the cost of climate change impact in Nigeria: Emphasis on wind and rainstorms. *Journal of Human Ecology* (In Press).
- Singer SF, Avery DT 2007. *Unstoppable Global Warming: Every 1000 Years*. New York: Rowman and Littlefield Publishers Incm, P. 114.
- Smith G 1994. Environmental pollution and global warming. *IRCD*, 2: 11-20
- Spore 2008. Climate change. Special Issue August, 2008. P. 23.
- Yaqub CN 2007 . Desert encroachment in Africa: Extent, causes and impacts. *Journal of Arid Environment*, 4(1): 14-20.
- Young J 2006. Black water rising: The growing global threat of rising seas and bigger hurricanes. *World Watch*, 19(5): 26-31.
- Yugunda BS 2002. Socio-economic and cultural impacts of desert encroachment in Nigeria. *Journal of Environmental Dynamics*, 5(2): 19-30.