

A Systematic Review of the Causes and Challenges of Climate Change on Nigerians' Economy and Ecosystem

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Abstract

Introduction: Climate change is an adverse environmental phenomenon that the impact is felt at both local and global communities. Nigeria like the rest of the entire continent of Africa is considered highly vulnerable to climate change because of its limited coping capacity, poverty, illiteracy, food insecurity, and diseases associated with climate change. While data on the global impacts of climate change is available, those at regional levels are scanty, rarely available and inaccessible. Hence the need for this study on the causes and effects of climate change on Nigerians economy and ecosystem.

Methods: The methodology adopted was purely on content analysis of secondary data and observed information from field survey. Reports and presentations from Intergovernmental Panel on Climate Change (IPCC), and Department for International Development (DFID), National Climate Change Commission (NCCC) and Nigerian Environmental Study Team (NEST) were identified for review through a comprehensive search by using electronic and non-electronic databases. Related published literatures and documents were also searched in a systematic manner, using a range of key words relating to climate change impact on the Health, Ecosystem and Nigerians Economy.

Results: Our review of the subject matter indicated that many areas of Nigerian economy and ecosystem appear to be directly vulnerable to the impacts of climate change, such as agricultural and health sectors, due to increase in average temperature and rainfall. Rising in sea levels, emerging pest/diseases, changing of the ecosystem and food insecurity were also established.

Conclusion: Climate change effects are significant and requires technological and policy innovation to realise low-carbon growth in Nigeria. Field trials on crop production in local ecosystems will highlight crops that are most vulnerable to the changing climate and identify areas of research focus. Greenification of the lands, minimization of pollutants/contaminants in the atmosphere and adoption of environmentally friendly technology are highly advocated.

Keyword: Climate change, ecosystem, global warming, greenhouse gases, greenification.

Abstrait

Contexte : Le changement climatique est un phénomène environnemental néfaste dont l'impact est ressenti au sein des communautés locales et mondiales. Le Nigeria, à l'instar du reste de l'ensemble du continent africain, est considéré comme extrêmement vulnérable au changement climatique en raison de ses capacités d'adaptation limitées, de sa pauvreté, de son analphabétisme, de son insécurité alimentaire et des maladies associées aux changements climatiques. Tandis que des données sur les impacts globaux du changement climatique sont disponibles, celles-ci au niveau régional sont rares, rarement disponibles et accessibles. D'où la nécessité de cette étude sur les causes et les effets des changements climatiques sur l'économie et l'écosystème Nigérien.

Méthodes : La méthodologie adoptée a consisté uniquement en une analyse du contenu de données secondaires et des informations observées provenant d'enquêtes de terrain. Rapports et présentations du Panel Intergouvernemental sur le Changement de Climat (PICC), et Département de Développement International (DFID), Commission Nationale sur les Changements Climatiques (CNCC) et l'Equipe d'Etude Environnementale du Nigeria (NEST) ont été identifiés aux fins d'examen par une recherche complète en utilisant des bases de données électroniques et non électroniques. La littérature et documents semblables publiés ont également été recherchés de manière systématique, en utilisant une gamme de mots clés relatifs aux impacts sur la santé des changements climatiques, l'écosystèmes et l'économie Nigérien.

Résultats : Notre examen du sujet a montré que de nombreux domaines de l'économie et de l'écosystème nigériens semblent directement vulnérables aux effets du changement climatique, tels que les secteurs de l'agriculture et de la santé, en raison de l'augmentation des températures et des précipitations moyennes. L'élévation du niveau de la mer, l'apparition de parasites / maladies émergents, le changement de l'écosystème et l'insécurité alimentaire ont également été constatés.

Conclusion : Les effets du changement climatique sont importants et nécessitent des innovations

technologiques et politiques pour parvenir à une sobre croissance en carbone au Nigéria. Les essais sur le terrain de la production végétale dans les écosystèmes locaux mettront en évidence les cultures les plus vulnérables au changement climatique et identifieront les domaines de recherche. L'afforestation / gazonnage des terres, la minimisation des polluants / contaminants dans l'atmosphère et l'adoption de technologies respectueuses de l'environnement sont vivement recommandées.

Mot-clé : *Changement climatique, écosystème, réchauffement de la planète, gaz à effet de serre, afforestation / gazonnage.*

Introduction

Climate change is an undeniable environmental threat of the 21st century which the world is currently experiencing and seeking measures to adapt and mitigate its impact. The United Nations Framework Convention on Climate Change (UNFCCC) defines 'climate change as a change which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere over comparable time periods'. Climate change is already beginning to transform life on earth. Around the globe seasons are shifting, temperatures are increasing and sea levels are rising. Climate change affects the whole world though the poorest people who contribute least to the change are the ones who suffer the most. Scientific research shows that the net climate resulting from the change will largely be driven by atmospheric greenhouse gases [1,2].

Global warming is closely associated with climate change especially as a co-traveler in the interplay of the equilibrium between hydro-fluorocarbons-(HFCs); and perfluorocarbons (PFCs) the natural and man-made components of the Green House Gases (GHGs) that have been eminently adjudged globally as the culprit for the warming of the Earth's atmosphere and oceans. Global warming is the term used to describe the gradual increase in the average temperature of earth's atmosphere and its oceans [3]; a change that is permanently changing earth's climate forever. Global warming is caused by increase in the emission of GHGs, through the burning of fossil fuels (oils, natural gas and coal), burning of wood, wood products and solid wastes, raising of livestock and the decomposition of organic waste in solid waste landfill; combustion of solid waste and fossils fuel in industrial and agricultural activities, bush burning; and deforestation. All these human (anthropogenic) activities, contribute to alter the balance of the equilibrium between the natural GHGs (water vapour, carbon dioxide, methane and

nitrous oxide) and the man-made GHGs (sulfur hexane fluoride-(SF₆); hydro-fluorocarbons-(HFCs); and perfluorocarbons (PFCs) in Earth's atmosphere, thus promoting the warming of both the atmosphere and the oceans since they are heat-trapping gases [4].

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 [5,6]. Nigeria is one of such developing countries. Researchers have shown that Nigerians are already being plagued with diverse ecological problems, which have been directly linked to the on-going climate change [7-12]. A recent finding [7] revealed erratic pattern of weather elements in Nigeria, while in another similar research [8] showed that climate change has started imparting on desertification. Climate change has been documented to be impacting negatively on plant species composition in North eastern Nigeria [12]. These may not be the only impacts of climate change in Nigeria. It is on this premise that this study took an insight into the implications of climate change on the Ecosystem, Health and Economy in Nigeria with the aim of compiling and analyzing them holistically.

Methodology

The methodology adopted was purely on content analysis of secondary data and observed information from field survey. Reports and presentations from Intergovernmental Panel on Climate Change (IPCC), Ministry of Environment (MOEFN), and Department for International Development (DFID), National Climate Change Commission (NCCC), Nigerian Environmental Study Team (NEST) were used for review. Literatures were identified through a comprehensive search by using electronic and non-electronic databases. Related published literatures and documents were searched in a systematic manner, using a range of key words relating to climate change impacts on the Health, Ecosystem and Nigerians Economy.

Causes of climate change

According to a report on climate in Canada [13], Climate change is caused by two basic factors which include natural process (Bio-geographical) and human activities which are also known as Anthropogenic. The earth's climate can be affected by natural factors that are external to the climate system such as changes in volcanic activity, solar output and earth's orbit around the sun, these factors and its effects have relatively short term effects on climate.

The Anthropogenic factors are human activities that emit large amount of greenhouse gases into the atmosphere that depletes the ozone layer or activities that reduce the amount of carbon absorbed

from the atmosphere. Human activities such as burning of fossil fuels, gas flaring, urbanization, agriculture and changes in land use like deforestation, release greenhouse gases (GHGs) into the atmosphere which increases the already existing concentration of these gases. The human factors have been proven to be responsible for the ongoing unequivocal climate change or global warming [14].

According to the South African Confederation of Agriculture Union [15], the main GHGs are Carbon dioxide, methane and nitrous oxide, which account for 80%, 14% and 6% of the total GHG emission respectively. GHGs are good absorbers of heat radiation coming from earth's surface acting like a blanket over the atmosphere, keeping it warmer than it would be. It has been suggested that if the current trends of anthropogenic GHG emissions continue through 2030, earth is likely to experience an average rise in temperature ranging from 1.5°C to 4.5°C [16]. It is well established that the activities of developed nations are mostly accountable for climate change, but developing nations are those suffering more due to inability to cope as a result of poverty and low technological development [17]. The causal factors of climate change as related in a report [18] are as given in Figure 1.

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 imparting 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 [19,20]. 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 [9]. Coastal settlements like Bonny, Forcados, Lagos, PortHarcourt, Warri and Calabar among others that are less than 10 m above the sea-level would be seriously threatened by a meter 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

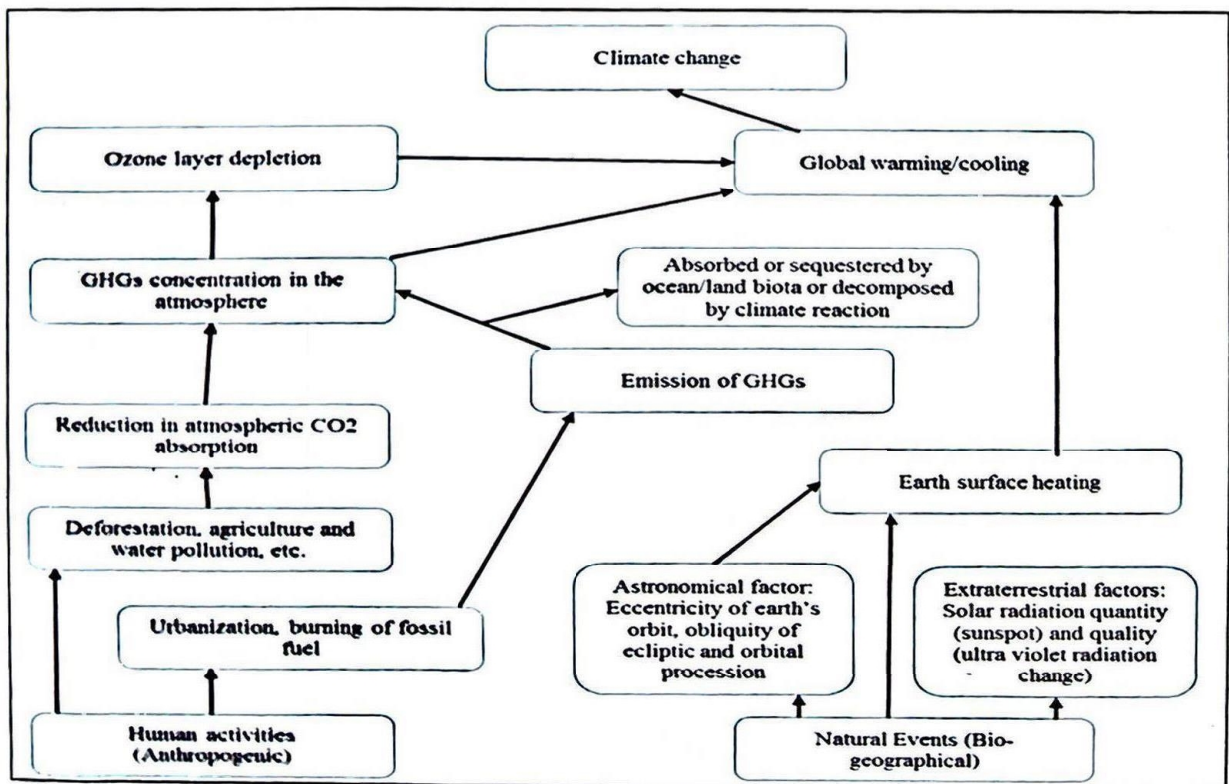


Fig. 1: Causal factors of climate change. Source: [18]

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 meter rise in sea level will displace about 14 million people from the coastal areas of Nigeria [21]. Sea-level rise up to a meter will displace 10, 13 and 72 million people in the coastal areas of Egypt, Bangladesh and China respectively [22].

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 Sahellian region of Africa with annual expansion of 1-10 km [8,23]. The 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 [23,24]. 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 [25]. Climate change will alter all aspects of the hydrological cycle ranging from evaporation through precipitation, run off and discharge [26]. 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 [27]. It has been established that Lake Chad has shrunk by 95% since the 1960s [28].

Impacts on Agriculture in Nigeria

The agricultural sector contributes some percentage of the Nigerian Gross National Product and majority of the rural populace are employed in this sector.

The concern with climate change is heightened given the linkage of the agricultural sector to poverty. It is anticipated that adverse impacts on the agricultural sector will exacerbate the incidence of rural poverty. Climate change has the potential to affect African agriculture in a range of ways leading to an overall reduction of productivity, which could result to a loss in GDP [29].

Over 80% of Nigeria's population depends on rain-fed agriculture and fishing as their primary occupation leading to a high risk of food production system being adversely affected by the variability in timing and amount of rainfall. Crops occupy nearly 94% of the agricultural sector in Nigeria and some areas are already experiencing a loss in length of growing days by 20% [30]. Growth rates of maize, guinea corn, millet and rice are reduced by rises in temperature. Warming trends also make the storage of root crops and vegetables more difficult for those without access to refrigerators or preservative facility. Agriculture in Nigeria will be adversely impacted by increasing variations in terms of timing and amount of rainfall. Water deficits may also depress crops and livestock production and hence, food supply necessitating imports [31].

Climate change has caused a shift in crop cultivated in northern Nigeria as noted by a researcher [32]. The preferred crops the farmers cultivated were guinea corn followed by groundnut and maize, but due to increasing temperature and decreasing rainfall amount and direction 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 of agriculture in Nigeria due to climate change is the reduction of arable lands. While the sea incursion is reducing the arable lands of the coastal plains, the desert encroachment with its associated sand dunes is depriving farmers of their agricultural farmlands and grazing lands. Sand dunes and desert encroachment have been reported to cover from 25,000 hectares to more than 30,000 hectares, with its attendant negative impact on food and livestock production [33].

Livestock production

Climatic variations between the Northern and Southern parts contribute to the distribution of animals in the country. Generally, the large ruminants, geese, guinea fowls and turkeys are more common in the Northern parts of the country where rainfall and humidity are lower, the dry season is longer than the diurnal and seasonal temperature fluctuations are wider. The availability of natural

grasses for grazing is very limited and highly dependent on rainfall which is low in most parts of the North. The Southern parts of the country which have more rainfall and more grazing are wetter and have more parasites and endemic diseases. This is because high temperature and high humidity increases the rate of growth of parasites outside their host. Climate stress reduces feed, water intake, grazing time and hence the rate of growth and productivity [34].

High temperatures have hindered livestock (sheep and goat plague; cattle, poultry and piggery) production through retarded reproductive cycles, reduced meat and milk outputs, as well as their grazing lands. Livestock mortalities (stock losses) have increased in poultry, piggery and rodentary production systems to the level of at least 15% per annum. Animal production as well is affected by increases in disease and pests (including *Peste des Petits Ruminants (PPR)*, also known as sheep and goat, is a highly contagious animal disease affecting small ruminants; foot rot; mange, etc.) under the influence of climate change impacts that cut investment profits in livestock production system by more than 20% per annum.

Forestry

Climate change will potentially increase the incidence of pests and diseases that decimate forest trees. This in turn can lead to species extinction in the various ecosystems of Nigeria, as it has already been the case for Iroko and oil bean in the southeast; various mahogany species in southwest; the baobab and the locust bean in the northwest and gum Arabic in the northeast [35]. Nigeria is presently losing about 351,000 square kilometers of its landmass to the desert, which is advancing southward at the rate of 0.6 kilometers annually [34]. The consistent reduction in rainfall leads to a reduction in the natural regeneration rate of land resources, which presents a chain of causal reaction that, makes people to exploit more previously undisturbed lands leading to depletion of the forest cover and increase on the sand dunes deposit. The excessive exploitation of forest resources has cause a serious problem in Nigeria environment. When the forest is destroyed, the vegetative cover of the soil is removed and the soil is exposed to environmental forces of wind and surface runoff and the topsoil will experience erosion and reduction of fertility and become less productive [36]. Moreover, deforestation leads to accumulation of global carbon, emitted from burning of fossil fuels, in the atmosphere, the main consequences of this are global warming and climate change.

Mining and quarrying

Increase in precipitation in the South combined with irregular rainfall events will trigger flooding which will adversely affects the mining operations located in the region. Also extreme weather events around the coastal region will threaten off-shore drilling. About \$13 billion is at risk of loss from sea level rise in the Niger Delta [37].

Manufacturing sector

This sector will suffer losses from reduced potentials to produce output requiring agricultural produce as inputs. Sea level rise may lead to flooding which can destroy transportation and other infrastructure as well as plants and industrial layouts that can hamper productivity and efficiency in the sector [38].

Wholesale and retail trade

Infrastructure is at direct risk due to sea level rise and extreme weather events which consequently damages the infrastructure. This also affects the supply and distribution of their products thus challenging wholesale retail trade business [35].

Transport and tourism

Roads, bridges, airports terminal and rail line are destroyed due to floods and erosions caused by excess rainfall or sea level rise. Tourism, especially the beach-based tourism will be negatively affected, the beaches and lagoons will be taken over by water due to sea level rise as in the case of Lagos bar beach and Lekki Island [38]. Increase in the occurrences of natural disaster such as flooding, drought, land slide and windstorm may cause a lot of damages to business facilities and activities; this may cause a lot of cost to the insurance companies in compensating its clients [35,39].

Implication of climate change on the future Gross Domestic Product (GDP) of Nigeria

The data reviewed was based on the up-to-date national economic data and forecasts along with most recent peer reviewed scientific studies of the potential impacts of climate change on Nigeria, including IPCC's 2007 4th assessment report as shown in Tables 1 and 2 and Fig. 2 [31].

In terms of benchmarking these figures against other studies [40], a potential loss of GDP of 11% by 2060 based on a 2°C rise for Nigeria was estimated. Poorer countries could lose in excess of 10% of their GDP based on 5-6°C warming by 2100 [41]. Currently, each wet year in the Sahel causes a loss of around 1.25% of GDP and 3.5% for a dry year.

Table 1: Percentage Loss of Sectoral GDP from Climate Change in 2050

Sector	Low Scenario	High Scenario
Agriculture	8%	36%
Mining	4%	21%
Wholesale & Retail	5%	27%
Others	5%	27%
Overall	6.4%	29.5%

dynamics may increase the distribution of disease vectors such as dengue, malaria and incidence of diarrheal disease [42].

The Guardian Newspaper of 30th march 2010 reported that within one week in the early of 2009, over 209 people were killed by meningitis in Nigeria and Niger republic. From analysis of reports, climate change will increase threats to human health, thereby affecting their productivity [43]. Already a study by the World health Organization showed that

Table 2: Percentage Loss of GDP through Climate Change by 2050 according to Regions

Regions	Agric.	Mining	Retail	Others	All
North	8-33%	16%	7-27%	5-23%	8-30%
SE/SS	3-38%	5-22%	2-10%	5-26%	2-25%
SW/Lagos	8-42%	5-25%	7-34%	5-29%	7-34%

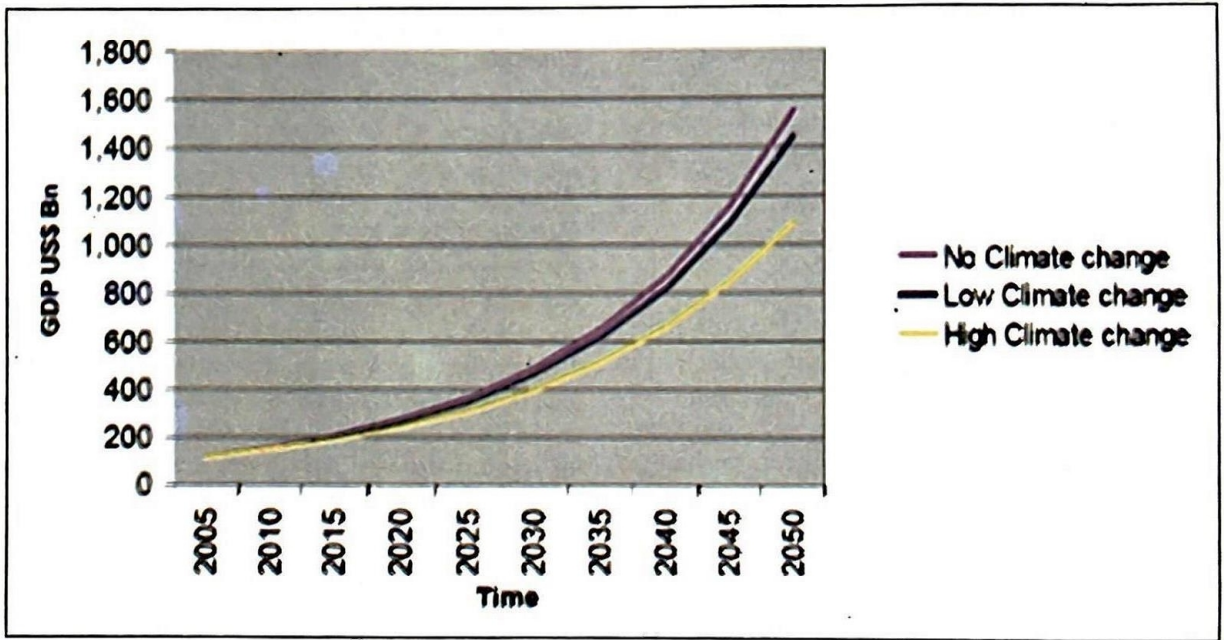


Fig 2: Potential climate change impact on Nigeria's GDP under a medium growth scenario.
Source: [31, 38]

Impact of climate change on health sector in Nigeria

Climate change could negatively impact human health in developing country like Nigeria. Climate change affects human health directly or indirectly in many ways. Changes in temperature, precipitation, rising sea levels, increasing frequencies have great implications on human health in the area of injury, illness, morbidity and mortality. Rising sea level is anticipated as a result of climate change. Hence, flooding may result which is likely to increase the vulnerability of the poor to malaria, typhoid, cholera and pneumonia. Also temperature and rainfall

climate change is the cause of 150,000 deaths every year [1]. Heavy rainfall events can also carry terrestrial micro-biological agents into drinking water sources, which eventually could lead to outbreak of cryptosporidiosis, giardiasis, amoebiasis, typhoid and other infections [44].

Recent evidence showed that typhoid is mostly triggered in high temperature, and increased humidity over the years is a proof of climate change. A large part of Nigeria's economy is dependent on natural resources that are vulnerable to climate impacts. When resources are affected, the health of Nigerians can also be affected.

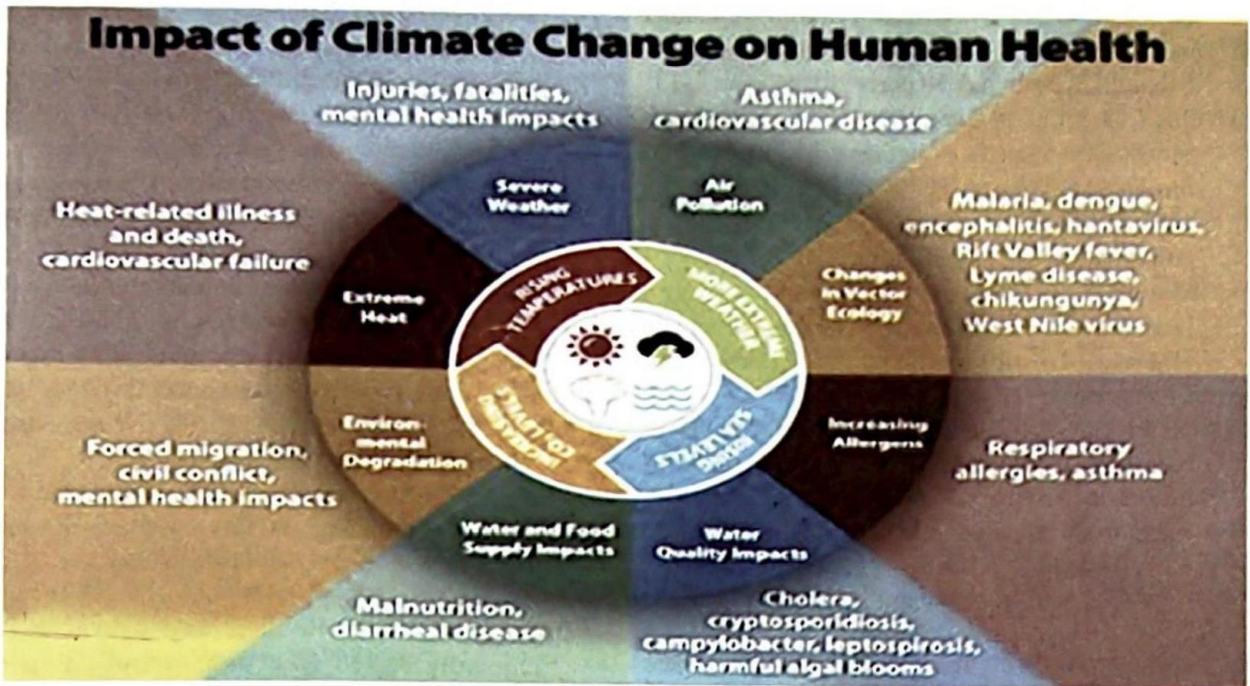


Fig. 3: Impact of Climate Change on Health SOURCE:[38]

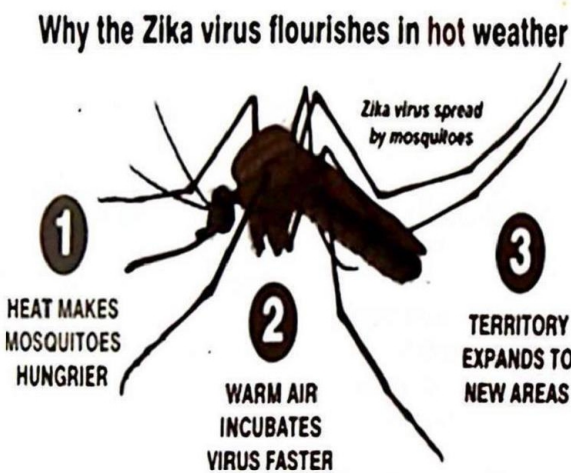


Fig. 4: Insect in hot wether SOURCE: [38]

Conclusion and recommendations

Climate change impacts are real in Nigeria; they are currently been observed in all spheres of lives. However, it is possible to promote and actualize the strategies for limiting and adapting to the impacts of climate change in Nigeria. Providing cost-effective and sustainable collaboration between governments, development partners and stakeholders can be effective strategies for mitigating the consequences of incessant climate change on the environment and the livelihoods of all. In addition, agricultural adaptation to climate change should be mainstreamed into government's poverty alleviation programs. There should be an explicit national agricultural

research policy framework to provide a conducive environment for continuity and effectiveness in agricultural programs/projects. Nigerians should be encouraged to practice clean technologies geared towards reducing the rate of deforestation and enhanced afforestation programs, with a view to improving the rate of carbon sinks and preventing ozone layer depletion.

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. Quality health information and robust enlightenment campaigns should be put in place to help people adapt before any disaster. Campaigns on preventive and defensive medical practices should be taken to the grass roots in local areas. Undertaking research to better understand impacts of climate change on human in respect to Nigeria health sector and status should be considered. In all, there is a strong need for policy to address climate change at the Federal, State and local area levels, and to ensure that the private sector adequately factor the risks posed by climate change into risk assessment, investment planning and project execution.

References

1. Nkmedirim L.C. *Climates in transition*. Commission on climatology. Washington DC: Minateman Press. 2003.

2. Nebedum EE and Nnaemeka VE. Climate Change and Its Impact in Nigerian Economy. *Journal of Scientific Research & Reports* 2016; 10(6): 1-13.
3. Okali, D. Climate Change and Nigeria: A Guide for Policy Makers. Nigerian Environmental Study/Action Team (NEST) 2004. Available: [www.nestinteractive.org / climate change docs/ policymakersoct25.pdf](http://www.nestinteractive.org/climate_change_docs/policymakersoct25.pdf)
4. Idowu A.A. Ayoola SO, Opele A.I. and Ikenweiwe N.B. Impact of Climate Change in Nigeria. *Iranica Journal of Energy and Environment* 2 (2): 145-152, 2011.
5. Nwafor JC. Global climate change: The driver of multiple causes of flood intensity in Sub-Saharan Africa. Paper presented at the International Conference on Climate Change and Economic Sustainability held at Nnamdi Azikiwe University, Enugu, Nigeria, 12-14 June 2007.
6. Jagtap S. 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.
7. Odjugo PAO. An analysis of rainfall pattern in Nigeria. *Global Journal of Environmental Science*, 4(2): 139-145, 2005
8. Odjugo PAO and Ikhuoria AI. 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, 2003.
9. Nigerian Environmental Study/Action Team (NEST). Climate Change in Nigeria. A Communication Guide for Reporters and Educators: Ibadan 2003; 5-16.
10. Chindo A and Nyelong PN. Lake Chad: From Megalake to Minilake. *Arid Wetland Bulletin* 2004; 6: 24 – 27
11. Mshelia AD. Adaptation strategies to climate change. *Journal of Energy and Environment* 2005; 18(3): 74-81.
12. Ayuba HK, Maryah UM and Gwary DM. Climate change impact on plant species composition in six semi-arid rangelands of Northern Nigeria. *Nigerian Geographical Journal* 2007; 5(1): 35-42.
13. Sheikh I.A. Facts on Climate Change. By Canada's action on climate change. Issue 15, September 2016. Available: [http://climatechange.gc.ca/default.asp? lang=En&n=65CD73F4-1](http://climatechange.gc.ca/default.asp?lang=En&n=65CD73F4-1)
14. Intergovernmental Panel on Climate Change (IPCC). Climate Change Impact, Adaptation and Vulnerability: Contribution of Working Group II to the Fourth Assessment Reports of the IPCC: Cambridge University Press. 2007b.
15. South African Confederation of Agriculture Unions, SACAU. Key element of Climate change. 2009.
16. Porter G and Brown J. Global environmental politics: Dilemmas in world politics. 1991.
17. Odjugo PAO. General overview of climate change and spatial planning concerns in Nigeria: Remedial measures for more effective response. *J. Hum. Ecol.* 2010; 29(1):47-55.
18. Odjugo PAO. Quantifying the cost of climate change impact in Nigeria: Emphasis on wind and rainstorms. *Journal of Human Ecology* (In Press). 2008.
19. Hengeveld GH, Bush E and Edwards P. Frequently Asked Questions about Climate Change Science Canada: Environment Canada. 2002.
20. Hengeveld H and Whitewood B. Understanding climate change: A synthesis of climate change science Canada. Environment Canada. 2005; 31-35.
21. Abu B. Sea level rise and the Niger Delta of Nigeria. *Journal of Wetland* 2007; 3(1): 44-52
22. Young J. Black water rising: The growing global threat of rising seas and bigger hurricanes. *World Watch* 2006, 19(5): 26-31.
23. Yaqub C.N. Desert encroachment in Africa: Extent, causes and impacts. *Journal of Arid Environment* 2007; 4(1): 14-20.
24. Yugunda BS. Socio-economic and cultural impacts of desert encroachment in Nigeria. *Journal of Environmental Dynamics* 2002; 5(2): 19-30.
25. Akonga AZ. The causes and impacts of drought. ANIS Monograph No. 3, pp. 1-16, 2001.
26. Mcquire B, Mason I, Kilburn C. *Natural Hazards and Environmental Change*. London, Arnold. 2002; 53-63.
27. Odjugo PAO. The impact of climate change on water resources; global and regional analysis. *The Indonesian Journal of Geography* 2007; 39: 23-41.
28. Nwafor, J.C. Environmental Impact Assessment for Sustainable Development: The Nigerian perspective. Enugu: EL 'DEMAK publication 2006; 359-394.
29. Pan African Climate Justice Alliance (PACJA). The Economic Cost of Climate Change in Africa 2009.

30. Mendelsohn R, Nordhaus W and Shaw D. The Impact of global warming on agriculture: A Ricardian analysis. *American Economic Review* 1994; 84: 753-771.
31. Usman YD and Dije BI. Potential challenges of climate change to the Nigeria economy. *IOSR Journal of Environmental Science, Toxicology and Food Technology* 2013; 6(2):07-12.
32. Scoones I. Introduction to new Directions for African agriculture. *IDS Bulletin. Institute of Development Studies* 2005; 36(2):1-12.
33. Yobe State Ministry of Environment (YSME) (2004) as quoted in Niasse A, Afouda A, Amani A, Reducing West Africa's vulnerability to climate change impacts on water resources, wetlands and desertification. IUCN Regional office for West Africa; 2001.
34. Obioha E. Climate Variability, Environment Change and Food Security Nexus in Nigeria. *J Hum Ecol* 2009; 26(2): 107- 121.
35. Nigeria Environmental Study/Action Team. Facts on Climate Change in Nigeria #4: Repercussions for Agriculture, Food Security, Land Degradation, Forestry and Biodiversity. 2008b.
36. Okonji M A. Depletion of Forest Resources in Eastern Nigeria- Who Loses?. *The Environmentalist* 2001; 21: 197 – 203.
37. Ministry of Environment of Federal Republic of Nigeria (MOEFRN). Nigeria's First National Communication under the United Nations Framework Convention on Climate Change. Abuja. 2003.
38. Department for International Development (DFID). Impact of climate change in Nigeria's economy. Final Report. 2009.
39. Gwary DM. Climate Change, Food Security and Nigerian Agriculture. A Report submitted to Federal Ministry of Environment Abuja and UNDP Abuja. 2007.
40. Mendelsohn R, Nordhaus W and Shaw D. The impact of global warming on agriculture: A Ricardian Analysis. *American Economic Review* 84: 753–771, 1994.
41. Haines N, Korats RSD, Campbell-Lendrum C and Corralan C. Climate change and human health: Impacts, vulnerability and public health. *Journal of the Royal Institute of Public health* 2006; 120:585.
42. Pittock A.B. Climate change: Turning up the heat. *London Earth Scan* 2005; 1: 23
43. Lisle JT. Cryptosporidium contamination of water in the US and UK: A Mini- review. *Aqua* 1995; 44:103-117
44. Rose J. B., Lisle J. T. and LeChevallier M. Waterborne cryptosporidiosis: Incidence, outbreaks, and treatment strategies. In R. Fayer (Ed.), *Cryptosporidium and Cryptosporidiosis*, CRC Press, Boca Raton, Florida, 1997.