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Review

The impact of climate change in Nigeria

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Abstract

There is a scientific consensus that concentration of green house gases (GHGS) are increasing and that is causing climate change. Scientists have spent decades figuring out what is causing global warming. They have looked at the natural cycles and events that are known to influence climate .but the amount and pattern of warming that has been measured cannot be explained by these factors alone .the only way to explain the pattern is to include the effect of green house gases(GHGS) emitted by humans. to bring all this information together the united nations formed a group of scientist called the intergovernmental panel on climate change (IPCC). The IPCC meets every few years to review latest scientific findings and write a report summarizing all that is known about global warming, each report represents a consensus or agreement among hundreds of leading scientists. There era several green house gases responsible for warming, and humans emit them in a variety of ways .most came from the combustion of fossil fuels in cars, factories and electricity production. the gas carbon dioxide, is responsible for most warming other contributors include methane released from landfills and agriculture (especially from digestive system of grazing animals) nitrous oxide from fertilizers, gases used for refrigeration and industrial processes and the loss of forests that would otherwise store Co_2. Different green house gases have different heat trapping abilities; some of them can even trap more heat than Co_2. A molecule of methane produces more than twenty (20) times the warming of a molecule of Co_2.nitrous oxide is three hundred (300) times more powerful than Co_2, other gases such as chloroflourocarbons (which have been banned in much of the world because they also degrade the ozone layer)have heat trapping potentials thousands of times greater than Co_2. But because their concentration is much lower than Co_2 none of these gases adds as much warmth to the atmosphere as Co_2 does.

Keywords: climate change, Co_2, atmosphere

INTRODUCTION

In order to have an understanding of all these gases together, scientist tend to talk on green gases in terms of the equivalent amount of Co_2. Since 1990, yearly emissions have gone up by about six (6) million metric tonnes of carbon dioxide equivalent worldwide more than 20 percent increase .Glaciers are melting sea level are rising, cloud forest are drying and wildlife are scrambling to keep pace.

Its becoming clear that humans have caused most of the century's warming by releasing heat trapping gases as we power our daily lives. The green house gases levels are now higher now than in the last 650,000 years. Now humans have increase the amount of Co_2 in the atmosphere by more than a third since the industrial revolution. These changes have historically taken mate faster thousands of years but are now happening over the cause of decades. The rapid rise in the green house gases is a major problem because its changing the climate faster than some living things may be able to adapt to. Also a new and more unpredictable climate poses unique challenge to all life. Historically Earths

climate have regularly shifted back and forth between temperatures we see today and the temperature's cold enough that large sheets of ice covered much of north America and Europe .The difference between average global temperatures today and during those ice ages is only about five (5) celsius (9 degrees fahrenheit) and these swings happen slowly over hundreds of thousands of years. Now with the concentration of green house gases rising, Earth's remaining ice sheet (such as Greenland and Antartica) are starting to melt too. The extra water could potentially raise sea levels significantly. As the mercury rises the climate can change in unexpected ways .In addition to sea levels rising weather can become more extreme .This means more intense storms. more rains followed by longer and drier droughts (a challenge for growing crops) changes in the ranges in which plants and animals can live, a loss of water supplies that have historically came from glaciers.

Scientist are already seeing some of these changes occurring more quickly than they had expected. According to Intergovernmental panel on climate change eleven of the twelve hottest years (since thermometer readings become available) occurred between 1995 and 2006.The result is global warming and its causing a set of changes to the earth's climate or long term weather patterns, that varies from place to place.

Nigeria is experiencing adverse climate condition with negative impact on the welfare of millions of people. persistant drought and flooding of seasons rains and dry spells have sent growing seasons out of orbit on a country dependent on rain fed agriculture .alarm bells are ringing with lakes drying up and a reduction on river flow in the arid and semi arid regions. The result is fewer water supply for use in agriculture, hydropower generation and other uses. The main suspect for all this is climate change. Scientific studies shows snows are disappearing rapidly. Climate change have been confirmed following release of the 4th IPCC Assessment report. Africa will be worst hit by the effect of climate change in which Nigeria is part of it.

The aim of the review was to reveal that climate change was no longer in doubt but is now unequivocally apparent based on evidence from scientific observations o increase in global average air and ocean temperature (IPCC,2007).Although violent weather has occurred throughout history. Recent upsurge in climate related hazards is confirming the argument for global warming and climate change (Mcguire et al., 2002. Nwafor, 2006) and to reveal the impact of climate change in Nigeria. The evolving climate change coupled with increasing temperature has been has been observed to plunged some localities into experiencing extreme weather conditions (Olaniran, 2002; Odjugu,2005). 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 (Mshelia, 2005; Jaglap, 2007).Nigeria is one such developing countries. Researchers have shown that Nigeria is already plagued with diverse ecological problems, which have been directly linked to the ongoing climate change (Odjugu, 2005; Adelolalu et al., 2007)

Climate change

Changes in long term weather pattern's cause by natural phenomena and human activities that alter the chemical composition of the atmosphere through the build up of Green House Gases (GHGS) which trap heat and reflect it back to the earth surface. Also defined as a change of that is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and that is in addition to natural climate variability observed over comparable time period, It can also be referred as an increase in global temperatures. Natural events and human activities are believed to be contributing to an increase in average global temperatures. This is caused primarily by increase green house gases such as carbon dioxide.

Climate change could occur naturally or as a result of a change in the sun's energy or earth orbital cycle (natural climate forcing) or it could occur as a result of persistent anthropogenic forcing, such as the addition of green house gases, sulfate aerosols, or black carbon to the atmosphere or through land use change.

Evidence of effects of global climate change

The is warming from North pole to South pole and everywhere in between. Globally the temperature is already up by 1 degree Fahrenheit (0.8 degrees Celsius) and even more in sensitive polar regions. The effects of rising temperatures are happening right now signs are appearing all over .The heat is not only melting the glaciers and sea ice ,its also shifting precipitation patterns and setting animals on the move. Some impacts from increasing temperature are already happening, ice is melting worldwide especially at the earth's pole .This include mountain glaciers, ice sheets covering west Antarctica, Greenland and Arctic sea ice. Sea level rise became faster over the century. Penguins in the Antarctica their numbers have fallen from thirty two thousand (32,000) breeding pairs to eleven thousand (11,000) in thirty (30) years some butterflies, foxes and alpine plants have moved farther North to higher cooler areas. Spruce bark beetles have boom in Alaska. The insects have chewed up four (4) million acres of spruce trees. Sea levels are expected to rise

between seven (7) and twenty (23) inches by the end of the century and continued melting at the poles could add between four (4) and eight (8) inches

Climate change in the recent past may be detected by corresponding changes in settlement and agricultural patterns. Acheological evidence, oral history and historical documents can offer insights into past changes in the climate. Climate change effects have been linked to the collapse of various civilizations.

Glaciers

Glaciers are considered among the most sensitive indicators of climate change. Their size is determined by a mass balance between snow input and melt output. As temperatures warm, glaciers retreat unless snow precipitation increases to make up for the additional melt; the converse is also true. Glaciers grow and shrink due both to natural variability and external forcing. Variability in temperature, precipitation and englacial and sub glacial hydrology can strongly determine the evolution of a glacier in a particular season. Therefore, one must average over a decadal or longer time-scale and/or over a many individual glaciers to smooth out the local short-term variability and obtain a glacier history that is related to climate.

A world glacier inventory has been compiled since the 1970s, initially based mainly on aerial photographs and maps but now relying more on satellites. This compilation tracks more than 100,000 glaciers covering a total area of approximately 240,000 km^2, and preliminary estimates indicate that the remaining ice cover is around 445,000 km^2. The World Glacier Monitoring Service collects data annually on glacier retreat And glacier mass balance From this data, glaciers worldwide have been found to be shrinking significantly, with strong glacier retreats in the 1940s, stable or growing conditions during the 1920s and 1970s, and again retreating from the mid 1980s to present.

The most significant climate processes since the middle to late Pliocene (approximately 3 million years ago) are the glacial and interglacial cycles. The present interglacial period (the Holocene) has lasted about eleven thousand (11,700) years. Shaped by orbital variation, responses such as the rise and fall of continental ice sheets and significant sea-level changes helped create the climate. Glaciers leave behind moraines that contain a wealth of material—including organic matter, quartz, and potassium that may be dated—recording the periods in which a glacier advanced and retreated. Similarly, by tephrochronological techniques, the lack of glacier cover can be identified by the presence of soil or volcanic tephra horizons whose date of deposit may also be ascertained.

Vegetation

A change in the type, distribution and coverage of vegetation may occur given a change in the climate. Some changes in climate may result in increased precipitation and warmth, resulting in improved plant growth and the subsequent sequestration of airborne CO_2. Larger, faster or more radical changes, however, may result in vegetation stress, rapid plant loss and desertification in certain circumstances. An example of this occurred during the carboniferous Rainforest Collapse (CRC), an extinction event 300 million years ago. At this time vast rainforests covered the equatorial region of Europe and America. Climate change devastated these tropical rainforests, abruptly fragmenting the habitat into isolated 'islands' and causing the extinction of many plant and animal species.

Satellite data available in recent decades indicates that global terrestrial net primary production increased by 6% from 1982 to 1999, with the largest portion of that increase in tropical ecosystems, then decreased by 1% from 2000 to 2009.

Pollen analysis

Palynology is the study of contemporary and fossil palynomorphs, including pollen. Palynology is used to infer the geographical distribution of plant species, which vary under different climate conditions. Different groups of plants have pollen with distinctive shapes and surface textures, and since the outer surface of pollen is composed of a very resilient material, they resist decay. Changes in the type of pollen found in different layers of sediment in lakes, bogs, or river deltas indicate changes in plant communities. These changes are often a sign of a changing climate as an example, palynological studies have been used to track changing vegetation patterns throughout the Quaternary glaciations and especially since the last glacial maximum

Precipitation

Past precipitation can be estimated in the modern era with the global network of precipitation gauges. Surface coverage over oceans and remote areas is relatively sparse, but, reducing reliance on interpolation satellite data has been available since the 1970s. Quantification of climatological variation of precipitation in prior centuries and epochs is less complete but approximated using proxies such as marine sediments, ice cores, cave stalagmites, and tree rings

Climatological temperatures substantially affect precipitation. For instance, during the Last glacial maximum of eighteen thousand (18,000) years ago, thermal-driven evaporation from the oceans onto continental landmasses was low, causing large areas of extreme desert, including Polar deserts (cold but with low rates of precipitation) In contrast, the world's climate was wetter than today near the start of the warm Atlantic period of eight thousand eight thousand (8000) years ago. Estimated global land precipitation increased by approximately 2% over the course of the 20th century, though the calculated trend varies if different time endpoints are chosen, complicated by ENSO and other oscillations, including greater global land precipitation in the 1950s and 1970s than the later 1980s and 1990s despite the positive trend over the century overall. Similar slight overall increase in global river runoff and in average soil moisture has been perceived

Dendroclimatology

Dendroclimatology is the analysis of tree ring growth patterns to determine past climate variations. Wide and thick rings indicate a fertile, well-watered growing period, whilst thin, narrow rings indicate a time of lower rainfall and less-than-ideal growing conditions.

Ice cores

Analysis of ice in a core drilled from a ice sheets such as the Antarctic ice sheet, can be used to show a link between temperature and global sea level variations. The air trapped in bubbles in the ice can also reveal the CO_2 variations of the atmosphere from the distant past, well before modern environmental influences. The study of these ice cores has been a significant indicator of the changes in CO_2 over many millennia, and continues to provide valuable information about the differences between ancient and modern atmospheric conditions.

Insects

Remains of beetles are common in freshwater and land sediments. Different species of beetles tend to be found under different climatic conditions. Given the extensive lineage of beetles whose genetic makeup has not altered significantly over the millennia, knowledge of the present climatic range of the different species, and the age of the sediments in which remains are found, past climatic conditions may be inferred.

Fish

While far from the only factor involved, very substantial relationships have been observed between climatic conditions and the historical abundance of fish species. Changes in the primary productivity of autotrophs in the oceans can affect marine food webs.

Sea level change

Global sea level change for much of the last century has generally been estimated using tide gauge measurements collated over long periods of time to give a long-term average. More recently, altimeter measurements - in combination with accurately determined satellite orbits — have provided an improved measurement of global sea level change. To measure sea levels prior to instrumental measurements, scientists have dated coral reefs that grow near the surface of the ocean, coastal sediments, marine terraces, ooids in limestones and near shore archaeological remains. The predominant dating methods used are uranium series and radiocarbons, with cosmogenic radio-nuclides being sometimes used to date terraces that have experienced relative sea level fall.

Evidence of climate change in Nigeria

Ahmad and Ahmad (2000) IPCC (2001), NEST (2003) and Hengeveld et al. (2005) provided indicators that one could use to assess the evidence of climate change in a region. These include increasing temperature, increasing evapotranspiration, decreasing rainfall amount in the continental interiors, increasing rainfall in the coastal areas, increases disruption in climate patterns and increasing frequency and intensity of unusual or extreme weather related events such as thunderstorms, lighting, landslides, floods, droughts, bush fires, unpredictable rainfall patterns, sea level rise, increase desertification and land degradation, drying up of rivers and lakes and constant loss of forest cover and biodiversity (Chindo and Nyelong, 2005; Ikhile, 2007; Nwafor, 2007; Umoh, 2007). There is a gradual increasing air temperature between 1901 and 1970 and a higher increase since 1970. An increase of 1.7 degrees centigrade in air

temperature in Nigeria for the one hundred and five (105) years. The implication is that if the increase continues at this rate by 2100, Nigeria will fall within the low or medium scenario of global warming of not less than 2.5 degrees centigrade, should it continue at the 1971 -2005 rate, Odjugo (2010). Another indicator is the increasing frequency and intensity of unusual and extreme weather related events such as erratic rainfall pattern floods and sea level rise among other recent studies have confirmed their existence in Nigeria (Odjugo, 2005; Molega, 2006; Nnodu et al., 2007). Odjugo (2009) observed decline in rainfall amount in Nigeria A further support of the evidence of climate change in Nigeria. The study indicates a constant decline in rainfall amount and duration in the continental interiors of the semi arid regions of Nigeria. The increasing rainfall in the coastal cities may have been partly responsible for the increasing floods devastating the coastal cities of Warri, Lagos, Port Harcourt and Calabar as observed by (Ogundebi, 2004; Ikhile, 2007; Nwafor, 2007; Umoh, 2007; Odjugo, 2010).

The increasing temperature and decreasing rainfall in the semi-arid region of Sokoto, Katsina, Kano, Nguru and Maiduguri may have resulted in the increasing evapotranspiration, drought, and desertification in Nigeria as reported (Adefolalu, 2007). Constant loss of forest cover and biodiversity in Nigeria is linked to global warming and climate change (NEST, 2003; Ayuba et al., 2007). Lake Chad in Nigeria is reported to be shrinking in size at an alarming rate since the 1970's

Causes of climate change

Climate changes in response to changes in the global energy balance. On the broadest scale, the rate at which energy is received from the sun and the rate at which it is lost to space determine the equilibrium temperature and climate of Earth. This energy is then distributed around the globe by winds, ocean currents, and other mechanisms to affect the climates of different regions. Factors that can shape climate are called climate forcing mechanism. These include variations in;

A. solar radiation
B. deviation in the earth's orbit mountain building
C. continental drift and
D. changes in green house gas concentration

Forcing mechanism can either be internal or external. Internal forcing mechanism are natural processes within the climate system itself, eg the meridional turn over. external forcing mechanism can be either natural (e.g changes in solar output) or anthropogenic (e.g. increase emission of green house gases) Whether the initial forcing mechanism is internal or external, the response of the climate system might be fast (e.g., a sudden cooling due to airborne volcanic ash reflecting sunlight), slow (e.g. thermal expansion of warming ocean water), or a combination (e.g., sudden loss of albedo in the arctic ocean as sea ice melts, followed by more gradual thermal expansion of the water). Therefore, the climate system can respond abruptly, but the full response to forcing mechanisms might not be fully developed for centuries or even longer.
Factors that can shape climate are called climate forcing mechanism. These include such as follows:

Ocean variability

The ocean is a fundamental part of the climate system. short term fluctuations (years to a few decades) e.g El Nino southern oscillation the pacific decadel oscillation. The North atlantic oscillation and the Arctic oscillation represent climate variability rather than climate change on longer time scales, alterations to ocean processes such as thermohaline circulation play a key role in redistributing heat by carrying out a slow and extremely deep movement of water and the long term redistribution of heat in the world's ocean.

Orbital variation

Slight variation in the earth's orbit lend to changes the in the seasonal distribution of sunlight reaching the earth's surface and how it is distributed across the globe.
The three types of orbital variations are variations in the earth's eccentricity, changes in the tilt angle of earth's axis of rotation and precision of earth's axis. These combine together produces Milankovitch cycles which have a large impact on climate change and are notable for their correlation to glacial and interglacial periods, their correlation with the advance and retreat of the Sahara and for their appearance in the stratigraphic record.

Solar output

The sun is the predominant source for energy input to the earth. both large term and short term variations in solar intensity are known to affect global climate. Until recently, many scientists thought that the Sun's output of radiation only varied by a fraction of a percent over many years. However, measurements made by satellites equipped with radiometers in the 1980s and 1990s suggested that the sun's energy output may be more variable than was once thought. Measurements made during the early 1980s showed a decrease of 0.1 percent in the total amount of solar energy reaching the Earth over just an 18 month time period. If this trend were to extend over several decades, it could influence global climate. Numerical climatic models predict that a change in solar output of only 1 percent per century would alter the Earth's average temperature by between 0.5 to 1.0° Celsius.

Volcanism

For many years, climatologists have noticed a connection between large explosive volcanic eruptions and short term climatic change. For example, one of the coldest years in the last two centuries occurred the year following the Tambora volcanic eruption in 1815. Accounts of very cold weather were documented in the year following this eruption in a number of regions across the planet. Several other major volcanic events also show a pattern of cooler global temperatures lasting one (1) to three (3) years after their eruption.

At first, scientists thought that the dust emitted into the atmosphere from large volcanic eruptions was responsible for the cooling by partially blocking the transmission of solar radiation to the Earth's surface. However, measurements indicate that most of the dust thrown in the atmosphere returned to the Earth's surface within six months. Recent stratospheric data suggests that large explosive volcanic eruptions also eject large quantities of sulfur dioxide gas which remains in the atmosphere for as long as three years. Atmospheric chemists have determined that the ejected sulfur dioxide gas reacts with water vapor commonly found in the stratosphere to form a dense optically bright haze layer that reduces the atmospheric transmission of some of the Sun's incoming radiation.

In the last century, two significant climate modifying eruptions have occurred. El Chichon in Mexico erupted in April of 1982, and Mount Pinatubo went off in the Philippines during June, 1991. Of these two volcanic events, Mount Pinatubo had a greater effect on the Earth's climate and ejected about twenty (20) million tons of sulfur dioxide into the stratosphere Researchers believe that the Pinatubo eruption was primarily responsible for the 0.8 degree Celsius drop in global average air temperature in 1992. The global climatic effects of the eruption of Mount Pinatubo are believed to have peaked in late 1993. Satellite data confirmed the connection between the Mount Pinatubo eruption and the global temperature decrease in 1992 and 1993. The satellite data indicated that the sulfur dioxide plume from the eruption caused a several percent increase in the amount of sunlight reflected by the Earth's atmosphere back to space causing the surface of the planet to cool.

Human influences

Anthropogenic factors are human activities which affect the climate. The scientific consensus is that climate is changing and these changes are in large part caused by human activities and it is largely irreversible. “Science has made enormous inroads in understanding climate change and its causes, and is beginning to help develop a strong understanding of current and potential impacts that will affect people today and in coming decades. This understanding is crucial because it allows decision makers to place climate change in the context of other large challenges facing the nation and the world. There are still some uncertainties, and there always will be in understanding a complex system like Earth’s climate. Nevertheless, there is a strong, credible body of evidence, based on multiple lines of research, documenting that climate is changing and that these changes are in large part caused by human activities. While much remains to be learned, the core phenomenon, scientific questions, and hypotheses have been examined thoroughly and have stood firm in the face of serious scientific debate and careful evaluation of alternative explanations.”

Consequently, the debate is shifting onto ways to reduce further human impact and to find ways to adapt to change that has already occurred and is anticipated to occur in the future. Of most concern in these anthropogenic factors is the increase in CO_2 levels due to emissions from fossil fuel followed by aerosols (particulate matter in the atmosphere) and cement manufacture. Other factors, including land use, ozone depletion, animal agriculture and deforestation are also of concern in the roles they play - both separately and in conjunction with other factors - in affecting climate, microclimate , and measures of climate variables.

Impact / effect of climate change in Nigeria

Climate change has become a reality, it brings with it changes in weather patterns that can have serious repercussions, upsetting seasonal cycles, harming ecosystems and water supply, affecting agriculture and food production, causing sea level to rise. It's effect include flood, landslides, drought and famine. As weather becomes fiercer and storms increase in frequency and intensity serious economic consequences results such as

Economic impact

Nigeria's economy depends on natural resources, when these resources are affected, whole communities are implicated .disease loss of livelihood and settlements can force entire communities into relocation and even refugee status. It can also affect the effectiveness and productivity of Nigeria's labor force. Climate change is a serious threat to efforts at poverty eradication and sustainable development in Nigeria because of large rural population directly depending on climate sensitive economic development sectors (Agriculture and fisheries)

Improper nutrition /malnutrition

Poor nutrition or lack of it is already a problem in Nigeria, whether due to population growth, poverty or low agricultural yields. Droughts reduce variety in diets and reduce overall consumption, this can lead to micronutrient deficiencies (Confalonieri *et al*., 2007)

Proliferation of insect and pest

Climate changes causes higher temperature changes precipitation and wind are all affected by climate change which will result in proliferation of disease carrying insects and pests, malaria, sleeping sickness, dengue fever, shistosomiasis, infectious diseases, pneumonia, tuberculosis and other respiratory diseases are now common in various parts of the country. Higher temperature causes a boom to these diseases and abundance of rain provides more breeding sites .wind helps to disperse them. Experts have found a correlation between weather and the disease meningitis. It is generally known that the disease attacks more people during the dry season because of dust, wind and cold nights, especially in Northern Nigeria. The spatial distribution intensity of transmission and seasonal malaria is influence by climate in sub Saharan Africa. Climate change has impacted on health in Nigeria (Adefolalu, 2007)

Agricultural yield

Foodstuffs are affected by the presence of pests resulting in low agricultural yield and food shortages as well as human population problems e.g. malnutrition. Erratic and unpredictable weather has also confused farmers about planting seasons raising fear about food production and security. The harsh weather condition in Northern Nigeria has affected agriculture. The dryness' has led to dry water bed and movements of people and their pasture to he southern regions, thus causing tension and conflicts between the original inhabitants and the new comers. Increase temperature and extreme droughts are causing a decline in productivity around the world, decrease crop productivity can mean food shortages which will have many social implications. Climate change has impact in Nigeria (Mshelia, 2005; Adefolalu,2007) the decreasing rainfall ,increasing temperature and evapotranspiration have resulted in either reduction of water levels or total dry up of some rivers and lakes in Northern Nigeria there by affecting agricultural production.

References

Ahmad OK, Ahmed AU (2000). Social sustainability. Indicators and climate; in munasingh M and Swart,R. (Eds): " Climate change and its linkages with development equity and sustainability proceedings of the IPCC expert meeting held in Colombo SriLanka. 27 -29Apr, 1999.

Adefolalu DO (2007). Climate change and economic sustainability in Nigeria" Paper presented at the International conference on climate change and economic sustainability held at Nnamdi Azikiwe University, Enugu, Nigeria. 12 -14, June 2007.

Adefolalu DO, Pam JL, Habbi HN (2007). "Climate change and safety of air transportation- A Nigerian perspective"Proceedings of the International conference on the impacts of extreme weather and climate on socio- economic development in Africa.Held at the Federal University of Technology, Akure, Nigeria. 11- 15 Nov, 2007. Pp. 1- 15

Ayuba HK, Maryah UM, Gwari DM(2007). Climate change impact on plant species composition in six semi-arid range lands in Northern Nigeria" Nig. Geogr. J. 5(1): 35- 42

Chindo A, Nyelong PN (2005) "Lake Chad"From Mrgaleke to Minilake". Arid wetland Bull, 6: 24-27.

Ikhile CL(2007). Impacts of climate variability and change on the hydrology and water resources of the Benin Owena River Basin" Phd Thesis submitted to the Department of Geography and Regional Planning, University of Benin City, Nigeria.

Intergovernmental Panel on Climate IPCC (2001). The report of working group 1 of the intergovernmental panel on climate (IPCC) 2007,climate change 2007; synthesis report, Summary for Policy Makers" available at; htpp/www.ipcc- wg1-ucar.edu/wg1/wg1-report_htm, (accessed 29 october -2010)

Intergovernmental Panel on Climate Change IPCC (2007). "Climate change 2007";Synthesis report. Summary for Policy makers; available at http/www.ipcc.wg 1ucar.edu/wg1/wg-report.htm (accessed 26 october 2010) pp. 1 - 22.

Jagtap. S.(2007). "Managing vulnerability to extreme weather and climate events; implications for agriculture and food security in Africa " Paper presented at the international conference on the impacts of extreme weather and climate on socio-economic development in Africa. held at Federal University of Technology, Akure, Nigeria. 11-12 Nov. 2007. Pp. 1-15

McQuine B, Maco I, Kiburn C(2002). Natural hazards and environmental change. Arnold, London. Pp. 13-61.

Molege AD(2005). Rainfall anomalies in Nigeria. J.Arid Environ. 5(1):1-8.

Mshelia AD(2005). "Adaptation strategies to climate change. J. Energy Environ. 18(3):74-81.

Nigerian Environmental Study/action Team (NEST), (2003). Climate change in Nigeria; A communication guide for reporters and educators. NEST. Ibadan.

Nnodu VC, Onwuka SV, Okoye CV(2007). Climate variability and its impacting South- eastern Nigeria "Paper presented at the international conference on climate change and economic sustainability held at Nnamdi Azikiwe University, Enugu, Nigeria.12-14 June 2007.

Nwafor JC(2007). 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

Odjugo PAO (2005). An analysis of rainfall pattern in Nigeria "Global J. Environ. Sci. 4(2):139 – 145.

Odjugo PAO(2007). The impact of climate change on water resources, global and regional analysis" Indonesian J. Geogr. 39((1): 23- 41.

Odjugo PAO(2010). General overview of climate change impacts in Nigeria. J. Human Ecol. 29(1): 16 – 30.

Ogundebi AO(2004). Socio-economic impacts of flooding in Lagos State Environ. Impact Anal. 12(1):16 – 30

Umoh E(2007). Flooding problems in Rivers State. J. Environ. Sci. 4(2): 44 – 60.