

Chapter 38

ENVIRONMENTAL MITIGATION STRATEGIES FOR POLLUTION AND CLIMATE CHANGE CHALLENGE IN NIGERIA:

AN OVERVIEW

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Introduction

The vulnerability of individuals and overall global communities to effects of climate change is not felt by one location or one area, but by the world communities. It is opined and widely accepted that the poorest communities are the most vulnerable, because they lack access to the most basic needs for urban/regional liveability and this place them at a disadvantage and challenges their capabilities to take on additional stresses resulting from climate change (Laukkonen *et al.*, 2009). Such complex vulnerabilities require comprehensive responses that link climate change adaptation and mitigation efforts to the sustainable development of the global communities, enhancing their adaptive capacity. It is therefore, not sufficient to concentrate on either mitigation or adaptation, but a combination of these results for most sustainable outcomes. Yet, these strategies do not always complement each other, but can be counterproductive. A similar argument can be made for linking climate change adaptation with sustainable development. In order to avoid these conflicts, priorities need to be set and this call for an overview by all stakeholders. This will lead to successful outcomes through different adaptation and mitigation strategies with the overall development goals as global mitigation measures for all environmental predicaments known to man. Therefore, this work as an overview, discusses some relative

environmental mitigation and strategies for pollution and climate challenges as affecting Nigeria as a country and the world communities at large.

The land, water, air, plants, animals, solid wastes and other things that are around us constitute our environment. Man and environment are closely intertwined with each other, to maintain a balance or equilibrium in nature (EPA Victoria, 2012). All the external factors that affect an organism could be defined as environment. These factors may be other living organisms or non-living variables, such as animals, soil, climate, light, and oxygen among others. The environment is never static, as physical forces continuously change the surface of the earth through weather, the action of waves and natural phenomena such as volcanic eruptions, flooding and other natural disasters among others are always at work. These natural phenomena, at the same time, introduce; gases, vapour, dust and pollution into the atmosphere. Living organisms therefore play an important role through respiration, excretion and ultimately death and decay, recycling their constituent elements through the overall environment.

Pollution on the other hand, is the introduction of contaminants into the natural environment that causes adverse changes. Pollution can take the form of chemical substances or energy, such as noise, heat or light. The components of pollution, can be either foreign substances/energies or naturally occurring contaminants (Khan and Ghouri, 2011). There are three major types or forms of pollutions and these are; air, water and land. Nevertheless, this work considers the three; the air (atmospheric), water (aquatic) and land pollutions. The atmosphere is polluted mainly by biomass burning, vehicular emissions, industrial emissions, and oil-gas producing refineries in the manufacturing arena (Dokun, 1995). Among the developing nations of the world, taking African nations as our instance, agricultural practices there-in, involves clearing of grasses and bushes burning at the onset of the rain seasons. This method represents a major source of carbon dioxide (CO_2), Nitrous oxide (NO), hydrocarbons and sulphur dioxide (SO_2), in the atmosphere. Biomass burning is a significant source in the emission of methane and could represent one of the total methane emissions in the tropics (Dokun, 1995; Ahmed and Tilakasiri, 2015).

Pollution, is considerably elevating in Nigeria due to rise in human activities associated with modern technologies and population growth. Though, the daily normal livelihood requirements are highly contributing factors to never ending pollution of all categories. Pollution poses health hazards, endangers wild life and makes the planet unsafe for future human survival. The present technology and desire for development adds more to pollutions but the steps taken to control or decrease it are very meagre.

What is Climate Change?

Climate change refers to any change in climate overtime, whether due to natural variability or as a result of human activity (McCarthy, 2001). It can also be seen as: “a change of climate which is attributed directly or indirectly to human activity that alters the

composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods (Parry, 2007:9). While Ozor (2009) asserts that climate change is change in climate and weather over time due to natural variability or as a result of human activity, which is widely recognized as the most serious environmental threat facing our planet today. The intergovernmental panel on climate change (IPCC) (2007) defines climate change as statistically significant variations that persist for an extended period, typically decades or longer. It includes shifts in the frequency and magnitude of sporadic weather events as well as the slow continuous rise in global mean surface temperature. This definition elicits the seriousness of the threat posed by climate change, and the urgency of the need for countries of the world to rise up to combating the negative effects of climate change.

Scientists have noted that the average temperature of the earth has increased by 0.74°C over the past 100 years (DEFRA, 2010). Whereas, if nothing is done, there is going to be more rise in the earth's temperature to the extent that it will be difficult to cope with it. This statement buttresses more the seriousness of the threat pose by climate change to countries that depend mostly on climate-sensitive resources for sustenance of livelihood and overall development. Eboh (2004) stated that countries in Sub-Saharan Africa, including Nigeria are likely to suffer the most because of their geographical location, low income (earnings), low institutional capacity as well as their greater reliance on climate-sensitive renewable natural resources sectors like agriculture and petroleum products. This is further supported by Watson (1997) which stated that, African countries are particularly vulnerable to climate change because of their dependency on rain fed agriculture, high levels of poverty, low levels of human and physical capital, inequitable land distribution as well as poor provision of infrastructural facilities.

Perception of Environmental Changes and Pollution

Climate change refers to all changes in climate variability as a result of anthropogenic activities or natural variations. With emphasis, the earth is surrounded by a layer of gases that act like the goblet wall (earth's blanket) and ceiling of a green house. Without doubt, the green house gases are essential to sustain life on earth and these gases let the sun's rays enter but stop much of the heat from escaping, keeping the planet warm enough to allow life. The problem that we face today is that the blanket of greenhouse gases that occurs naturally in the troposphere is quickly getting thicker as a result of increase emissions of green house gases and this result in the rapid warming of the world's climate. Most world renowned scientists have sometimes opined that, the global temperature will continue to rise (depends on future emissions of green house gases) and if the temperature rise is high, changes are likely to be so extreme that it will be difficult to cope with them.

There are likely to be more instances and frequencies of extreme weather events, like floods and hurricanes, and sea levels may rise further. The Intergovernmental Panel on Climate Change (IPCC) says that, human activities are the main cause of the changes seen

in climate (DEFRA, 2010). This assertion may be as a result of the following three major factors; burning of fossil fuels, deforestation and growing world population. Nigeria like all the other countries of sub-Saharan Africa is highly vulnerable to the impacts of climate change (NEST, 2004; IPCC, 2007; Apata *et al.*, 2009). Butt *et al.* (2005) went further to predict future economic losses and increased risk of hunger due to climate change. It is stark clear that the combination of high climatic variability, poor infrastructure and a range of other problems associated with climate variability will constitute important challenges for African countries, Nigeria in particular and the Tropical world in general. Smith and Skinner (2002) further asserted that climate plays a principal role in agriculture, having a direct impact on the productivity of physical production factors, for example the soil's moisture and fertility. This work overviews, and seeks further to provide more explanations on some disquieting questions about climate change, its attendant subsidiaries- the pollution categories among others. Also, the concept of climate change, its nature, scope and impacts national and internationally tend to show the benefits (to beneficiaries) that are likely incurred and as indicated in the Vision 20:20:20, the vision indicates that if all climate change challenges and pollutants are well controlled and managed, they may turn beneficiary to every affected areas in the world if policy/plan propounded in the vision is adopted (Figure 1).

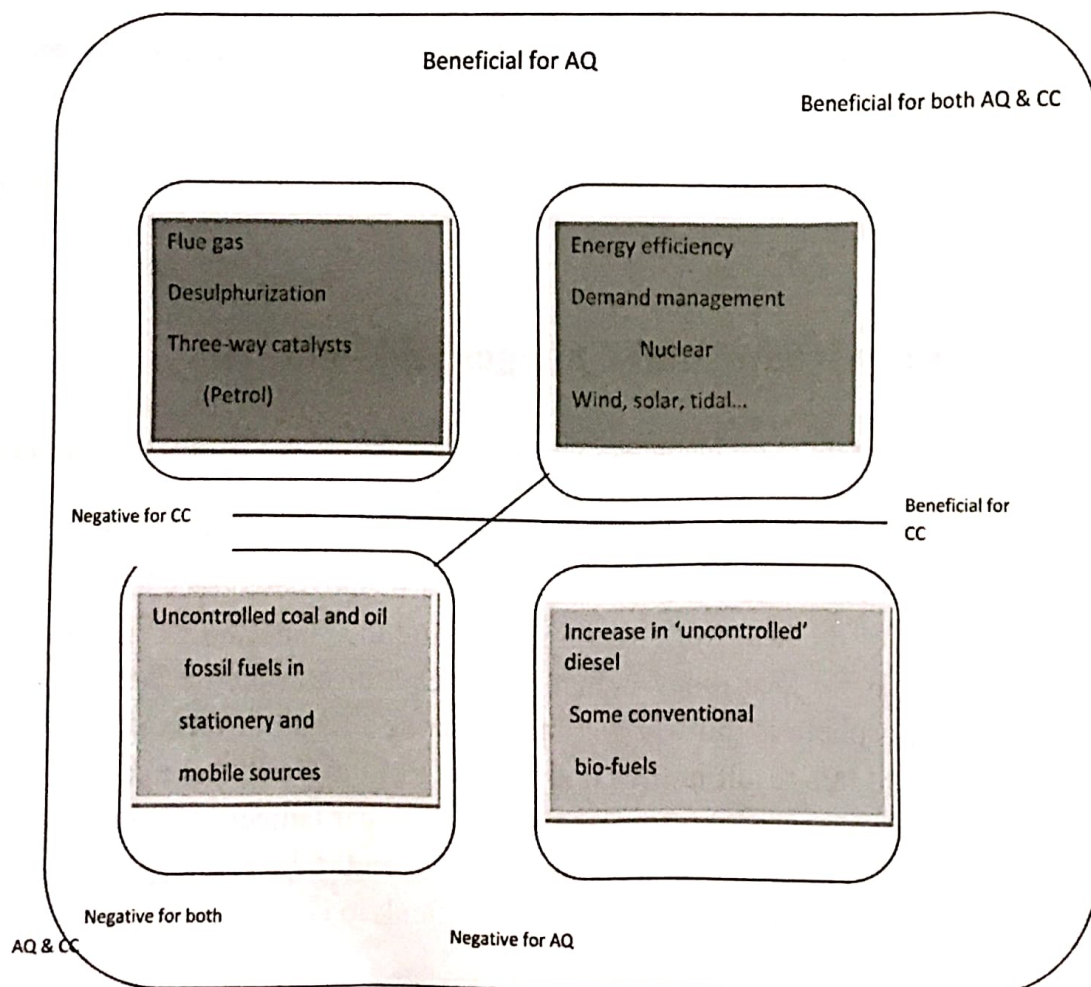


Figure 1: Policy Plan Displaying Air Quality/Climate Change Interactions/Benefits (Vision 20:20:20).

Causes of Changes in Climate

Going through historical antecedent, within the last one hundred and fifteen (115) years average global temperatures have increased by 1.1°C. While in Nigeria, average annual rainfall decreased by 81mm from 1901 but increased rapidly as from 1970. The air temperature patterns from 1901-1935 and 1936-1971 were almost the same, but differ significantly between 1971 and 2005. The changes in the climate parameters have substantial effects in the atmospheric composition of our natural environment and have had devastating effects. In Nigeria, for instance, the flooding pattern that occurred in many urban areas in the recent times is a warning signal that needs urgent attention to forestall its reoccurrence. The National Emergency Management Agency (NEMA) has repeatedly given warnings that people of the southern parts of the country are likely to experience greater flood disaster if left unchecked; there is the tendency for such changes to occur progressively (Nwona, 2013). The factors that cause climate change are legion and it has been widely accepted that the major causes of global warming are from us. These factors can be divided into two categories-those related to human or anthropogenic activity and those to natural processes.

Human (Anthropogenic) Causes

Climate change caused by human activities such as; the burning of fossil fuels and the conversion of land for forestry and agriculture. Since the beginning of the Industrial Revolution, these human influences on the climate system have increased substantially. In addition to other environmental impacts, these activities change the land surface and emit various substances to the atmosphere. These in turn can influence both the amount of incoming energy and the amount of outgoing energy and can have both warming and cooling effects on the climate. The dominant product of fossil fuel combustion is carbon dioxide, a greenhouse gas. The overall effect of human activities since the Industrial Revolution has been a warming effect, driven primarily by emissions of carbon dioxide and enhanced by emissions of other greenhouse gases. Other human cause of climate change most especially in Nigeria has been widely accepted is that most global warming is from the human race and the effects are severe. For instance, The Citizen newspaper of 21st June, 2013 (online version) reports that no fewer than 171 plant species were classified as endangered and vulnerable; and that these plants are harvested from our forests through commercial activities that cause rapid deforestation at about 400,000 hectares per annum. The disappearance of the affected species could disrupt the nation's genetic resource with resultant threat to our biodiversity. Other major causes of climate change as induced by man include; astronomical causes, volcanic eruptions, variations in solar output and changes in earth's environment as a result of human activity. The Intergovernmental Panel on Climate Change (IPCC) says that human activity (anthropogenic) is the main cause of the changes seen in climate. This is through activities that cause emissions of greenhouse gases (mainly carbon dioxide, water vapour, methane and nitrous oxide). Studies of long-termed climate

change have discovered a connection between the concentrations of carbon dioxide in the atmosphere and mean global temperature. Carbon dioxide is one of the most important gases responsible for the green house effect. These green house gases are able to alter the energy balance of the earth by being able to absorb long wave radiation emitted from the earth's surface. The net result of this process and the re-emission of long wave back to the earth's surface increase the quantity of heat energy in the earth's climatic system.

Further more of the actions of man that promote climate change are; the widespread misuse of land, the major technological and socioeconomic shifts with reduced reliance on organic fuel, and the accelerated uptake of fossil fuels (Millennium Ecosystem Assessment, 2005). Spore (2008) explained the weather patterns that can lead to easy understanding of climate change. According to him, each day, the sun emits rays of light onto the earth's surface. The earth absorbs part of the heat, reflects another share into the atmosphere and sends out a third share in the form of infra-red rays. These rays are cushioned by the clouds and water vapour, which stabilizes the earth's temperature under normal circumstances. The problem we are facing today is that the concentration of GHGs produced by human activity has increased significantly. The gases absorb the terrestrial radiations from the earth and reradiate the heat back to earth, thereby leading to a general increase in temperature known as global warming.

Natural Causes

The Earth's climate can be affected by natural factors which are global factors that are external to the climate system, such as changes in volcanic activity, solar output, and the Earth's orbit around the Sun. Among these, the two factors relevant on timescales of contemporary climate change are changes in volcanic activity and changes in solar radiation. In terms of the Earth's energy balance, these factors primarily influence the amount of incoming energy. Volcanic eruptions are episodic and have relatively short-term effects on climate. Changes in solar irradiance have contributed to climate trends over the past century but since the Industrial Revolution, the effect of additions of greenhouse gases to the atmosphere has been over 50 times that of changes in the Sun's output.

Short-lived and long-lived climate forcers (natural causes)

Carbon dioxide is one of the main causes of human-induced climate change. It has been emitted in vast quantities from the burning of fossil fuels and it is a very long-lived gas, which means it continues to affect the climate system during its long residence time in the atmosphere. However, fossil fuel combustion, industrial processes, agriculture, and forestry-related activities emit other substances that also act as climate forcers. Some, such as nitrous oxide, are long-lived greenhouse gases like carbon dioxide, and so contribute to long-term climate change.

Other materials have shorter atmospheric lifetimes because they are detached fairly quickly from the atmosphere. Therefore, their effect on the climate system is in the same way short-lived. Together, these short-lived climate forcers are accountable for a considerable amount of current climate forcing from anthropogenic substances. Some short-lived climate forcers have a climate warming effect ('positive climate forcers') while others have a cooling effect ('negative climate forcers'). If atmospheric levels of short-lived climate forcers are continually refilled by ongoing emissions, these continue to apply a climate forcing. However, reducing emissions will quietly but quickly lead to reduction in atmospheric levels of such substances. A number of short-lived climate forcers have climate warming effects and together are the most important contributors to the human enhancement of the greenhouse effect after carbon dioxide. This includes methane and tropospheric ozone – greenhouse gases – and black carbon, a small solid particle formed from the incomplete combustion of carbon-based fuels-coal; oil and wood among others are typical examples.

Impacts of Climate Change on Nigerian Environment

There is a growing consensus in the scientific literature that in the coming decades the world will witness higher temperatures and changing precipitation levels. The effects of this will lead to low/poor agricultural products. Evidence has shown that climate change has already affecting crop yields in many countries (IPCC, 2007; Deressa *et al.*, 2008; BNRCC, 2008). This is particularly true in low-income countries, where climate is the primary determinant of agricultural productivity and adaptive capacities are low (SPORE, 2008; Apata *et al.*, 2009). Many African countries, that have economies largely based on weather-sensitive agricultural productions systems like Nigeria, are particularly vulnerable to climate change (Dinar *et al.*, 2006). This vulnerability has been demonstrated by the devastating effects of recent flooding/erosion in the Niger Delta regions of Nigeria and the various prolonged droughts that are currently witnessed in some parts of Northern region (Plates1-3). Thus, for many countries like Nigeria that are highly vulnerable to effects of climate change, understanding farmers' responses to climatic variation is crucial, as this will help in designing appropriate coping strategies.



Plate 1: Effect of Climate Change in South-Eastern Part of Nigeria (Adopted From Julia Agwu)(2015).



Plate 2: Parchedness of a River Resulting from Climate Change in Ilorin, Nigeria. Source: Authors' Compilation (2016).



Plate 3: Erosion Activity in Part of Nigeria (Adopted from Julia Agwu) (2015).

Climate change is unarguably the biggest environmental issue of our time. Climate change is global in its causes but its consequences are far more reaching in developing countries, particularly in Nigeria. Climate change is an environmental, social and economic challenge on a global scale creating activities like heating homes and building, transportation and cooking food, traveling (for example, by car, plane, bus and train), treating water to make it drinkable, heating it and piping it into homes, manufacturing from fridges, gas flaring, bush burning etc people induce the emission of carbon dioxide into the atmosphere. Since the industrial revolution which began in the 18th Century, the amount of CO₂ in the atmosphere has increased by 35 per cent. The Niger Delta region of Nigeria is reported to have over one hundred and twenty three gas flaring sites making Nigeria one of the highest emitters of greenhouse gases in Africa (Akinro *et al.*, 2008). A recent study by the World Bank (2008) revealed that Nigeria accounts for roughly one-sixth of worldwide gas flaring, Nigeria flares about 75 per cent of her gas. The flares have apparently contributed more greenhouse gases hence climate change in the country.

When taking into consideration the impact of human activities such as overgrazing, bush burning, extraction of fuel wood, pesticide use, gas flaring on climate change, the phenomena may lead to poor yield of agricultural products, changes in ecosystems (crops/ animals) are forced to adapt and those that cannot adapt may die-out. Has impact felt of climate change become a new reality in Nigeria environment, disruption in seasonal cycles and ecosystems; water needs and supply, and food production are deleterious and adversely affected. Climate change also leads to sea level rise with its attendant consequences, such as fiercer weather, increased frequency and intensity of storms, floods, hurricanes, droughts, increased frequency of fires, poverty, malnutrition and series of health and socio-economic consequences. This indirectly has a cumulative effect on natural resources and the balance of nature.

Nigeria is affected by climate change in a variety of other ways. For example, urban and rural population concentrations are serious under pressure, particularly along the coastline due to sea-level rise and related phenomena. Some settlements are known to have already relocated farther inland from their original sites in response to sea incursion over some decades. The phenomenon also threatens urban and rural infrastructure facilities in low lying coastal regions. While extreme climate conditions such as high wind, heavy rainfall, heat and cold results in wide-ranging scenarios such as tropical storms, floods, and landslides. Communities and government no doubt, face with burden of making reparations to individuals for property damage and loss, unemployment, clean-up, and reduced socio-economic viability of the communities affected as a result of the combine human induced climate change of our time.

Changes in weather and climate have been known to profoundly influence water resources, a factor that increases the vulnerability of humans to infection. Generally, water resources involve all forms of fresh water needed for life's necessities, ranging from domestic needs to drinking, washing and cleaning, to agricultural needs involving food processing and irrigation, to other general needs.

Climate change is surely one phenomenon that has tested the Nigerian government and so far, the government has failed the test looking at the low level preparedness of the country in tackling the imminent dangers of climate change. Apart from various workshops and seminars to pay lip services to the many problems climate change poses to the nation, some experts have said Nigeria still has no structure or any coordinated mechanism in place to tackle the challenge of climate change in the country. The International Centre for Energy, Environment and Development (ICEED) and Nigerian, environmental group Non Governmental Organization (NGO), have continued to call on the Federal Government to put in place mechanisms that would enable Nigeria mitigate and adapt to climate change difficulties but little has been done in that regard. Many environmental stakeholders are beginning to describe the delay as a show of lack of commitment to the danger created by climate change.

Globally, extreme weather is predicted to become more common and animals, plants and crops are all expected to be badly affected. In Nigeria the effects of climate change is expected not to stop at just effecting the crops and plants (i.e the farmers), it will surely affect the lives and overall development of country. Eboh (2009) stated that the effects of climate change are projected to manifest through changes in land and water regimes, specifically, changes in the frequency and intensity of droughts, flooding, water shortages, worsening of droughts, worsening soil conditions, desertification, disease and pest outbreaks on crops and livestock. Anyadike (2009) stated that the general environmental effects of climate change include; rise in sea level due to melting of ice caps; changes in dates of onset and end of the rainy season; reduced rainfall amounts in some areas and increased rainfall amounts in others, leading to flooding and increase in intensity of atmospheric disturbances such as thunderstorms and line squalls. He went further to state that climate change will deepen poverty both directly and indirectly. The direct impact he explained will manifest through

the loss of lives, livelihoods, assets, infrastructure, etc. from climate extreme events. Ozor (2009) in listing the impact climate change on national development of the country stated that variations in climate change have led to devastating consequences and effects in various parts of the country which include flooding, heat stress, pests and diseases, erratic rainfall patterns and land degradation, specifically he stated that the South-south geopolitical zone is mainly affected by sea level rise and deforestation-induced changes; the South-west zone also is affected by sea level rise and deforestation-induced changes; South-east by erosion, flooding and land degradation; North-central by changes due to de-vegetation and overgrazing; North-east by drought, desertification and heat stress; and North-west also by drought an, desertification and heat stress. While assessment report by the IPCC (2001) stated that the poorest countries are more vulnerable to the risk of climate change. It listed some impacts like; stalinization of fertile areas, exposure of millions of people to new health risks, wide spread of vector-based diseases like malaria and schistosomiasis, as well as water-borne diseases like cholera, dysentery and malnutrition from the reduction in crop yields.

In Nigeria, though the impact of climate change is already significant, but its long run impact will be devastating if nothing is done now to build up the country's resilience against the threat pose by climate change. The impacts of climate change will surely be felt in almost all the geographical location as well as sectors of the nation's development, specifically, it will be apparent in the following ways;

(i) Animal crop and production: As temperature increases and rainfall pattern becomes more unpredictable, crop yields are expected to drop significantly. Also extreme weather events such as thunderstorms, heavy winds and floods devastate farmlands and can lead to crop failure. Pests and diseases migrate in response to climate changes and variations It is estimated that by 2100, Nigeria and other West African countries are likely to have agricultural loses of up to 4 per cent of GDP due to climate change (Mendelson *et al.*, 2000). Parts of the country that experienced soil erosion and operate rain fed agriculture could have decline in agricultural yield of up to 50 per cent between 2000 – 2020 due to increasing impact of climate change (Agoumi, 2003; IPCC, 2007).

(ii) Fishery: Fish farming and the associated processes are becoming an important source of revenue and employment in Nigeria. Ozor (2009) stated that subtle changes in key environment variables such as temperature, salinity, wind speed and direction, ocean currents, strength of upwelling due to climate change could sharply alter the abundance, distribution and availability of fish production in the country. This will also affect the revenue sustenance of those who work on fishery resources. Tubiello (2008) noted three major pathways through which climate change will affect fisheries and aquaculture, as well as dependent communities and their economic activities as:

- Physical and chemical changes in oceans and fresh waters, including increase in water temperature and changes in salinity among others,

- Change in fish production, catch composition and species distribution resulting from a complex interplay of ecological changes, and,
- Physical changes to coasts, estuaries, wetlands, lakes and rivers caused by changing weather patterns, weather-driven natural disasters and sea-level rise. Fishery resources are known to be highly sensitive to marine environmental changes. Though they had always coped with these changes, future climate changes will likely be so extreme that it may be difficult for them to cope with. Therefore, identification of proper adaptation strategies is a high priority for the fishery sector in the country.

(iii) Forestry: The forest reserves of Nigeria are also posed to the threat of climate change. Francesco,(2008) asserted that climate change will affect agriculture and forestry through higher temperatures, elevated CO₂ concentration, precipitation changes, increased weeds, pests and disease pressure, and increased vulnerability of organic carbon pools. He said that eleven, out of the thirty-six states in the country referred to as the frontline states are gradually being consumed up by desertification. As at 1985, deforestation claimed not less than 1,544 sq miles of the nation's forest land. While, between 1983 and 1993 alone, Nigeria lost 20 per cent of its forest and woodland areas to climate change effects. Nigeria's primary tropical forest in Cross River State has been decimated by 97 per cent, mostly since 1990. The country's broader forest cover was estimated at just over 12 per cent in 2005, being depleted at a rate of 3.3 per cent per annum. The main cause is the demand for wood fuel. This depletion of the nation's forest reserves when critically looked at is not far from indirect effect of climate change. As a result of the drying up of village or communities forest which the dwellers depend on for firewood, they resort to the depletion of forest reserve as a means of getting wood fuel.

(iv) Health and infirmity of the people: A healthy nation is said to be wealthy nation. Climate change is expected to induce health problems directly and indirectly. The direct effects manifest in persistent and resistant to treatment as were never experienced before. Okhimamhe (2009), in studying the impacts and adaptation of climate change in Northern Nigeria found out that diseases like persistent malaria, hypertension, ulcer, diarrhoea, asthma and diabetes are new ailments that were ushered in by the changing climate, with malaria being the most widespread. She critical pointed out that thirty years ago, the people of the area relied on local herbs for treating illnesses, but now, they have to go to nearby fairly functional clinics for treatment especially because the herbs are no longer able to stop diseases. In addition most of the herbs used are no longer available. Some diseases like tick-transmitted meningitis are infectious diseases that can be influenced by climate change. Also extreme weather events are known to facilitate some cardiovascular disease like asthma.

Climate change would inevitably have a direct impact on human health by increasing the concentration of pollutants which would subsequently endanger the lives of human beings and other creatures within the earth's ecological system. (Ayoade, 2003). Increases

or decreases in climatic variables such as : Temperature, rainfall, wind , atmospheric pressure etc, all pose a great deal of health risks (Table 1) Climate change would inevitably have a direct impact on human health by increasing the concentration of pollutants which would subsequently endanger the lives of human beings and other creatures within the earth's ecological system. (Ayoade, 2003). Increases or decreases in climatic variables such as: temperature, rainfall, wind, atmospheric pressure etc, all pose a great deal of health risks. The projected changes in climate are likely to alter the health conditions of millions of people through increased deaths, disease and injury due to heat waves, floods, storms, fires and droughts. Increased malnutrition, diarrhoeal disease and malaria in some areas will increase vulnerability to extreme long term damage to health systems. (IPCC, 2008).

Table 1: Projection of the Climate Change Scenario in Nigeria.

Environmental Elements	Location	Baseline	Projected Time Horizon	Projected change
Temperature	Coastal areas	1980/99	2080/99	+2.5αC
Temperature	Middle belt and North-east Nigeria	1980/99	2080/99	+3αC
Temperature	North-west of Nigeria	1980/99	2080/99	+3.5αC
Rainfall	Sudano-sahelian zone	1980/99	2080/99	+5-15αC
Rainfall	Forest and coastal areas	1980/99	2080/99	0-5αC

Source: Francis *et al.* (2011).

Globally, extreme weather is predicted to become more common and animals, plants and crops are all expected to be badly affected. In Nigeria the effects of climate change is expected not to stop at just effecting the crops and plants (i.e. the farmers), it will surely effect the lives and overall development of country. Eboh (2009) stated that the effects of climate change are projected to manifest through changes in land and water regimes, specifically, changes in the frequency and intensity of droughts, flooding, water shortages, worsening of droughts, worsening soil conditions, desertification, disease and pest outbreaks on crops and livestock. Anyadike (2009) stated that the general environmental effects of climate change include; rise in sea level due to melting of ice caps; changes in dates of onset and end of the rainy season; reduced rainfall amounts in some areas and increased rainfall amounts in others, leading to flooding and increase in intensity of atmospheric disturbances such as thunderstorms and line squalls. He went further to state that climate change will deepen poverty both directly and indirectly. The direct impact he explained will manifest through the loss of lives, livelihoods, assets, infrastructure, etc. from climate extreme events. Ozor (2009) in listing the impact climate change on national development of the country stated that variations in climate change have led to devastating consequences and effects in various parts of the country which include flooding, desertification, erosion, drought, sea level rise, heat stress, pests and diseases, erratic rainfall patterns and land degradation, specifically he stated that the South-south geopolitical zone is mainly affected by sea level rise and deforestation-induced changes; the Southwest zone also is affected by

sea level rise and deforestation-induced changes; Southeast by erosion, flooding and land degradation; North-central by changes due to de-vegetation and overgrazing; Northeast by drought, desertification and heat stress; and Northwest also by drought and desertification and heat stress.

The Third assessment report of IPCC (2001) stated that the poorest countries are more vulnerable to the risk of climate change and went further to identify a range of poverty-related climate change impacts as follows; reductions in crop yield (fall in agricultural productivity) in most tropical and subtropical regions due to decreased rainfall, changes in food security, employment, incomes and economic growth, displacement of people from coastal and densely populated low lying areas, salinization of these fertile areas, exposure of millions of people to new health risks, especially from vector-based diseases like malaria and schistosomiasis, as well as water-borne diseases like cholera and dysentery and malnutrition from the reduction in crop yields. In Nigeria, though the impact of climate change is already significant the long run impact will be disastrous if nothing is done now to build up the country's resilience against the threat posed by climate change. The impacts of climate change will surely be felt in almost all the geographical entity, location as well as sectors of the nation's development. Specifically it will manifest in various ways as discussed above.

Pollution and Change in Nigerian Environment

The world population is increasing at an alarming rate, and so is Nigeria's population. The demands of increasing population coupled with the desire of most people for a higher material standard of living are resulting in worldwide environmental pollution on a massive scale (Teeseme, 2008).

Environmental pollution in Nigeria is a national problem and its potential to influence the health of human population is great. Over the past few years there has been increasing national concern over the public health impacts attributed to environmental pollution, in particular, the National burden of disease. The World Health Organization (WHO) estimates that about a quarter of the diseases facing mankind today occur due to prolonged exposure to environmental pollution (*ibid*).

Environmental problems in Nigeria generally are many, diverse in nature, and are caused by man's interaction with nature (environment) for exploits in a number of ways-both in the cities; where industrial activities predominate, and rural areas; where agriculture thrives. Man utilizes air for survival, harnesses land and water resources for domestic, commercial, industrial, agricultural and other purposes. Through these activities; man directly or indirectly creates problems which are detrimental to his health/survival, wellbeing, natural existence and stability. These problems are consequences of environmental pollution which also degenerates into environmental degradation and several other hazards such as widespread epidemics, depletion of natural habitats, and thus; impede the socio-economic development as seen in the case of Nigeria as a nation (Bamgbose, 2015).

Air pollution is a major problem in Nigeria due to the rapid urbanization and industrialization. Another major source of air pollution in Nigeria is the un-tarred nature of some roads, which has been a major cause of dust in the atmosphere particularly in the rural areas characterized by poor infrastructural development. Moreover, in some Nigerian cities such as Lagos, Enugu, Ibadan, Kano, Port Harcourt, Benin, Warri, Kaduna, Abuja, and Benin where industrial activities dominate, industries inject into the air various pollutants that deplete the ozone layer. Gas flaring in the oil exploitation zones of Niger delta and mining activities reduces the quality of the air in the South-South environment.

Water pollution is a critical and drastic situation in Nigeria, which needs immediate attention. Due to improper or no constructions of channels for water bodies, which leads to agricultural waste, household waste, industrial waste and human waste being deposited directly into our water bodies. In the Niger Delta area to be specific, most oil spills come from vessels or involves pipelines, oil terminal and bulk storage facilities which are sometimes caused by accidental or deliberate sabotage. The blow out of offshore oil and gas wells, the dumping of drilling mud and oil soaked waste, the destruction of drilling rigs are major sources of water pollution in these areas (Raji *et al.*, 2013).

Noise on the other hand, is one of the most pervasive pollutants and as a musical clock may be nice to listen during the day, but may be an irritant during sleep at night. Noise by definition is sound without value or any noise that is unwanted by the recipient. Noise in industries such as stone cutting and crushing, steel forgings, loudspeakers, shouting by hawkers selling their wares, movement of heavy transport vehicles, railways and airports leads to irritation and an increased blood pressure, loss of temper, decrease in work efficiency, loss of hearing which may be first temporary but can become permanent in the noise stress continues (Ted *et al.*, 2015). Noise could be any loud sound. It becomes a pollutant when it is unpleasant, and could be disturbing to humans and the public. In contemporary times, industrial activities of people in construction industries, recording studios, air and sea ports, transportation firms, in towns and cities specifically-Lagos, Abuja, Kaduna, Enugu, Kano, Lagos, Port Harcourt, Benin, Ibadan, Onitsha, Owerri, etc have not just caused noise pollution but have worsened the bad case of the already polluted environment in affected areas (Peter *et al.*, 2006). Noise level is measured in terms of decibels (dB), (Table 2). World Health Organization (WHO) has prescribed optimum noise level as 45 dB by day and 35 dB by night and anything above 80 dB is hazardous.

Table 2: Indicates the Noise Intensity in Some of the Common Activities.

Source	Intensity	Source	Intensity
Quiet Conversation	20-30dB	Radio Music	50-60 dB
Loud Conversation	60 dB	Traffic Noise	60-90 dB
Lawn Mower	60-80 dB	Heavy Truck	90-100 dB
Aircraft Noise	90-120 dB	Space Vehicle	140-179 dB
Beat Music	120 dB	Launch Jet Engine	140 dB
Motor Cycle	105 dB		

Source: Bamgbose (2015).

Relatively, the use of loud horns of motorists/vehicles, heavy duty, trains, etc. at their loudest level are another disturbing issue of noise pollution in our cities/urban centres. In a similar vein, due to the challenges faced from the public power supply-generating sets from individual residents and business firms make a hell of noise, thus, causing disturbance to the public in most urban/cities in Nigeria. Irrespective of the devastations caused by noise pollution, the subject matter has not been given scholarly attention. The world seems to ignore the effects, to the extent that when issues of pollution are discussed at world environmental conferences and seminars, noise pollution is given very little recognition (Raji and Abejide, 2013).

Mitigation Measures for Environmental Challenges

Some of the mitigation strategies to cushion the effects of climate change in Nigeria environment include the following:

Phase in Weather Indexed Agriculture

The agricultural sector is perhaps where persistent attention should be concentrated for obvious reasons of maintaining food security. High temperatures usually lead to droughts or more rainfall as well as cut annual crop productivity due to longer or shorter crop seasons. Farmers will need to be taught how to adapt their crops to a climate rife with both drought and flooding through regular campaigns. Farmers that grow crops on risk-prone lands will need seeds that can withstand higher temperatures, more or less water, and fluctuating crop seasons. Efficient irrigation systems can help farmers in affected regions in the country to cope with the uncertainty that comes with climate change.

Develop Climate Resilient Housing Scheme

The housing and construction industry must recognize its dual role of helping people cope with climate change as well as developing sustainable and efficient building practices in order to prevent environmental degradation. There is need to build the capacity of the construction industry to be able to step up to these critical challenges. The ministry of Housing and Urban Development (HUD) should take the lead in mobilizing the stakeholder groups to come out with innovative design models that city development control authorities could rely on to encourage, model and monitor new housing projects. Climate mitigation strategy suggests building homes on stilts, constructing barriers around natural and artificial water bodies in populated regions and providing local or on-site energy generation technologies.

Adopt Appropriate Water Management Strategies

Water resources will likely come under intense pressure in a warming climate. Harsher and more wide-spread droughts coupled with the rising concentration of salt in ground water sources from rising sea levels will lead to pressure on already fragile farming communities. Changing weather patterns will also increase flood risk along waterways. Mitigation strategies that go along this path will require huge investments in desalination technology, increased gray water use and rainwater harvesting for crops and everyday human uses other than drinking, and flood control mechanisms to protect communities and crops from overflowing rivers. Mitigation efforts should also focus on how the infrastructure can be designed to simultaneously manage water for hydropower, agriculture and human consumption to further scale up the environmental and economic development of communities. The challenge remains how these strategies can be affordably made available in a struggling economy like Nigeria.

Improve Weather Prediction Technology

We cannot run away from extreme weather conditions occasioned by climate change. Massive floods and hurricanes will become more common because of the warming of the earth. Government institutions like the Nigerian Metrological Agency (NIMA) should not limit their operational jurisdiction to mere weatheforecasting, but they should invest in technologies to enable more accurate predictions and warning systems. There is also need for accurate environmental data, particularly from sensors located in the soil, ocean, atmosphere, flood zones and arid, drought-stricken lands (Annez and Buckley, 2008). It will be important to track the changes in order to have timely and quality information that will assist disaster aversion and emergency management strategies to minimize losses. Financial resources from the Ecological Funds Office, domiciled in the ministry of environment, would need to be deployed towards acquiring these innovative weather monitoring technologies if our strategized measures should work for the country.

Development of Resilient for Localized Economy

Perhaps the most powerful response to climate change would be the development of a resilient; local economy. This is particularly true because most of the projected future global economic growth is set to take place in developing countries. Nigeria seriously needs to look inwards and apply some out-of- the-box measures that have multi-dimensional positive implications for her economy as well as the health of her citizens. For example, Nigerians, have adopted many western conventions that are not only out of alignment with our culture and climate, but that rid our country of local economic opportunities. Suits and coats make sense in colder climates but not in Nigeria where average temperatures

are about 40°C. This exotic culture vestige not only makes us uncomfortable, but requires importing products that we could easily produce in country with local employment, using local resources while at the same time maintaining our national identity. Think of the local and global environmental benefits if the Nigerian government encourages massive switch to our locally made apparels as an adaptation measure to promote public health of her citizens in a changing climate.

Rally and Coordinate Government Ministries

Ultimately the government will need to play a pivotal role in adaptation by articulating a national framework driven by the climate change commission. This framework will require leveraging the critical ministries, agencies and parastatals of government like the National Emergency Management Authority [NEMA], Ministry of Health, Nigerian Metrological Agency, Ministry of Agriculture, Ministry of Water Resources, Ministry of Housing & Urban Development, National Insurance Commission, Institute for Peace and Conflict Resolution and the Ministry of Niger Delta Affairs to build capacity in conflict management, work through coordinated, robust national mechanisms to address climate induced security challenges as well as ensure transparent management and allocation of interventionist resources. Mitigation measures/strategies for climate change challenges in Nigeria must be approached from the point of view of necessity in the context of sustainable development with greater emphasis on the generally accepted principle that economic empowerment, social development and poverty eradication constitute the first and current priorities of a developing country like Nigeria.

Current Governmental Position

Chasing sustainable development, just like implementing climate change measures against its challenges, requires political will at the highest level. Thus far, official responses have been feeble and not much progress has been made on the part of the Nigerian federal government. The way out is a central oversight body that will coordinate research and policy response, harmonize roles for sister agencies, and pursue aggressively the implementation of master plans in a seamless collaborative partnership with the countries and the UN climate change response organizations. The good news is that the out gone sixth national assembly of the country's parliament courageously passed the Nigerian Climate Change Commission Bill under (the last civilian rule) in the fight against our greatest impediment to development. Nigeria Climate Change Commission (NCCC), therefore, when fully operational, would be the first in Africa to take this bold step.

Land Resources Degradation

Improper construction techniques, inappropriate farming methods, overgrazing, bush burning, unauthorized mining activities, natural phenomenon among others contributed to environmental resources problems in Nigeria (World Bank Report, 1990:26). The World Bank (1991) corroborated in her report that environmental degradation directly affected the lives of about 50 million Nigerians. While, Nigeria's environmental losses amounted to about N25 million or 13 per cent of 1991 Gross National Product (GNP) and since then and hitherto the problems persisted (The Nigerian Environment). The government realized these problems and embarked on the following steps-some of the steps worked and others not):

- (i) The establishment of environmental quality standards, regulatory guidelines and methods for implementing, enforcing and evaluating them,
- (ii) the establishment of Environmental Impact Assessment (EIA) measures and policy initiative to review them,
- (iii) the establishment of reliable guidelines for state environmental management plans and action programmes and the cooperation of national and inter-state programmes, projects and exchange of information on environment,
- (iv) the review of federal policies that may have momentous adverse impacts on the environment and natural resources base of the country at large.

Conclusion and Recommendations

It is recognized that climate change is a global phenomenon that impinged on global communities in different scales, from individuals to localities, and entire regions. Therefore, in order to effectively respond to these challenges, all global stakeholders at different levels require equally, a methodology and a means to help them in the decision-making and taking processes.

Nigeria needs mainstream climate change adaptation and measures that would take into consideration, an economic blueprints and development master plans strategic actions at this stage of our development. This is would prepare guarantees and effective contingency plans to protect citizens, property and the environment. As proactive governments are beginning to realize that, in the long term, climate change adaptation and measures need to be supported by an integrated, and cross cutting policy approach. In view of the prevailing attention and priority given to climate change mitigation over the last two decades, the battle cry of Nigeria and the rest of Africa in the next few years as discussed before need to be properly implemented as among the surrogate measures. Therefore, the advanced methodological approach and a coping tool to help individuals, communities, nations or regions in the decision-making process towards the best response to climate change is inevitably essential.

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