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Research article

Implications of Global Warming for Sustainable Economic Development in Nigeria

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Abstract

The global climate has been changing continuously throughout the years of the earth's existence. There is a growing body of evidence that the quantity of greenhouse gases in the atmosphere has been rising steadily over the last century. The majority opinion of scientists is that this rise in greenhouse gases is exacerbating the "greenhouse effect" by trapping evermore of the sun's energy thereby raising the temperature worldwide. Greenhouse gases (GHGs) have been proven to be responsible for global warming with the consequent threat to climate change. This is a major threat facing human existence on planet earth. This paper therefore has reviewed and evaluated the effects of global warming and climate change, the inventory of greenhouse gases, the Kyoto protocol and its economic implications on Nigeria. More importantly, the paper stressed that economic and environmental well being are mutually reinforcing goals that must be pursued simultaneously if either one is to be reached.

Keywords: Global warming, Climate Change, Greenhouse gases, Sustainable Development, Nigeria.

Introduction

The issue of global warming and its consequences on the future of the planet earth and mankind is one that demands urgent attention. Globally, the threat of climate change is a source of concern, especially in a developing country such as Nigeria. The increasing levels of carbon dioxide emissions and the by-product of the incessant drive towards industrialization threaten to reduce human livelihoods and resources, to such an extent that it might become a huge task for nations with low technological acquisition to cope with their effects without damaging the sustainability capabilities. On global scene, the most threatening effects of climate change are melting of the polar ice, flood

problems coastal inundation, ecological destabilization and sea level rise (McQquire *et al.*, 2002; Nyelong, 2004; IPCC, 2007; Odjugo & Edokpa, 2009). Scientific uncertainties include the amount of warming expected in the future, and how warming and related changes will vary from region to region around the globe (Muhammad & Muhammed, 2008).

In a variety of ways, man relies heavily on carbon-based fuels. Cars and other vehicles are powered by gasoline or diesel fuel. Electricity is generated by power plants that consume coal, natural gas or oil. Man burns woods, charcoal, natural gas and coal to cook or keep them warm. All these activities add carbon dioxide to the atmosphere. This gas traps heat from the sun. Also, other heat-trapping greenhouse gases (GHGs) are being added from nitrous oxide from nitrogen fertilizer. All of these clearly suggest that there is a visible human influence on global climate.

For years now, environmental groups have promoted widespread use of pollution-free energy sources and have also urged governments to make and enforce laws to reduce emissions of heat-trapping gases. Also, in 1992, at the Earth Summit in Rio de Janeiro, Brazil, representatives of about 150 nations signed a treaty affirming their commitments to reduce GHGs emissions. While a few have made progress, most rich nations are not even close to keeping their pledge.

Despite these efforts, powerful industries, especially the extracting and processing ones use their considerable funds to influence and downplay the threat of climate change and exaggerate the economic impact of a shift away from the use of fossil fuels.

Nigeria being a developing economy, is heavily dependent on hydrocarbon as a source of energy with resultant implications unquantified. In fact, the pollution of our atmosphere is but one of the environmental problems we have created. This paper therefore discusses in details some of the causes of climate change, the extent to which domestic and industrial activities have impacted on this long term observable and predicted climate change. The paper also examines the effects of global warming, the inventory of greenhouse gases and presenting available data on emission of greenhouse gases in Nigeria, the Kyoto protocol and its economic implications on Nigeria and suggests mitigation measures. Consequent upon the global warming, the paper notes some obvious implications and asserted the need for the minimization of GHGs emissions into the atmosphere, as increases in these gases contribute immensely to both the global warming and the depletion of the ozone layer.

Global Warming and Climate Change

Global warming refers to the increase in the average temperature of the earth's near surface air and oceans in recent decades and its projected continuation (Muhammad & Mohammed, 2008). It is the gradual increase of the temperature of the earth's lower atmosphere as a result of the increase in greenhouse gases since the industrial revolution. The surface temperature of the earth in the last century is clearly warmer than in any other century during the last thousand years. The earth has become warmer by between 0.4 and 0.8^{o}C over the last century, with land areas being warmer than the oceans and with the last two decades being hottest in the last century (IPCC, 1990).
Climate change is a long-standing phenomenon, as the mix of the various gases that make up the earth's atmosphere have changed over long periods of time, so average global temperature have fluctuated. What is alleged to be different about the current spelt of global warming is that it is taken to be caused by human action occurring at an unprecedented rate.

The temperature of the atmosphere near the earth's surface is warmed through a natural process called the greenhouse effect. Visible, short wave light comes from the sun to the earth, passing unimpeded through a blanket of thermal, or greenhouse gases composed largely of water vapour, carbon dioxide, methane, nitrous oxide, and ozone. Infrared radiation reflects off the planet's surface towards space does not easily pass through the thermal blanket. Some of it is trapped and reflected down-ward, keeping the planet at an average temperature suitable to life, about 60^{0}F (16^{0}C) (IPCC, 1990).

Growth in industry, agriculture, and transportation since the Industrial Revolution has produced additional quantities of the natural greenhouse gases plus chlorofluorocarbons and other gases, augmenting the thermal blanket. It is generally accepted that this increase in the quantity of greenhouse gases is trapping more heat and increasing global temperatures, making a process that has been beneficial to life potentially disruptive and harmful. Among factors that may be contributing to global warming are the burning of fossil fuel (which are major sources of carbon dioxide, methane, nitrous oxides, ozone), deforestation, which increases the amount of carbondioxide in the atmosphere; animal production which results to deforestation as well as releases methane gas. Tables 1 and 2 show the domestic and industrial activities and their consequences as causative agents for greenhouse gases.

Table 1: Domestic Activities and their Consequences as Causative agents for Greenhouse Gases

S/No	Activity	Consequences
1	Bush fire for pastures	Agricultural activities considered responsible for increase in carbondioxide levels in our atmosphere include: deforestation and land clearance, biomass burning, tillage and intensive cultivation and drainage of wetlands.
2	Deforestation for grassland establishment, change of land use.	In many countries, especially in the developing countries of the southern hemisphere, systematic burning, grazing and cutting of forest land is carried out in order to provide new land for agricultural and livestock purposes.
3	Deforestation for pasture establishment	In many countries, especially in the developing countries of the southern hemisphere, systematic burning, grazing and cutting of forest land is carried out in order to provide new land for agricultural and livestock purposes.
4	Good grazing management e.g. controlled use of fire	Most human activities impact the environment and the keeping of livestock is no exception.
5	Poor grazing management: Use of fire to maintain pasture.	Agriculture activities considered responsible for increase in carbondioxide levels in our atmosphere include: deforestation and land clearance, biomass burning, tillage and intensive cultivation and drainage of wetlands.
6	Promotion and subsidies on mechanization, motorization replacing Draught Animal Power (DAP).	The principal anthropogenic source of carbondioxide is the combustion of fossil fuel, which accounts for about three-quarters of total anthropogenic emissions of carbon world-wide.

(**Source:** IPCC, 1990)

Table 2: Industrial Activities and their Consequences as Causative agents for increase in Greenhouse Gases Emission

S/N0	Activity	Consequences
1	Increased Greenhouse Gas Emission	Agriculture accounts for about one-fifth of the projected anthropogenic greenhouse effect producing about 50% and 70% respectively, of overall anthropogenic CH_4 and N_2O emission.
2	Increased use of fresh water	The demand for fresh water resources is accelerating, and competition for fresh water is increasingly of concern to planners and policy makers.
3	Loss of biomass through land clearing.	Over the last century, the atmosphere concentration of CO_2 has about doubled. Through photosynthesis, plants incorporate the carbon from CO_2 and produce oxygen.
4	Pollution of the air as a result of handling, transportation and processing the concentrates	Dust occurs during handling (transportation, processing, packing) of fine powdered materials e.g. concentrate ingredients (cassava powder, ground grain) or milk powder.
5	The manure could be used for biogas	Manure contains organic matter, which under anaerobic

	production; the production of renewable energy resources will reduce CO_2 emission.	condition (as in manure storage pits and in lagoons) will be converted into CH_2 and CO_2, Both CH_4, and CO_2 are greenhouse gases.

Source: (IPCC, 1990)

Greenhouse Gases (GHGs) Phenomenon

Greenhouse gases are gases that have the ability or potential to intercept infrared radiation and re-radiate same back to the earth's surface at their wavelength. Greenhouse gases are responsible for maintaining warmth (temperature) on the earth's surface. The greenhouse effect was discovered by Joseph Fourier in 1824 and was first investigated quantitatively by Svente Arrhenius in 1996. It is the process by which absorption and emission of infrared radiation by atmospheric gases warms a planet's atmosphere and surface. Simply stated, greenhouse effect is the process of maintaining surface air temperature by components of the atmosphere through allowing the incoming solar radiation and inhibiting their escape. This is analogous to what happens to glass roof and wall of a greenhouse.

Naturally occurring greenhouse gases have a mean warming effect of about 33^0C (59^0F), without which earth would be uninhabitable (IPCC, 2007). The debate centers on how the strength of the greenhouse effect is changed when human activity increases the atmospheric concentrations of these greenhouse gases (CO_2, methane, SOx, NOx etc.).

The extent of the greenhouse effect is directly related to the concentration of greenhouse gases in the atmosphere. As the concentration increases, the insulating ability of the earth rises. The major greenhouse gases are water vapour, which causes about 36 – 70% of the greenhouse effect (not including clouds); carbondioxide (CO_2), which causes 9 – 26%, methane (CH_4), 4 – 9% and ozone, 3- 7%) (Kiehl and Kelvin,1997). Some other naturally occurring gases contribute very small fractions of the greenhouse effect; one of these, nitrous oxide (N_2O), is increasing in concentration owing to human activity such as agriculture. The atmospheric concentrations of CO_2, and methane have increased by 31% and 49% respectively above pre- industrial level since 1750 (Pearson and Palmer, 2000). These levels are considerably higher than at any time during the last 650,000 years, the period for which reliable data has been extracted from ice cores. From less direct geological evidence, it is believed that this high values of CO_2 were last attained 20 million years ago (Pearson and Palmer, 2000). Fossil fuel burning has produced about three quarters of the increase in CO_2 from human activities over the past 20 years. Most of the rest are due to land use change, in particular deforestation (IPCC, 2001).

As greenhouse gases build up in the atmosphere, they prevent the escape of heat energy (infrared radiation) from the earth's surface into space. This heat is re-radiated to the earth and as such causing further rise in the surface temperatures of the earth. Also, the production, consumption and utilization of chlorofluorocarbons (CFC's) and halons by man are causing a lot of harm on the ozone layer. Table 3, shows the regions already identified by IPCC (1990) to be at risk. Table 4 also summarizes the greenhouse gases and activities that cause their production.

Table 3: Region "at Risk" from climate change

Continent	**Specific Regions**
Africa	Meghreb, West Africa ,Hon of Africa ,Southern Arabia
Asia	Western Arabia
North and Central America	Mexico and Central America
South America	Parts of Eastern Brazil

Source: IPCC Working Groups 2, 1990 (cited in Kates and Chan, 1993).

Table 4: The Greenhouse Gases and activities that cause their production

Greenhouse Gas	**Human Activities**
Carbon dioxide (CO_2)	Released during the burning of fossil fuels (industry, automobiles, etc) wood and wood products and solid waste.

Methane (CH_4)	Emitted during the extraction and production of fossil fuels, the decomposition of organic wastes from herding and farming, and the decomposition of municipal landfills.
Nitrous oxide (NO_2)	Emitted during agricultural and industrial activities as well as during the combustion

(After: Climate Change and the Kyoto Protocol)

Effects of Global Warming

The cumulative and the resultant effect of unchecked emission of greenhouse gases and the continuous depletion of the protective ozone layer cause deleterious changes in global climatic conditions and are characterized by increases in earth's temperature – global warming. An increase in global temperature is expected to cause increase in intensity of extreme weather events, threatening of natural habitats, and change in the amount and pattern of precipitation, general rise in sea level and consequent flooding of coastal land due to melting of polar ice sheet. Other effects of global warming include changes in agricultural yields due to climate change; reduced stream flows, species extensions as ecological niches disappear and increases in the ranges of disease vector. Others include disruption of drinking water supplies dependent on snow melts and more frequent tropical storms etc.

There is also evidence that glaciers are retreating worldwide, that the Artic Sea ice is thinning, and that the incidence of extreme weather events is increasing in some parts of the world owing to global warming (Watson, 2000). Moreso, certainly, the fate of many islands and coastal cities will be undecided. In fact, many islands will be submerged following rising sea levels and incursion of sea waters to the land. People living in and around coastal areas would probably have to relocate, unless projects are put up to hold back the seas from transgressing onshore.

Similarly, our forests which help to filter the air, our wetlands which are good nesting grounds for many biodiversity and our water bodies which are rich in biodiversity would be put at risk. Bush and forest fires may become more frequent and more intense (Watson, 2000).

Many regions will experience prolonged drought, while others will have heavier rainfall. Storms, floods and hurricane would become more severe. Increasing deaths, displacements, and economic losses projected due to extreme weather attributed to global warming may be exacerbated by growing population densities in affected areas, although temperate regions are projected to experience some minor benefits, such as fewer deaths due to cold exposure (IPCC, 2007).

Additional anticipated effects include sea level rise of 110 to 770 millimeters (0.36 – 2.5ft) between 1990 and 2100 (Church, 2001). Others include repercussions to agriculture, possible slowing of the thermoline circulation, reductions in the ozone layer, increased intensity and frequency of hurricanes, lowering of ocean pH, and the spread of diseases such as malaria and dengue fever. Thomas (2004) predicts 18% of a sample of 1,103 animal and plant species would be extinct by 2050.

Kyoto Protocol and its economic impacts/implications on Nigeria

The Kyoto protocol was initiated at a meeting held in Kyoto, Japan under the United Nations Framework Convention on Climate Change (UNFCCC) on December 11, 1997, committing the developed and developing and nations to specified, legally binding reductions in emission of six greenhouse gases-carbon dioxide ($C0_2$), methane (CH_4), Nitrous oxide (N_20), Hydrofluorocarbons (HFCs), Perfluorocarbons (PFCs), Sulphur hexafluoride (SF6).
The Kyoto Protocol has 28 Articles with two annexure. The Protocol relates directly to the issue of climate change and operates within the UNFCCC. The Protocol calls on all programmes to improve "local emission factors", activity data, models, and national atmosphere and guides parties in promoting:

- Energy efficiency and renewable forms of energy
- Protection of sinks and reservoirs
- Sustainable forms of agriculture

- Fiscal policies aimed at reducing the emission of greenhouse gases
- National policies/programs for the transport, energy and agricultural sectors in order to increase the level of emissions
- The development and diffusion of environmentally sound technologies.

All parties are also committed to formulate, publish, and update climate change mitigation and adaptation measures, and to cooperate in promotion and transfer of environment sound technologies and in scientific and technical research on the climate system.

The Protocol covers all the major greenhouse gases and takes into account emission charges resulting from changes in forest and land use patterns. The Protocol sets legally binding limits on industrialized countries to reduce their collective GHGs emissions by at least 5% compared to their 1990 levels by the period 2008-2012. Table 5 shows the reduction in the human-made emissions of Greenhouse Gases required to stabilize concentrations at present levels.

Specifically thirty nine countries were identified and listed in Annex B Kyoto Protocol. Nigeria signed the Kyoto Protocol (Part of the Non-Annex I economies, so it is not committed to take measures). This is not to say that we have complied with the United Nations level of emission of greenhouse gases. The obvious fact is that Nigeria is not yet industrialized to the extent that its industries will produce greenhouse gases to any appreciable level.

Nigeria is the eight largest oil supplier in the world and ninth largest deposits of gas are located in the country. The Nigerian National Economy would be massively affected by a sustainable reduction of fossil energy consumption. Nigeria is practically a monoculture: about 80% of the government income, 90-95% of the export earnings and more than 90% of the foreign exchange revenues evolves from the oil sector.

However, during the last years, the government of Nigeria tried to diversify. Special attention is nowadays paid to gas which emerges in the joint-production of oil. So far, the gas has mainly being flared (75%) simply due to lack of technical facilities to make use of it. Nigeria is flaring more gas than any other country in the world (Escravos Gas Project, 1993). In 1989, 617 billion cubic feet of associated gas was flared off in Nigeria, releasing some 30 millions tons of $C0_2$ (see Table 5) (ESMAP, 1993).

Table 6: Flaring of Natural Gas in major producing countries (% of gross production in 1991)

USA	0.6
Holland	0.0
Britain	4.3
Ex-USSR	1.5
Mexico	5.0
OPEC Countries	
Nigeria	76.0
Libya	21.0
Saudi Arabia	20.0
Iran	19.0
Algeria	4.0
OPEC Total	18.0
World Total	4.8

Source: Escravos Staff Appraisal Report of Production of Associated and Non-Associated gas 1993

Following the Kyoto Protocol is double-edged sword for Nigeria. The probably positive long-term effects on climate change are opposed to the negative short term effects for the economic development. Observing the Kyoto Protocol would reduce the income of OPEC-States, amongst them Nigeria, about 25% until 2010

Unfortunately, Nigeria development plan does not recognize the economic threat caused by the climate change nor the menace of declining oil price which could result from a reduced consumption of fossil fuels. Correspondingly, concepts to deal with these issues have not been dealt with so far. The diversification of the economy, the independence of fossil fuels (in this case independence of selling fuels), revitalization of the stagnant agriculture, industrialization and the development of the hardly existing service sector are some keywords. In a summary of

economic cost associated with climate change, the United Nations Environment Programme (UNEP) emphasizes the risks to insurers, re-insurers, and banks of increasingly traumatic and costly weather events. Other economic sectors likely to face difficulties related to climatic change include agriculture and transport. Developing countries, rather than the developed world, are the greatest economic risk (Dlugolecki, 2002).

Other possible implications is that the Chad- lake, which is the water supplier of more than 10 million people of the riparian state, has already shrunk to one-tent of its original size. (Nigeria is like Niger, Chad and Cameroon – a member of the "Lake Chad Basin Commission", but due to the rapid shrinking of the lake, it might soon lose its status of being an abutting owner).

The Way Forward

The emission of greenhouse gases in Nigeria is generally low based on low per capital energy and other resources consumption in the country. These are expected to rise in the future as a result of the high population growth rate and corresponding increase in per capital energy and other resource consumption. The assessment of options to reduce future greenhouse gases emission is considered an important contribution to the sustainable development of Nigeria. This is being undertaken in respect of the energy, landuse change and forestry sectors which are the contributor of carbon emissions.

It is to be stressed here that economic and environmental well-being are mutually reinforcing goals that must be pursued simultaneously if either one is to be reached. Economic growth will create its own ruin if it continues to undermine the healthy functioning of the earth's natural systems or to exhaust natural resources. It is also true that healthy economic developments are most likely to provide the necessary financial investments in environmental protection. For this reason, one of the principal objectives of environmental policy must be to ensure a decent standard of living for all. The solution, at least in the broad scope, would be for a society to manage its economic growth in such a way as to do no irreparable damage to the environment. This is the whole idea of sustainable development - balancing economic requirements with ecological concerns i.e satisfying the needs of the people without jeopardizing the prospects of future generations. Sustainable development requires choices based on values. Both depend upon information and education, especially regarding the economics of decisions that affect the environment. Considering the consequences of the greenhouse effect, the following remedial measures are suggested:

(1) A local agenda to achieving the International Treaty – United Nations Framework Convention on climate change, with the ultimate objective of preventing dangerous anthropogenic (man-made) interference with our climate system must be developed without delay.
(2) Various state governments through their Ministries of Environment should provide environmental laws/regulations and standards in addition to the National regulatory framework on environment to guide the operations and activities of the industrial sector.
(3) Environmental awareness, sensitization and enlightenment programmes should be organized regularly to pattern our behaviours towards sustainable environmental practices.
(4) The attitudes of the industrial operators and all whose activities impact negatively on the environment must change. This is imperative as the legal framework alone cannot make the change.
(5) Steps must be taken to change current energy use patterns away from fossil fuels. Alternative energy sources like wave energy from the sea and solar should be explored to the fullest.
(6) Aforestation and re-aforestation should be encouraged as this could serve as sinks to volumes of $CO_{,2}$.

Above all, there should be the political will to curb greenhouse gas emissions.this is because the whole issue is politicized.

Conclusion

There is a dire need for minimization/reduction in the greenhouse gas emission. This is very imperative as increase in the emission of these gases have contributed, as the paper noted, to global warming including depletion of the ozone layer.

There is yet no legislation in Nigeria as to the reduction of greenhouse gas emission, though some oil companies operating in the country have stopped the use of appliances using CFCs as a way of checking global warming. The major problem which confronts Nigeria is the status of being a dumping ground for used and refurbished appliances that are daily shipped to the country.

This paper therefore has reviewed and evaluated the climate change and raised a lot of burning issues and asserted the need for the minimization of GHGs emission. The paper has also identified other concerns of environmental indicators and argued that economic growth must be balanced with environmental policy option and finally emphasized that if the mitigation measures identified/suggested are taken seriously, we could have a cleaner environment and bequeathing same to future generations.

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