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Climate Change and Global Warming: Implications for Sub-Saharan Africa

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ABSTRACT

The study reviews the potential threats of climate change in sub-Sahara Africa. It paints a picture of how the major green house gases (GHGs)-CO_2, CH_4 will grow in the sub-continent before the year 2015. The study also highlights the potential causes of climate change in the sub-continent based on anthropogenic and physical factors. It further examined the impacts of climate change in the sub- region based on the sensitivity, vulnerability and adaptations opened to the sub –region. Observation shows that overall social and economic activities in sub-Sahara Africa will be substantially worse than in any other developing world. Consequently, mitigation and adaptation measures were suggested to alleviate the impacts of climate change in the sub-region.

Key words: climate change, vulnerability, sensitivity, adaptations, mitigations, green house gases.

INTRODUCTION

Global Warming – The Basic Scientific Findings

The consequences of the industrialization from age past have changed the concentration of the Green-house-Gases (GHGs) and their effect on global temperature. Boden et al (1990) in their publication titled "TRENDS 90" have observed that global and hemispheric annual variation in temperature show little trend during the first half of 19th century. Although there was marked warming up to 1940, it was relatively steady up to the mid-70s only to be followed by rapid warming during the 1980's.

The same deductions have been corroborated by Hansen and Lebedeff (1988) who found that from 1950 to 1980, global surface air temperature in

the 1980s are warmest in the history of meteorological records and that the four warmest years on records are all in the 1980s – with the warmest year being 1981 and 1987.To find the remote and immediate causes of this serious trend in temperature anomalies, analysis of baseline data on $C0_2$ (carbon dioxide) and NH_4 (Methane) – the two green-house gases which have become the major contributors to global warming are discussed below.

It has been confirmed that present $C0_2$ concentration are about 350ppm, whereas levels in 1850 are estimated to have been approximately 265ppm. Global surface temperature data suggest that the surface temperature has increased by 0.5^{0C} over the past 100 years (Hansen and Lebedeff, 1988). Concentration of $C0_2$ increase from about 316ppm in 1958, when atmospheric levels were first measured at the Mauna Loa (observatory in Hawaii) to about 347ppm in 1986 (Keeling, 1986). Using a straight line interpolation function on these data gives a $C0_2$ concentration rise of absent 1.1ppm/yr. Based on energy consumption patterns from the last 30 years; however, typical projections are between 0.5 to 2 percent annual growth in the world wide consumption of fossil fuels for the next 50 years, which implies that $C0_2$ concentration in the lower atmosphere will increase much more rapidly than the 1.1ppm/yr. Projection from this level of increased energy consumption are that $C0_2$ concentration will double (to about 600ppm) within the next 50 – 60years (Goldenberg et al, 1987).

$C0_2$ Emissions

On short term $C0_2$ emissions which account for fluctuations, (Keeling, 1986) found that the three countries which have the highest emission, producing over worlds emission from the fossil fuel (solid, liquid, gasses, flaring and cement) are USA, Soviet Union (Russia) and China while Spain, in the 20th position, contributed slightly less than 1%. The situation in the West African sub-region will be similar, if not worse (Agboide et al, 1999). Thus, higher surface temperature will persist at least in the short time up to year 2015 – going by the trend in temperature regimes.

Atmospheric CH_4

Methane is recognized as one of the important radioactive trace with significant potential to contribute to climate change. Its major sources are fermentation in ruminant, anaerobic decay of organic matter in rice paddies, wetland and landfills, coal mining, natural gas and oil (exploration and production) and biomass burning.

In West-Africa, all these sources are relevant – especially mining and natural gas and oil exploration and production with Gabon and Nigeria as major 'power house' in petroleum production. Unfortunately, there is no coordinated monitoring network of atmospheric CH_4 in the sub-region. Analysis carried out on weekly basis at Ascension Island at 7 sites globally for 1980 – 1988 shows that CH_4 emission has risen from 1,582ppbv in 1983

to 1602ppbv in 1985 giving a growth rate of about 14ppbv (Khalil and Rasmussen, 1990). Within the last 160,000 years, rapid increase have occurred between 1890 and 1990 as CH_4, jumped from 800 – 900ppbv to about 1700 – 1800ppbv. Evidently, these value point to gas and oil-related industrialization and large-scale mismanagement of agricultural lands, especially biomass burning in the sub-region.

CFCs and Ozone (0_3) Depletion

The chloro-fl uoro-carbons known as CFC gases or halocarbons play dual and damaging role in the atmosphere. They not only slow down the rate of infra-red (IR) radiation back to space at night thus causing surface warming, they also (and more importantly) reduce ozone concentrations in the atmosphere which constitutes a major health hazard to all living things due to higher ultra-violent (UV) Radiation that may penetrate into lower troposphere under declining 0_3 levels. Lozan et al (2000) identified 27 green house gases in the atmosphere. A principal component of these gases is $C0_2$, which contributes approximately 49% of the 3.3^0C increase in warming.

Climate Change: An Overview

Climate change refers to any change in climate over time, whether due to natural variability or as a result of human activity. The United Nations Framework Convention on Climate Change (UNFECC) defines climate change as: a change of climate which is attributable 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 a comparable time periods (IPCC, 2001a: 74).

Climate systems evolve constantly through natural climatic variability and climate change. The earth's climate has remained relatively stable (global temperature changes of less than 1^0C over a century) during the last 10,000 years (IPCC, 1996).

Since the industrial age began around 1750, atmospheric concentrations of greenhouse gases (GHGs): carbon dioxide ($C0_2$ – the major contributor to global warming), methane (CH_4), and Nitrous Oxide (N_20); and aerosols have increased steadily. Billions of tons of these GHGs are released into the atmosphere every year and their concentrations have steadily increased in recent past.

These rapid increases in the condition of these gases in the atmosphere due mainly to human activity, particularly the burning of fossil fuel and deforestation, have been affecting the surface climate of the earth. This alteration is achieved through altering the radiation balance of the earth, warming the surface and affecting atmospheric circulation. It is this global warming of climate, the enhanced greenhouse effect that has become the subject of concern at global, national and local level (Carter et al, 1994:1).

Climate Change: Causes and Features

The major causes of climate change are both anthropogenic and physical/natural. The anthropogenic causes are:

- Changes in the concentration of the natural component gases in the atmosphere,
- Changes in the water vapour content of the troposphere and the stratosphere,
- Alterations in surface characteristics of the lands and oceans.
- Introduction of finely divided solid substances into the lower atmosphere along with gases not normally found in substantial amounts in the unpolluted atmosphere (Strahler and Strahler, 1977).

The natural causes are increases in the volume of gases, moisture and particulates in the lower atmosphere, by volcanic eruptions, ocean turbulence, desert winds etc. These forces combine with anthropogenic forces to create green house conditions. A serious natural factor is the alteration in the intensity of solar radiation itself in the form of sunspots – representing the most well known expression of solar activity (Lozan, Hupter and Global, 2000).

The climate change argument is not one directional. There are evidences of a drop of 1% in temperature over the years in some places. The stronger argument, however, is that there is a continuous net temperature rise. Lozan et al (2000), observed an average increase of between 0.4^0C and 0.7^0C since 1850 except for 15months of the period. Mendelsohn and Dinar (1999) noted that by the year 1999, the 1^0C rise in temperature projected for the year 2000, had been exceeded in 1999 to a record of 3.5^0C.

Sensitivity, Vulnerability and Adaptation to Climate Change

Climate change from human activities represents an important additional stress to existing stresses and pressures on systems and sectors. For example, in sub-Saharan Africa, the convergence of existing stress and climate change render the regions ecological and socio-economic system highly sensitive to even modest changes in climate. Low investment in agriculture is the major reason why African agriculture is extremely sensitive to climate fluctuations (IPCC, 1998: 57).

Sensitivity includes the potential for substantial harmful effects, and one to which the ability to adapt is constrained, especially by poverty. For example, the implication is that the sub-Saharan Africa with low levels of investment in agriculture, infrastructure and directly productive capital goods, and continued reliance on nature (natural resources), is incapable of moderating the effect of climate change. By extension, the region is also

incapable of taking advantage of opportunity created due to a given changes in climate.

Vulnerability refers to the extent to which climate change may harm or damage a system. The extent of vulnerability depends not only on a system's sensitivity, but also on its ability to adapt to new conditions. The level of vulnerability of human populations and natural systems (ecosystems, hydrology and water resources and food production), and sectors (industry, energy, transportation, health) in sub-Sahara Africa is the highest of all the regions in the world.

Finally, the issue of adaptation to climate change. By adaptation is meant the degree to which adjustments are possible in practices, or structures of systems to projected or actual changes of climate (IPCC, 1998: 496). A high sensitivity and high vulnerability sector means a dismally weak adaptive capacity.

Vulnerability of Impacts of Climate Change

So far, Global Climate Models (GCMs) have projected three generalized impact of effect of climate change arising from global warming which are of immediate relevance to Africa in general and Nigeria in particular (IPCC, 1999). These are summarized as follows:

i. Desert are likely to become extreme-becoming hotter but not significantly wetter. The Sahara desert which borders West African to the north has been noted to be making almost persistent "incursion" into the Sahel (Lat. 14-20^{0}N) resulting in drier conditions during the summer monsoon.

ii. Global hydrology cycle will be intensified with changes in precipitation, its total amount, frequency and intensity. In relation to these expectations, global concern has been expressed on water scarcity since UNCED – 92. In West Africa, the literature is full of various attempts made within the past twenty-five years to explain such phenomena as the SAHELIAN DROUGHT OF 1969 – 73 without any concrete indications on future reoccurrence.

iii. Agricultural Production (including forestry) will increase in some areas and decrease in others taking into account the beneficial effects of $C0_2$ concentrations.

Table 1 shows the declined state of major economic and social indicators for sub-Sahara Africa since 1970s. Productivity fell, population rates increased and output and incomes declined. The overall social and economic situation in sub-Sahara is substantially worse than in the other developing world (DFID, 2000).

One of the major consequences of existing pressures of climate change is the state of extreme poverty, which has given global poverty a distinctive African Character. Africa, for example, is the only one of the world's continents that has grown poorer in 40 years. Also, the continent is home to

35 of the world's 48 poorest nations. Worse still, the member of chronically under-nourished people in sub-Sahara African region has more than doubled between 1970 and 1990. Warfare, recurrent droughts, and many other factors have led to repeated food shortages since 1900s including famines in the Sahel and the Horn of African in the 1970s (Rosenzweig, 1994, Koket and Heij, 1998). At least 13 African countries including Somalia, Ethiopia, Sudan, Sierra Leone, Zimbabwe and Liberia, have food shortages requiring international intervention (Downing, 1992; Parry et al, 1990; Rosenberg, 1992). For this reason, Africa receives the largest amount of food aid of any continent (IPCC, 1998: 52).

Table 1: Indicators of Performance: Sub-Saharan Africa.

	Measure	Sub-Saharan Africa (excluding South Africa)
Population growth 1997	%	2.9
GNP per capita 1997 Atlas	$	315
Gini Index (Simple average for latest year available)	Index	45.9
GDP per capita		
1970	87$	525
1997	87$	336
Gross Domestic Investment per capita		
1970	87$	80
1997	87$	73
Output per Worker		
1960 – 1973	Ratio	1.9
1973 – 1994	Ratio	-0.6
Total Factor Productivity		
1960 – 1973	Ratio	0.3
1973 – 1994	Ratio	-1.3
Human Development Index 1995 (Simple average)	Highest = 100	39.8
Access to Safe Water		
1996	% of Pop	45
Land area per capita		
1970	ha	8.03
1997	ha	3.89

Source: DFID 2000.

Another set of existing pressures revolves around land degradation in all its forms: soil erosion, loss of soil organic matter and decline in nutrient levels. Allied to them are existing pressures arising from recurrent drought and desertification, degradation of water resources and high disease burden.

The alteration of the spatial and temporal patterns in temperature, rainfall, (reductions in annual rainfall, run-off and soil moisture) solar radiation and winds as a result of climate change will exacerbate desertification. Furthermore, increasing temperature and changing precipitation patterns will affect soil micro-organisms, processes and properties with important implications for agriculture and land-use (Parry et al, 1990). Change in seasonal and regional precipitation in conjunction with more frequent and intense rainfall system, and increased soil erosion that is expected due to more intense rainfall system have been identified as the main detriment impact of climate change across the region.

In the area of water resources, the combination of continual population increases and global warming impacts is likely to accentuate water scarcity in sub-humid regions of sub-Saharan Africa. Equally increase in drought, floods and other extreme climatic disturbances will add to stresses on water resources, food security, human health and infrastructure and will constrain sustainable development in the region.

ADAPTATION

Planning with Weather and Climate Data

The science of weather prediction and now climate prediction – is rapidly advancing. The improvement in weather forecast achieved over the last decade has saved millions of lives through warming of tropical cyclones, floods and other severe weather events. Weather and climate forecast and the use of historical climate data for planning have been a major boost to the efficiency of food production.

Considerable progress towards longer-range prediction is likely over the next few years, as a result of work being carried out under WMO programmes, for example, the world climate programme. New service based on medium-term or seasonal predictions are likely to become established during the next decade.

Seasonal forecasting clearly has huge potential to mitigate the impacts of weather-related disasters, knowledge of general weather patterns a few months in advance can be used in all stages of handling disasters: awareness and education, preparedness and prevention, and disaster detection and prediction. It may also become possible in the future to forecast weather-related outbreaks of certain vector-borne diseases. Climate forecasts could therefore be used to prepare health facilities and to stockpile vaccines, pesticide and other control fools.

Biometeorology and Bioclimatology

In developing countries, especially in the sub-Saharan Africa, the potential for meteorological and climatological forecast to mitigate health service is not yet fully appreciated. This is unfortunate!

Currently, meteorological services in many developed countries include the provision, usually in co-operation with public health authority of regular measurements of pollen count, dust, comfort indices, bioclimatic maps, UV and sunburn forecasts.

For example, the vector responsible for epidemics of dengue (or "break-borne fever") is the *Aedes aegypti* species of mosquito. The current range of this mosquito is by cold weather, which kills both larvae and adults. In Australia, its distribution is limited to areas with a mean mid-winter temperature exceeding $10^{o}C$. In the United State of America, its current northern limit is $35^{0}N$ latitude, corresponding to the $10^{0}C$ winter isotherm.

Building Design and Urban Planning

One of the greatest specialties of human being is the ability to modify the surrounding environment. It is best expressed in the technological mastery of clothing and architecture. It has allowed humans to expand their range far beyond the tropics, into the desert, the polar region and even to the moons. For cold regions, a high standard of insulation is of great important so that reasonable comfort inside is economically attainable. In warm, humid climates, the need is primarily for shading from the sun (e.g. by trees), coupled with ample ventilation, preferably for free air movement.

In extremely hot, dry, climates, shading from the sun is required, by trees if feasible (or by other means) if not, construction materials should be insulating to protect the interior from hot outside air during the day. With such measure the daily range of temperature indoors can be much lower than that prevailing outside.

Bioclimatic mapping can help architects to plan optional building design. In addition, daily weather forecasting can help achieve indoor comfort with minimum energy consumption at all time. Seasonal climate monitoring and predictions can help plan for the storage and distribution of heating energy source in cold climates. A carefully designed building may change its responses to seasonal changes in energy flow. Energy efficiency is an important way to reduce fuel consumption and, therefore, reduce future climatic changes.

MITIGATION

Extreme Weather Events and Disaster Mitigation

Extreme weather and climate events and their impacts often appear as if they are beyond our control. However, there is much that can be done to mitigate their impacts. Extreme events need not lead to a disaster. A disaster only occur if emergency measure taken by a community fail to reduce the significant losses so that the population is unable to return to normality without substantial extreme assistance.

The early sharing of information about threatening weather patterns has saved many lives and livelihoods. Members of WHO routinely exchange meteorological observations under the World Weather Watch (WWW) and use the shared global information to provide national warming on weather-related disasters. The success of the world weather watch was illustrated by the cyclone in Bangladesh in May 1994. About 200 people were killed compared with over 130,000 deaths in a similar cyclone in 1991.

This was achieved principally through improvements in warming system and evacuation. During the last few years the accuracy and timeliness of warning of severe weather have improved as a result of a far better

understanding of how severe weather forms and far better methods for monitoring and forecasting the details of weather systems. Warning of severe weather can also be used by the National health services of the country concerned as they prepare to deal with the potential health hazards caused by natural disasters.

Heat "Health-Watch" Warning Systems

A global climate change will increase the frequency of hot summers, chilled winters and heat waves. Heat stress is an important issue facing both developed and developing countries due to the increased number of persons living in urban environments. In recent years, heat waves in cities in USA and India, among other countries, have had major impacts on their populations.

However, there is much that can be done to mitigate the health impact of hot weather. Heat health watch warming system can alert people to impending dangerous weather. Such systems can operate along side public health education campaigns to promote behaviour to reduce heat stress. Public health agencies also use the system to guide their implementation of mitigation procedures during very hot weather. Such bio-meteorological forecasting for hot weather is practiced in several countries, in Germany, a service tailored to the need of the medical profession and the general public has been in operation for sometime. In the eastern USA, the national weather service issue excessive heat warnings based on a daytime heat index.

CONCLUSION

The evolution of global climate-related problems has graduated from the level of climate change to the current status of climate crisis. The effects of the prevailing climate crisis are expected to be the greatest in sub-Saharan Africa, which has the larger share of its economics in climate sensitive sector. African countries on their own do not have sufficient resources to respond to climate change impacts.

There is the need for wealthy high income countries of the North which contribute a disproportionate amount of GHGs, and are therefore responsible for the current climate change crisis to show political will and commitment to address the problem. Also, International Agencies have an important role to play in generating global political commitment, and support effective coordinated action for countries in sub-Saharan Africa to effectively address problems arising from climate change. Above all, governments in the region must strive to understand the implications of climate change for their people. Inclusion of climate risks in the design and implementation of development initiations should underpin adaptation measures that need to be considered as a matter of urgency to enable nations cope with impacts of climate change that are already in the system.

REFERENCES

Agboide, T., Adefolalu, D.O. and Olaleye, J.O. (1999): "Flaring of Associated Gas in Oil Industry" FUTA Project, p. 26.

Boden, T.A., Kancimk, P. and Farell, M.P. (1990): "TREND 90" – A Compendium of Data on Global Change. ORNLCDIAC-36, 257.

Burton, I. (1989): Human Dimensions of Global Climate Change: Towards a Research Agenda. In Peezey, J. Sustainable Development Concepts: An Economic Analysis. World Bank, Washington, D.C: 159 – 165.

Carter, T.R., Parry, M.L., Harasawa, H. and Nishioka, S. (1994): IPCC, Technical Report for Assessing Climate Change Impacts and Adaptations. Department of Geography, University College London, UK; and Centre for Global Environment Research, National Institute for Environmental Studies, Japan.

DFID (2000): Can Africa have Poverty by 2015? Myths and Reality. DFID, London, July.

Downing, T.E. (1992): Climate Change and Vulnerable Places: Global Food Security and Country Studies in Zimbabwe, Kenya, Senegal and Chile. Research Report No. 1 Environmental Change Unit, University of Oxford, p. 54.

Hansen, J. and Lebedeff, S. (1988): Global Trends of Measured Surface Air Temperature. Update through 1987. Geoph Res. Vol. 15 pp. 323 – 326.

IPCC, (1996): Climate Change 1995: The Science of Climate Change. Cambridge University Press Cambridge.

IPCC (1999): Climate Change Impacts, Adaptations and Mitigation of Climate Change: Scientific – Technical Analysis. Cambridge University Press.

IPCC, (2001a): IPCC Third Assessment Report Cambridge University Press, Cambridge.

Keeling, C.D. (1986): A 3-dimensional Model of Atoms. CO Transport based on Observed Winds. Geoph Manu. 55 pp 165 – 235.

Khatil, M.A.K. and Rasmassen, R.A. (1990): Atmospheric Methan: Recent Global Trends. Environ Sci and Tech, 24: 549 – 553.

Lozan, J.L., Hupder, P. and Grabl, H. (2000): Climate of the 21st Century. University of Hamburg, Hamburg.

Mendelsohn, R. and Dinar Arial (1999): "Climate Change, Agriculture and Developing Nations", World Bank Research Observer. 14(2). International Bank for Reconstruction and Development, Washington D.C. pp. 277 – 293.

Parry, M.L., Carter, T.R. and Konijn, N.T. (1990): The Impact of Climate Change Variations on Agriculture, Volume 2, Assessments in Semi-Arid Regions, Kluwer, Dordrecht, The Netherlands, pp. 121 – 270.

Rosenberg, N.I. (1992): Adaptation of Agriculture to Climate Change. Climate Change, 21: 385 – 405.

Rosenzweig, C. and Parry, M.L. (1994): Potential Impact of Climate on World Food Supply, Nature, (367): 133 – 138.

Strahler, A.N and Strahler, A.H. (1977): Geography and Man's Environment. John Wiley and Sons, New York.