CHALLENGES OF CLIMATE CHANGE ON AGRICULTURAL PRODUCTIVITY IN SUB-SAHARAN AFRICA

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ABSTRACT

The effects of climate change continue to ravage globe upsetting or even overturning the entire communities in its wake. It is therefore on the front burner of most global issues affecting the world today. Hardly any field of endeavor has escaped the manifestation of its effects. The effects of climate change on agricultural productivity calls for intense study because of the nexus between agriculture, global food security and provision of employment for the teaming population in sub-saharan Africa. This paper examines current challenges of climate change on agricultural productivity in this region. This challenge indicated that both long and short term change in climate bring unpleasant repercussion on agricultural productivity as they manifest in vulnerability of industrial work force. The paper also focused on the impact of agriculture and bio-environmental engineering as a separate entity that will help to fight these major challenges facing humanity currently associated with negative effects of climate change such as scarcity of water, declining agricultural yields, desert encroachment and damage of coastal structures. Finally, a suggestion was put forward as an effort that should be directed towards mitigating the negative effects of climate change on our environment.

INTRODUCTION

Climate, in a narrow sense is usually defined as the average weather condition of a place over a long period of time (30 years according to WMO). Climatic is never static. It varies from one climatic normal period to another. Climatic change occurs when climatic variation or fluctuation brings a shift or change in the type of climatic prevailing in an area. A change in climate usually takes place over a long period of time of at least 150 years with clear and permanent impact on the ecosystem.

Climate change therefore refers to a statistically significant variation in either mean state of the climate or in its variability, persisting for an extended period (typically decades or longer). Climatic change involves a shift of climatic condition to a new equilibrium position with values of climatic elements changing significantly.

The Inter-governmental Panel on Climate Change (IPCC) defines climate change as any change in climate over time, whether due to natural variability or as a result of human activity. This implies that there are both natural and human factors causing climate change. The natural factors include terrestrial causes such as the alternation in the orientation of the earth, extra-terrestrial causes, such as the solar activities etc. The human causes include the emissions of greenhouse gases and aerosols, changes in land use and the depletion of the ozone layer through various human ‘activities such as industrialization, urbanization, and agriculture and land clearance amongst others. The outcome of these human induced changes is global warming which is the most visible symptom of global climate change.

Simply put, global warming refers to increase in the average temperature of the atmosphere, oceans and land masses of the earth. Over the last century there is evidence that the average global temperature (which is about 15^0C) has increased by 0.5^0C - 0.7^0C and scientists have predicted further warming of 1.4 to 5.8^0C by the year 2100 (Adebayo, 2011).

Climate change is one of the most serious environmental threats facing mankind today. It affects agriculture in several ways, including its direct impact on food production. Climate change which is attributable to the natural climate cycle and human activities, has adversely affected agricultural productivity in sub-Saharan Africa particularly the northern part of Nigeria (Ziervogel et al. 2006). Although, it is a global issue, but the most adverse effects are felt mainly by the developing countries, especially those in sub-Saharan Africa due to their low levels of agricultural productivity (Nwafor, 2007 and Jagtap, 2007). The purpose of this paper is to:

1. Understand the major causes of Climate change

2. Discuss the effects of climate change on the environment

3. Discuss impact of climate change on agricultural productivity in sub-Saharan Africa

4. Discuss the role of agricultural engineering in climate change mitigation and adaptation

5. Recommends for effective policy implementations

CAUSES OF CLIMATE CHANGE

The chief cause of global warming is the concentration of greenhouse gases (GHGs) in the atmosphere. Greenhouse gases include carbon dioxide, chlorofluro carbon (CFC), Methane, Nitrous Oxide etc. The contributions of these gases to global warming are as follows:

(i) Carbon dioxide - 55%
(ii) Chlorofluro carbon (CFC) - 24%

(iii) Methane -15%

(iv) Nitrous Oxide - 6%

Greenhouse Effect

The prospective climate change is global warming (with associated changes in hydrological regimes and other climatic variables) induced by the increasing concentration of radioactively greenhouse gases (IPCC, 1990a, 1992).The energy that comes from the sun to the earth is referred to as short wave radiation. When this energy reaches the earth surface, it changes from light to heat and warms the earth. The earth surface in turn releases some of the heat back into the space in form of long wave radiation. Much of the long wave radiation escapes back to the space while a portion is trapped and warms the earth. The high concentration of GHGs in the atmosphere acts as a blanket which prevents the escape of the long wave radiation into the space. Consequently the proportion of long wave radiation bouncing back to the earth surface is increasing and hence the earth is becoming warmer.

Sources of Greenhouse Gasses

Though the greenhouses are produced by both natural and human activities, human activities tend to aggravate the concentration of those gases in the atmosphere. We shall consider the sources of the major greenhouse gases.

Carbon dioxide

The level of carbon dioxide in the earth's atmosphere has been on the increase since the industrial revolution (Ayoade, 2003). At the beginning of Industrial revolution, Co_2 concentration was about 280 ppm, and this level was constant for about 700 years. However at around 1860, the concentration of Co_2 has grown exponentially. Currently, the rate of growth of Co_2 in the atmosphere is about 0.5% per year. If it continues at this rate it will double in 140 years! Today, the level of Co_2 in the atmosphere is approaching 400 ppm and it is predicted that this may rise to 450 ppm by year 2050 (Botkin and Keller 1997).

Carbon dioxide is a major source of emissions into the atmosphere includes cement manufacturing, burning of fossil fuels (through the use of automobiles, generators, firewood and bush burning) and deforestation. Deforestation contributes to carbon dioxide concentration in two ways. When the trees are burnt down as fuel wood they emit CO_2 into the atmosphere. Secondly, when trees are removed from the forests, less photosynthesis take place and more Co_2 is left in the atmosphere.

Methane

Methane is the main component of natural gas. It can be formed in marshy areas where organic matter is decomposing. Natural sources of methane include wet lands, termites and the oceans. Anthropogenic sources of methane include coal mining activities, petroleum industry, rice paddies, ruminant animal wastes, domestic sewage treatment plants etc.

CFCs gases

These are man-made chemicals. They are used as coolants in refrigerator, and air conditioners, expellant in aerosol spray cans etc. CFCs gases are not just greenhouse gases they are also ozone layer depleting substances (ODS).

Nitrous Oxide

The nitrous oxide is produced naturally by process of nitrification in oceans and soils. The major human sources of nitrous oxide are chemical industries, denitrification of fertilizer to be used on the farms and use of fossil fuels.

EFFECTS OF CLIMATE CHANGE ON THE ENVIRONMENT

Weather Condition

It will lead to increase in temperature and melting of ice and glaciers in northern hemisphere. Our research finding confirmed the increase in temperature in Yola in the last 25 years as shown in figure 1 (Adebayo, 20l0).The warmed world will be generally more humid as result of water evaporating from the oceans. More, water evaporating in the atmosphere will produce more clouds.

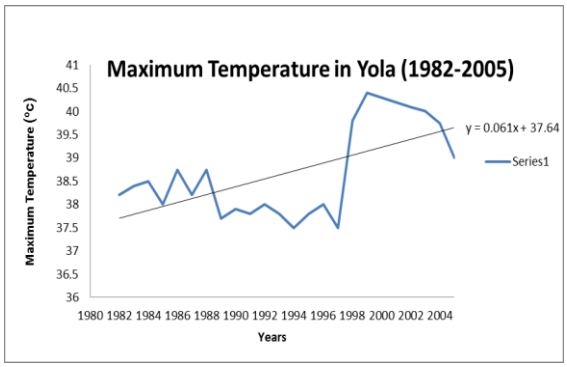


Figure 1: Maximum Temperature in Yola (1982-2005)

Source: Adebayo (2010)

Greater humidity will increase rainfall; Storms are expected to be more frequent and more intense**.** This will lead to flash floods as it is being experienced in many parts of the world today, including Nigeria (Table 1). Hurricanes, which gain their force from the evaporation of water, are likely to be more severe. However water will also evaporate more rapidly from, soil causing it to dry out faster between rains. Some region might actually become drier than before.

On Sea Level

Apart from warming and expanding the volume of ocean water Global warming will also melt much glacier Ice, especially around Green land and further swell the ocean. Sea level rise will affect life in many coastal regions. Storm surge, coastal erosion and flooding will increase as the case in Lagos and other Nigerian coastal cities.

Table 1: Flood Episodes in Nigeria (August/September, 2007)

S/NO	FLOOD EPISODE	LOCATION	SOURCE
1.	Flood Destroys 1000 houses in Borno and rendered Maiduguri-Damaturu highway impassable for 2 days.	Maiduguri-Damaturu Road	The Sun August 27, 2007
2	Flood washed away 50% of farmland and destroyed houses	Gombe State	The Sun August 27, 2007
3.	Flood Kills 6, destroy 400 houses	Adamawa State	The Sun August 27, 2007
4.	Flood rendered village homeless in Maino Village near Maiduguri	Maiduguri, Brono State	NTA News 3rd September, 2007
5.	Flood destroyed Railway line and cut off the West-North route	Wushishi LGA Niger State	NTA News 3rd September, 2007
6.	Rain causes pain in Yobe, River Katako over flown and submerged surrounding settlements. 500 families lost their homes at Ngazeleme, along Potiskum Damaturu Road	Damaturu, Yobe State	The Sun 8th September, 2007
7.	Flood sacks over 1000 houses in Kebbi	Dakin Gara Zuru Local Government Area, Yobe State	The Sun, 8th September, 2007

Source: Adebayo, 2007

On Agriculture

Climate change and agriculture are interrelated processes, both of which take place on a global scale. Global warming is projected to have significant impacts on conditions affecting agriculture, including temperature, precipitation and glacial run-off. These conditions determine the carrying capacity of the biosphere to produce enough food for the human population and domesticated animals. Rising carbon dioxide levels would also have effects, both detrimental and beneficial, on crop yields. The overall effect of climate change on agriculture will depend on the balance of these effects. Assessment of the effects of global climate changes on agriculture might help to properly anticipate and adapt farming to maximize agricultural production.

At the same time, agriculture has been shown to produce significant effects on climate change, primarily through the production and release of greenhouse gases such as carbon dioxide, methane, and nitrous oxide, but also by altering the Earth's land cover, which can change its ability to absorb or reflect heat and light, thus contributing to global warming. Land use change such as deforestation and desertification, together with use of fossil fuels, are the major anthropogenic sources of carbon dioxide; agriculture itself is the major contributor to increasing methane and nitrous oxide concentrations in earth's atmosphere

In Sub-Sahara Africa, less rain and higher temperature will shorten the growing season and reduce crop yields. As reported by Adebayo (1998) the incidence of dry spell in July and August is increasing in Yola for the past two decades. Likewise there has been persistence of late onset and early cessation of rains in northern Nigeria in the last three decades (Sawa and Adabayo, 2010).

Natural Disasters

Floods, hurricane, heats waves are fall out of global warming and they are claiming many lives in different parts of the world. Drought stricken areas of the world has doubled between 1970 and early 2005.

CLIMATE CHANGE IMPACTS ON AGRICULTURAL PRODUCTIVITY IN SUB-SAHARAN AFRICA

Directly or indirectly, climate change exerts tremendous impacts on agriculture particularly in sub-Saharan Africa. Climate change stresses pose additional burdens on agricultural production and other subsistence activities like water collection, which may burden families enough not to concentrate on their farming activities. Livelihood activities must become more resilient to future climate for agricultural productivity goals to be met.

Climate change also threatens to destroy infrastructure (e.g. storage structures and residential houses) and

increase the cost of maintenance as well as disrupting farming activities. Climate change increases the displacement and migration of families thus disrupting and limiting agricultural opportunities.

Climate change will worsen health primarily through: increased vulnerability to poor health due to reduced food security and water security; water-borne diseases associated with reduced water quality due to floods and drought; more favorable conditions for the spread of vector-borne and air-borne diseases; and the direct link between temperatures and heat stress.

Climate change threatens to exacerbate current challenges to the achievement of the Agricultural programs. Funding for development and adaptation must be greatly increased to meet the needs of the farmers.

THE ROLE OF AGRICULTURAL ENGINEERING IN CLIMATE CHANGE MITIGATION AND ADAPTATION

Agricultural engineering is a major catalyst for agricultural development. Given the scale of problems and challenges associated with climate change on agricultural productivity, engineering intervention becomes inevitable, failure to do so will lead to desertification and an overall reduction in potential global agricultural productivity. Agricultural engineering can offer sustainable increase in agricultural productivity under climate change. This can be achieved through application of the following strategies;

1. Practices such as reduce tillage in combination with crop residue retention can buffer crops against severe climate events
2. Diversification of cropping systems will help to control soil borne diseases.
3. Reduce emission of GHGs through greater precision in application of N and water as well as reduced use of fossil fuel.
4. Promotion of renewable energy programs such as use of solar energy, wind energy, macro and micro hydro plant, biogas etc.
5. Land leveling to increase water use efficiency.
6. Identification of low water requiring varieties of crops.
7. Use of GIS with sophisticated statistical and modeling tools is very essential in predicting climate change.

CONCLUSION AND RECOMMENDATIONS

There is no doubt that climate change is one of the greatest environmental issues of our time its impact is felt in all facets of life including agricultural sectors. Combating climate change is an urgent priority in achieving sustainable development. However, sustainable development is impossible without food production for teaming population particularly to the developing countries. Therefore; agricultural engineering has a critical role to play in climate change mitigation and sustainable development.

One major task for agricultural science teachers and extension workers is the incorporation of climate change issues into subject curricula and extension services. This can be introduced into existing subjects by creating and infusing some elements of climate change education into the existing subjects like: Agricultural Science. In addition, teachers should encourage the establishment of climate change clubs in schools.

On their part, government and agricultural development programs (ADP) should promote the training and retraining of teachers and extension workers in this new area of Science of Climate Change. They should also make resources available for teaching Climate change science. In particular, establishing weather stations in every school and ADP's cell for data acquisition and regular monitoring of the climate should be given a priority.

Thank you all for listening.

References

[1] Adebayo, A.A (1998). The incidence of dry spells during the growing season in Yola. In I.E. Ukpong (ed) Geography and the Nigerian environment. Nigerian Geographical Association. Pp 258-264.

[2] Adebayo, A.A. (2007) Global warming and its impact on the environment. Paper presented at the symposium on global warming organized by Adamawa state Polytechnic, Yola, September, 13, 2007.

[3] Adebayo, A.A. (2010) Climate: Resource and Resistance to Agriculture. Eight Inaugural Lecture of Federal University of Technology, Yola. May 9th, 2010

[4] Adebayo, A.A. (2011) Temperature variability and outbreak of measles and rneningitis in Yola, Nigeria. Global Journal of Pure and Applied sciences. Vol 7, No 1, pp 133-135.

[5] Ayoade, 'J.O. (2003) Climate Change. Vantage publishers, lbadan. l28pp

[6] Botkin, D.B and Keller, E.A.(l997) Environmental Science. John Willey &Sons, New York.

[7] Jagtap, S. (2007) Managing vulnerability to extreme weather and climate events: Implications for

agriculture and food security in Africa. *Proceedings of the International Conference on climate Change and Economic Sustainability held at Nnamdi Azikiwe University, Enugu, Nigeria*. 12-14 June, 2007.

[8] Nwafor, J.C. (2007) Global Climate Change: The driver of multiple causes of flood intensity in Sub-saharan Africa. *Proceedings of the International Conference on climate Change and Economic Sustainability held at Nnamdi Azikiwe University, Enugu, Nigeria*. 12-14 June, 2007.

[9] Sawa B.A. and Adebayo A.A. (2010) Spatial and temporal variation in the onset, cessation and length of rainy season in the Sudano-Sahelian region of northern Nigeria. Paper Presented at the 2010 held at University of Lagos.NUPRS/NAHS conference.

[10] Ziervogel G., A Nyong, B. Osman, C. Conde, S. Cortes, and T. Dowing (2006). Climate variability and changes: implications for household food security. Assesments of impacts and Adaptations to Climate Change (AIACC) working paper No. 20, January 2006. The AIACC Project Office, International START Secretariate, Washington DC, USA.

[11] http://www.unesco.ora/new/en/education

[12] http ://www.cmseducation.or~/role/goal

[13] www.eyagov/climatechangelwycd/school