GREEN HOUSE EFFECT AND GLOBAL CLIMATE CHANGE: THE AFRICAN PERSPECTIVE.

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ABSTRACT
Green House Effect naturally make the global climate to warm enough for life sustenance on earth. However, the 'enhanced Green House Effect' caused by several human activities across the globe is increasingly warming up the global climate beyond pre-industrial period (1850-1900). Green House gases mainly CO2 emitted by human activities trapped ultra violet rays emitted by the earth there by increasing the average surface temperature. This paper endeavored to ascertain whether Africa as a continent is warming. Africa role in the emission of Green House gases were x-rayed; the factors influencing increase in GHGs's emissions in Africa; Observed impacts and possible impacts of reaching the 1.50 C global warming mark in Africa; and measures to be taken by African Nations to ensure that the Continent is cleaned-up of GHGs for sustainable economic growth and environmental sustainability. carbon pollution pricing and replacement of fossil energy source with electricity power vehicles and home appliances were recommended among others as measures to clean up the continent of GHGs.

Keywords: *climate change, enhanced greenhouse effect, greenhouse gas, global warming.*

INTRODUCTION

Definition of GHG Effect and understanding

Increasing global warming resulting from Green House Effect can be aptly termed as the biggest environmental challenge threatening the planet earth's ability to continue to sustain life. Global warming has presented a plethora of environmental challenges that increasingly undermines the planet's life sustainability. Global warming is a threat to all living things on the planet, both plants and animal, the small and the large, as well as the primitive and the advanced. Our globe is warming; the average temperature is increasing unsustainably. Naturally, a moderate global warming is needed for the planet to be able to sustain all sorts of lives. Earth's temperature is a result of the equilibrium between the solar energy absorbed by the Earth and the long wave (infra-red) radiation from the Earth escaping into space (Jain, 1993). There are naturally existing gases in the atmosphere called the Green House Gases (GHGs) – carbon dioxide, methane, nitrous oxide and chlorofluorocarbons - which help conserve the heat energy that escaping from the earth by trapping the infra-red radiation from the earth. This enable the earth's atmosphere to be adequately warm enough in varying degrees according to regions and season to sustain various kinds of life. This results in a warming of the Earth by about 30^0C and makes it habitable.

While the existence of the natural greenhouse effect due to the presence of some of the trace gases has played an important role in keeping the climate of the Earth habitable, it is the increase in this effect-- 'enhanced greenhouse effect' resulting from the release of the greenhouse gases in the atmosphere due to increased human activities that is causing the present concern. Industrialization and host of several human activities in modern times has produced several GHGs in the atmosphere which means more trapping of the infra-red radiation. This has led to heating up of the earth beyond the natural habitable level. The sixth IPCC Report stated that "Humaninduced warming reached approximately 1°C (likely) between 0.8°C and 1.2°C) above pre-industrial levels in 2017, increasing at 0.2°C (likely between 0.1°C and 0.3°C) per decade'' (IPCC, 2022b). And this conclusion was rated by the report as high confidence due to the high level of certainty. The 'enhanced greenhouse effect' has the potential to cause unprecedented global warming and climate change on the Earth leading to wide- spread destruction, catastrophe and changes on our planet. It is worthy to note that Carbon dixoide alone contributes roughly two-thirds to the "enhanced greenhouse effect' which can be attributed to the heavy dependence on fossil fuel energy supply.

The purpose of paper is to x-ray the current global warming indicators in Africa, the connection between GHGs and the climate change, the sources of carbon foot prints in Africa and Measures to clean up Africa for sustainable GHGs emissions. Balancing the energy need for socio-economic development in Africa which is a dire and the need to clean up the continent to a sustainable level of GHGs is a dilemma which adequate insights need to be provided to policy makers before the desired outcome can be achieved. The target audience of this paper presentation is for policy makers at the various levels of governance in Africa and stakeholders in various organizations profit and non-profit. Cleaning up Africa to a sustainable level of GHGs at the atmosphere consistently is the collective responsibility of all, governmental and non-governmental, small and big enterprises.

Is Africa really warming?

Human activities are estimated to have caused approximately 1.0°C of global warming5 above pre-industrial levels, with a likely range of 0.8°C to 1.2°C (IPCC, 2018). if it continues to increase at the current rate (high confidence). Africa joined the rest of the world in the 2016 Paris Agreement on Climate Change to agree limit GHGs emissions in order to keep the temperature rise below 1.5 – 2^oC. The sixth Assessment Report of IPCC indicated a current global surface temperature rise of 1.09 ^{0}c above the pre-industrial era, 1850 – 1900 (IPCC, 2022 b). According to the report, the estimated global surface temperature rise since the last assessment report (the fifth report) was attributed to further warming since 2003 – 2012. Although upgrade of measurement system may account for the variation in difference between report 5 and 6. The sixth IPCC report estimated that ''there is at least a greater than 50% likelihood that global warming will reach or exceed 1.5^0 C in the near-term, even for the very low greenhouse gas emission scenarios''. Even now, the Sixth IPCC report established that '' 20–40% of the global human population live in regions that, by the decade 2006–2015, had already experienced warming of more than 1.5°C above pre-industrial in at least one season.'' This conclusion rated with medium level of confidence.

Africa's climate is warming significantly over the pre-industrial era. Already the continent experiencing temperature increases of approximately 0.7°C over much of the continent, and with predictions that temperatures will rise further (United Nations, 2006). The Working Group I of the sixth IPCC Assessment Report (IPCC, 2022a) concluded that mean temperatures and hot extremes have emerged above natural variability, relative to 1850–1900, in all land regions in Africa (high confidence). This conclusion was rated by the report as high confidence

in terms of certainty. Also, the WG I report concluded that the rate of surface temperature increase has generally been more rapid in Africa than the global average, with human-induced climate change being the dominant driver (high confidence). And it was projected that the observed increases in hot extremes (including heatwaves) and decreases in cold extremes (including cold waves) are projected to continue throughout the 21st century with additional global warming (high confidence).

Africa is not a significant source of greenhouse gas emissions compared to other continents of the world. The continent accounts for only 2 – 3 percent of the world's carbon dioxide emissions mainly from energy and industrial sources (United Nations, 2006). Africa accounts for the smallest share of global greenhouse gas emissions, at just 3.8%, in contrast to 23% in China, 19% in the US, and 13% in the European Union (CDP Worldwide, 2020). According to the World Resources Institute, Africa's per capita emissions of carbon dioxide in the year 2000 were 0.8 metric tons per person, compared with a global figure of 3.9 tons per person.

Factors influencing Green House Gas Emissions in Africa

Dependence on fossil fuel: Although Africa emits lower amount of GHGs emissions globally, several factors like energy, agriculture, and water supply are increasing the emissions (Gujba, Thorne, Mulugetta, Rai & Sokona, 2012). Globally, energy use especially the heavy dependence on the combustion of fossil fuels for energy which account for about 80% of human activities induced GHG emissions (Quadrelli, & Peterson, 2007). Africa is no exception to heavy dependence on fossil fuels. In fact, a vast majority of rural and urban poor depends on the use of fire wood and charcoals as their major source of energy for cooking. Due to poor electricity system, it is a common practice for several persons to result to generator with in efficient combustion systems. Aside from oil spillage, and gas flaring from multi- national communities operation within and offshore in the sea, there also exist illegal refineries that are seriously polluting the atmosphere with GHGs. One must not neglect the contribution of carbon emissions from poorly maintain vehicles that are plying the Africa roads, emitting GHGs to the atmosphere. This type of energy crisis will only make GHGs emissions worst for Africa now and in the near future.

Although emissions are decreasing elsewhere (e.g. Europe and the Americas) Africa's CO_2 emissions are poised to grow in the coming decades. The growth rate in energy related CO_2 emissions in Africa between 1990 and 2017 (123%) is considerably greater than the world average of 60%. A Study (Ayompe, Davis, & Egoh, 2020) revealed that about 89% of African countries studied have increasing emissions ranging from 0.1%–42.9% yr^{-1} as between 2010–2017. Similar results have been found in developing countries such as China (Gujba et al, 2012).

Population Increase: Population increase is another factor that has been associated to increase in carbon emissions in the literature (Adamsn & Acheampong, 2019; Ayompe, Davis & Egoh, 2020). An increase in population means more people needing energy for their daily use. The relationship between population increase and GHG emissions increase in Africa is understandable. Cohen (2010) argued that emissions of CO_2 and other greenhouse gases are influenced by the sizes and density of settlements, the sizes of households, and the ages of householders. Adding that between 2010 and 2050, these demographic factors are anticipated to change substantially. Therefore demography will play a substantial role in the dynamics of climate changes. Climate changes affect many aspects of the living environment, including human settlements, food production, and diseases. These changes will affect poor people more severely than rich and poor nations more severely than rich. Yet not enough is known to predict quantitatively many details that will matter enormously to future people and other species. Three kinds of responses are related to demographic issues that affect climate changes: universal secondary education, voluntary contraception and maternal health services, and smarter urban design and construction (Cohen, 2010).

More populations will mean more persons depending on the environment, cultivation of the lands, exploration of the sea and other areas of the planet for survival and sustenance. Increase in population in Africa will be more demand for energy supply and for infractructures like housing, hospitals, schools, roads and others to meet the growing demand. Hence, it has been observed that the ratio of emissions-to-population is higher with developing countries in Africa than in the developed countries. The ratio of emissions-to-population growth rates was 2.8 in developing countries compared with 1.6 in high-income countries (Stephenson, Newman, & Mayhew, 2010)

Economic Growth: Another factor which has been implicated for the growing CO_2 emissions in Africa is GDP. Like many countries around the world, most African countries are seeking to increase their wealth through GDP growth aiming to reach higher levels of income by 2050 (Ncube, Osei, Anyanwu, Anyanwu, Jebuni, & Vencatchellum, 2011). In addition, on average, 45%–50% of sub-Saharan Africans live below the poverty line—a much higher proportion than in any other regions of the world (Hope, 2004).. Economic development should be

a top priority over the coming decades if African countries are to meet their development goals. Ayompe et al (2020) revealed that CO_2 emissions increased in 81% of the African countries studied as a result of increase in GDP per capita between 1990 and 2017. This trend shows that economic growth resulting in increase in GDP should result in an expected increase in CO_2 emissions in many African countries. The default situation is that every country seeks to grow its GDP but such growth will have consequences for CO_2 emissions if measures are not taken to actively reduce emissions. To confirm the impact of GDP on emissions, the study (Ayompe et al, 2020) found decreases in CO_2 emissions in Zimbabwe and DR Congo where there was also decreases in GDP per capita.

With energy use per capita among the lowest in the world, there is no doubt that Africa will need to increase its energy consumption by providing access to modern energy services in order to drive economic growth and development goals (Gujba et al, 2012). Liu (2015) in the book, Global Energy Interconnection, argued that the energy required for development will probably mean higher energy intensity (energy per unit of GDP) of economies because industry takes much energy. A number of studies (Ayompe et al, 2020; Steckel, Hilaire, Jakob & Edenhofer, 2020; Acheampong, 2018; Shahbaz, Solarin, Sbia & Bibi, 2015) that found that increase in energy intensity increases CO_2 emissions in African countries while energy consumption also increases both economic growth, and financial development in Africa.

Observed impacts and Possible impacts of reaching the 1.5^0 C global warming mark in Africa

All things being equal, IPCC (2018) projected that Global warming is likely to reach 1.5°C between 2030 and 2052. Although Africa continent emits lesser green house gas emissions than the other continents, it is most vulnerable to the impacts of climate change. . In the near future, climate change will contribute to decreases in food production, floods and inundation of its coastal zones and deltas, spread of waterborne diseases and risk of malaria, and changes in natural ecosystems and loss of biodiversity. Climate change threatens sustainable development. Settlements in regions that are today water-deficient – including much of North Africa – can be expected to face still-higher demands for water as the climate warms. Beset by poverty, AIDS and other challenges, African countries may lack the resources to address these emerging and expected climate change impacts (United Nations, 2006).

Succinctly, the Working Group I Report – physical science basics - of the sixth IPCC Assessment (IPCC, 2022) outlined some of the observed changes that the African Region is already experiencing at the current warming level and those projected occur when a 1.5^0 C warming above pre – industrial era is experienced. They are:

- Mean temperatures and hot extremes have emerged above natural variability, relative to 1850–1900, in all land regions in Africa (high confidence).
- The rate of surface temperature increase has generally been more rapid in Africa than the global average, with human-induced climate change being the dominant driver (high confidence).
- Observed increases in hot extremes (including heatwaves) and decreases in cold extremes (including cold waves) are projected to continue throughout the 21st century with additional global warming (high confidence).
- Marine heatwaves have become more frequent since the 20th century and are projected to increase around Africa (high confidence).
- Relative sea level has increased at a higher rate than global mean sea level around Africa over the last 3 decades. Relative sea-level rise is likely to virtually certain to continue around Africa, contributing to increases in the frequency and severity of coastal flooding in low-lying areas to coastal erosion and along most sandy coasts (high confidence).
- The frequency and intensity of heavy precipitation events are projected to increase almost everywhere in Africa with additional global warming (high confidence).

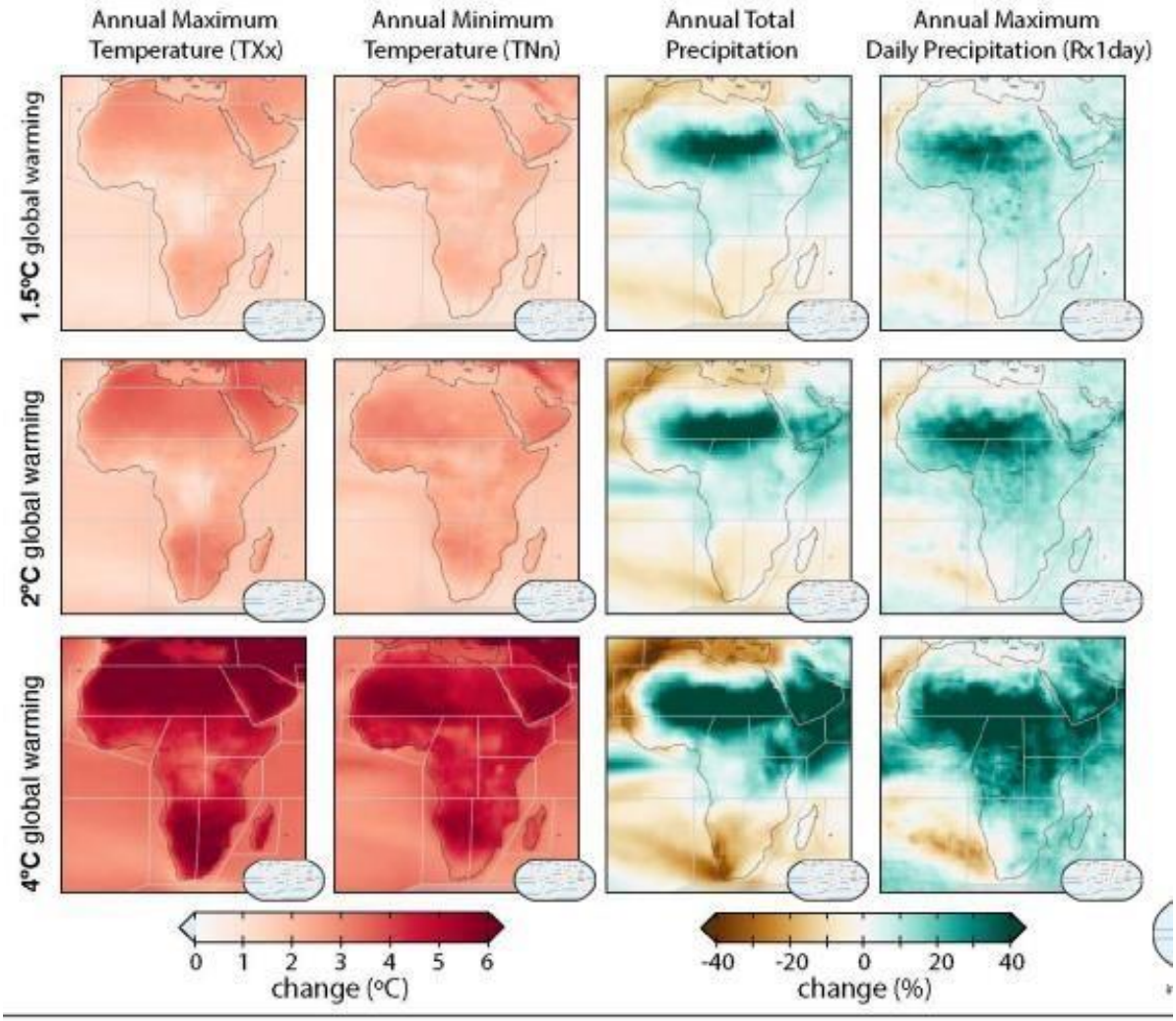

Figure 1: Simulations results on the Projected changes in annual maximum temperature (TXx), annual minimum temperature (TNn), annual mean precipitation and annual maximum daily precipitation (RX1day) at 1.5°C, 2°C, and 4°C of global warming (in rows) compared to 1851–1900 using the CMIP6 multi-model ensemble mean.

It is evident from figure 1 that ‘’with additional increases in global warming, changes in hot and cold temperature extremes, mean and maximum one day precipitation get larger.’’ (IPCC, 2022). This is a strong indication for flooding and other water related extreme events in the Continent.

Table 1: Observed impacts of climate change and projected impacts if global warming increase over 1.5^0 C abover pre-industrial era in various African Regions

s/n	African Regions	Observed impacts of climate change:	Projected impacts of climate change:
1	West Africa (WAF)	1. increase in river flooding; 2. increase in drying and agricultural and ecological droughts	1. increase in meteorological droughts at GWL 4°, mostly in seasonal timescales; 2. increases in mean wind speed; increase in heavy precipitation and pluvial flooding.
2	Mediterranean (North Africa)	increases in aridity, meteorological, hydrological and agricultural and ecological droughts	Increases in aridity, meteorological, hydrological and agricultural and ecological droughts Decreases in mean precipitation, increases in fire weather conditions and decreases in mean wind speed
3	Sahara including parts of the Sahel (SAH)		increases in heavy precipitation and pluvial flooding

4	North Eastern Africa (NEAF)	Decreases in mean precipitation; decreases in snow and glaciers;	Decreases in snow and glaciers; Increases in heavy precipitation and pluvial flooding;
			Decrease in meteorological drought at 4°C global warming
5	South Eastern Africa (SEAF)	Decreases in snow and glaciers	Increases in frequency and/or the intensity of heavy precipitation and pluvial flooding; Decreases in snow and glaciers; increase of average tropical cyclone wind speeds and associated heavy precipitation and of the proportion of category 4-5 tropical cyclones.
6	Central Africa (CAF)	Decreases in mean precipitation Decrease in standardized precipitation index (i.e deficit of precipitation) Increase in agricultural and ecological droughts	Increases in heavy precipitation and pluvial flooding; Increases in river flooding
7	East Southern Africa (ESAF)	Decrease in mean precipitation; Increase in heavy precipitation and pluvial flooding; Increase in aridity, agricultural and ecological droughts; Increase in meteorological drought, projected increase in meteorological droughts from 1.5°C, higher confidence at higher GWLs;	Increases in heavy precipitation and pluvial flooding; increase in aridity, agricultural and ecological droughts;
8	West Southern Africa (WSAF)	decrease in mean precipitation; increase in heavy precipitation and pluvial flooding; Increase in aridity, agricultural and ecological droughts	Increase in aridity, agricultural and ecological droughts Increase in dryness from 1.5°C, higher confidence with increasing global warming; increases in mean wind speed; increases in fire weather conditions
9	Madagascar (MDG)	increase in aridity	Increase in meteorological droughts from 1.5°C, higher confidence at higher GWLs; increases in agricultural and ecological droughts types particularly at higher warming levels; Increases in heavy precipitation and pluvial flooding; Increase of average tropical cyclone wind speeds and associated heavy precipitation and of the proportion of Category 4-5 tropical cyclones.
10	West African Monsoon (WAfriM)	increase since the 1980s are partly due to the growing influence of greenhouse gases and reductions in the cooling effect of human-caused aerosol emissions over Europe and North America.	Monsoon precipitation is projected to increase over the Central Sahel and decrease over the far western Sahel. The monsoon season is projected to have a delayed onset and a delayed retreat. •

Source: content synthesized from IPCC (2022) Working Grroup I – physical science basics -6th assessment report.

It is evident from Table 1 that the entire continent is vulnerable to climate change impacts. It is worthy to note that impacts of climate change vary from region to region. For instance, while it observed that climate change impact is leading to flooding due to high precipitations, on the other hand in North Africa increase in aridity, meteorological, hydrological and agricultural and ecological droughts is experienced. Also, within variability of climate change impacts is also observed. Taking West Africa as an example, while part of west Africa, the southern parts like is experiencing flooding, the northern parts are experiencing increase in drying and agricultural and ecological droughts. Within a country there also exist variability depending on the ecological zones. For example, in Nigeria while the southern parts are battling with flooding, the northern parts are facing increasing desertification.

Measures for cleaning up Africa with sustainable Greenhouse Gases emissions

World at large and Africa as a continent must work with the nations to ensure that global treaties and agreement made on climate change are adhered to. We have very limited time ensure that a meaningful process is made. The IPCC report of 2018 warned that we have only 12 years for global warming to be kept to a maximum of 1.5^0 C. Also, the report indicated that ''Under emissions in line with current pledges under the Paris Agreement (known as Nationally Determined Contributions, or NDCs), global warming is expected to surpass 1.5°C above pre-industrial levels, even if these pledges are supplemented with very challenging increases in the scale and ambition of mitigation after 2030 (high confidence).'' In this regard, coordination of efforts at the continent level is key. African governments work through a number of regional and global institutions to strengthen their response to climate change. There should be strong coordination in terms of regional positions and national policies on climate change through platforms like - the African Ministerial Conference on the Environment (AMCEN); the New Partnership for Africa's Development (NEPAD), which promotes projects and action plans relevant to climate change. At the global level, African countries can tap a variety of funds and institutions for support, including the Special Climate Change Fund and the Least Developed Country Fund created under the United Nations Framework Convention on Climate Change (UNFCCC), the Adaptation Fund under the Kyoto Protocol, the Global Environment Facility, the World Bank, and other UN and intergovernmental organizations and programmes. African countries can also participate in the Clean Development Mechanism (CDM), an innovative market-based instrument of the Kyoto Protocol that finances sustainable development projects in developing countries, which reduce greenhouse gas emissions.

Specifically, the following measures are recommended in order ensure that Africa is clean and at the same time economically viable to withstand current impacts of global warming;

- Price carbon pollution policy should be initiated by all African nations and impartially implement. Carbon pollution pricing involves placing price/incentives on carbon pollutions to organizations, big or small scale in order to their emissions or pay for polluting practices. There are two main types of carbon pricing: ○ **Emissions trading systems (ETS):** Otherwise known as a "cap-and-trade system," this approach sets a limit on total GHG emissions and allows industries with low emissions to sell their allowance to other polluters

○ **Carbon tax:** This approach sets a tax rate on GHG emissions or on the carbon content of fossil fuels. The bar for emissions isn't defined, but the tax rate is. In some countries such as Canada, the carbon tax that's collected by the government is then redistributed to citizens in the form of a rebate. Carbon tax worked in Canada and Britain but not in France as it triggers popular manifestations

 Provision of contact electricity to all households and organizations in all nations of the continent will massively clean up the continent of Green House gases. This will stop the dependence of trees for cooking energy and will clean up several homes and industrial process. The availability of constant electricity will bring in electric cars and will wipe out the current fossil fuel dependent automobiles and will remove generators.

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