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Research Article

The Impact of Climate Change on Human Population and Environmental Health in Sub-Saharan Africa

Donald Ezechukwu Iheaturu[1]*, Izuchukwu Innocent Ibeawuchi[2], Ifesinachi Cynthia Onuchukwu[2] and Nwankpa Pius Akachukwu[2]

[1]Department of Crop Science and Horticulture, Nnamdi Azikiwe University, Anambra State, Nigeria

[2]Department of Crop Science and Technology, Federal University of Technology, Imo State, Nigeria

***Corresponding Author:** Donald Ezechukwu Iheaturu, Department of Crop Science and Horticulture, Nnamdi Azikiwe University, Anambra State, Nigeria.

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Abstract

This paper focused on the impact of climate change on human population and environmental health in Sub-Saharan Africa. Africa is among the most vulnerable continents to climate change has a result of human's explorative activities. Throughout this region there are spatial and temporal discrepancies in temperature and precipitation trends; with dread impacts on human population, its sustainability and environmental health. The impacts of climate change include warming temperatures, changes in precipitation, extreme weather events, rising sea levels, population migration and displacement of coastal communities. These impacts threaten human population, population distribution and settlement, health, water quality and supply, agriculture and our ecosystems. Climate change can affect human health in a number of ways by: reducing the availability of safe food and drinking water; damaging roads and bridges, disrupting access to communication, utility, and health care services; increasing emission of greenhouse gases from human activities, such as the burning of fossil fuels (coal, natural gas, and oil) for energy and transportation; risk of respiratory, cardiovascular and vector borne disease; and aggravating mental health impacts such as depression and post-traumatic stress disorder (PTSD). For effective management of this risk, it requires the integration of mitigation and adaptation strategies in the management of ecosystem, agriculture and human health population in Africa.

Keywords: Climate Change; Human Population and Environmental Health

Introduction

Climate change is already a reality in Africa, this relates to aspects of climatic changes within the continent. Intergovernmental Panel on Climate Change reports that surface temperatures have increased over Africa since the late 19th century to the early 21st century by about 0.5 °C while observed precipitation trends indicate spatial and temporal discrepancies in variability among regions [1]. Africa is among the most vulnerable continents to climate change, due to a range of factors that includes weak adaptive capacity, high dependence on ecosystem for livelihoods and crude agricultural production system [4]. This climate change poses a great risk to the sustainability of various sectors which include: human population, population distribution and settlement, health, water quality and supply, agriculture and our ecosystems biodiversity with severe consequence on lives and sustainable development prospects in Africa. In order to manage this risk effectively, it requires the integration of mitigation and adaptation strategies in the management of ecosystem goods and services, and the agriculture production systems in Africa [19].

Climate change refers to any significant change in the measures of climate lasting for an extended period of time. In other words, climate change includes major changes in temperature, precipitation, or wind patterns, among other effects, that occur over several decades or longer. While global warming an offshoot of climate change refers to the recent and ongoing rise in global average temperature near earth's surface. It is caused mostly by increas-

ing concentrations of greenhouse gases (carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), Ozone (O_3), and Chlorofluorocarbons (CFCs)) in the atmosphere. Global warming is causing climate patterns to change. Human beings are largely responsible for recent climate change. Over the years, large amounts of carbon dioxide and other greenhouse gases have been released into the atmosphere through burning of fossil fuels to produce energy, deforestation and industrial processes. Consequently, the buildup of greenhouse gases has triggered a change in earth's climate resulting in dangerous effects to human health, water supplies, agriculture, power and transportation systems and ecosystems.

The earth is warming. According to Global Change Programme

Change	Region
Average conditions	
Temperature increase	Entire continent (median projected increase in annual average temperature: 3 to 4 °C (end of century to present)
Decrease in rainfall	West coast of Africa as far south as 15° N Southern Africa
Increase in rainfall	Northern parts of East Africa
Uncertain projections for rainfall	Sahel (already high variability) Guinean coast Southern Sahara
Sea level rise	Low lying islands and coastal zones Delta regions
Extremes	
Increase in intense	Entire continent (this applies also in regions of mean
precipitation events	drying because there is a proportionally larger decrease in the number of rain days)
Cyclones	Uncertain — changes in magnitude and frequency, and shifts in cyclone tracks possible

Table 1: Projected Climate Changes in Africa.

Source [12].

[14], earth's average temperature has risen by 1.5°F over the past century, and is projected to rise another 0.5 to 8.6°F over the next hundred years. These minute changes in the average temperature of the planet can translate to mighty and potentially dangerous shifts in climate and weather. Rising global temperatures have been accompanied by corresponding changes in weather and climate. Many places have experienced changes in rainfall, resulting in increased frequency and intensity of floods, droughts, or rain, as well as more frequent and severe heat waves. Also, oceans and glaciers are warming and becoming more acidic, ice caps are melting, and sea levels are rising. These and other changes present challenges to our society and our environment.

Greenhouse gas effect

Gases that trap heat in the atmosphere are called greenhouse gases. Greenhouse gases include carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), Ozone (O_3), and Chlorofluorocarbons (CFCs) in the atmosphere. Carbon dioxide is the primary greenhouse gas that is contributing to recent climate change. CO_2 is absorbed and emitted naturally as part of the carbon cycle, through plant and animal respiration, volcanic eruptions, and ocean-atmosphere exchange. Human activities, such as the burning of fossil fuels (coal, natural gas, and oil) for energy and transportation, certain industrial processes and changes in land use, release large amounts of CO_2, causing concentrations in the atmosphere to rise. Human activities currently release over 30 billion tons of CO_2 into the atmosphere every year. Increased concentrations of greenhouse gas concentrations in the atmosphere will continue to increase devastating effect such as:

- Increase earth's average temperature
- Influence the patterns and amounts of precipitation
- Reduce ice and snow cover, as well as permafrost
- Raise sea level
- Increase the acidity of the oceans
- Increase the frequency, intensity, and/or duration of extreme events
- Shift ecosystem characteristics
- Increase threats to human health including
- Negative impact on our food supply, water resources, infrastructure and ecosystems.

Impacts of climate change in Sub-Saharan Africa

The world average temperature is rising due to the greenhouse effect caused by increasing levels of greenhouse gases, especially carbon dioxide. As the global temperature changes, so also changes in climate are expected across the earth. Regional effects of global warming vary in nature, some are the result of a generalized global change or change in specific ocean current or weather system; resulting in local effects, such as melting or forming ice, changes in the hydrological cycle (evaporation and precipitation), changes of

Green House Gases	Atmospheric Life time	Recent Level	Global Warming Potential (in 100 yrs) time zone	Main Source
$C0_2$	1 OOyrs	389 ppm	1	Anthropogenic activities, fossil fuel etc.
CH_4	12yrs	1748 - 18709 PPb	25	Land wastes, livestock etc.
N_20	114yrs	323ppb	298	Agriculture, industry and combustion etc.
CFCs	12 - 1 OOyrs	75 - 534ppt	5000- 10900	Industries, old air conditioners and refrigerators etc.
0_3	Hours to days	34ppb	n.a	Fuel combustion, organic compound evaporation etc.

Table 2: Main sources of greenhouse gases, current level, global warming potential and their lifetime in the atmosphere. Source [12].

currents in the oceans and air flows in the atmosphere and rise of sea levels.

Human population

Africa is one of the most vulnerable continents to climate variability and change due to many predisposing factors such as poverty, political conflicts, and ecosystem degradation and low adaptive capacity. Climate change is projected to cause decrease in the availability of freshwater. With population growth and increasing demand from higher standards of living, this decrease could adversely affect billions of people the future. Islands, located in the tropics or higher latitudes, are already exposed to extreme weather events and changes in sea level. Regional temperature increases have affected most oceans resulting in changes in regional rainfall patterns, earlier leafing of trees and plants over many regions; movements of species to higher latitudes and altitudes in the Northern Hemisphere and shifting of the oceans' plankton and fish from cold- to warm-adapted communities [24].

According to the Report of Intergovernmental Panel on Climate Change [11], by 2050, between 350 million and 601 million people in Africa are projected to experience increased water stress due to climate change and displacement of large populations of low-lying coastal areas due to projected sea level rise. Rising sea levels and extreme events threaten indigenous groups that inhabit low-lying island nations. The results from various assessments of impacts of climate change on human population show that sea-level rise could increase flooding, particularly on the coasts of Eastern Africa [18]. Also, higher temperatures and reduced snow, ice, and permafrost threaten groups that live in mountainous and polar areas. Climate effects in these areas can affect hunting, fishing, transport, and other activities [1].

It was projected by [4] that in many African countries and regions, agricultural production and food security would probably be severely compromised by climate change and climate variability this means there will be high food insecurity, in the face of the ever-increasing population. Furthermore, climate variability and change can negatively affect human health and population. In many African countries, the prevalent health threats such as malnutrition, malaria and other diseases can be exacerbated by climate change, leading to tolling death- rate and decrease in population.

Population distribution and settlement

Climate change affects the migration of people within and between countries around the world. Harsh environmental factors such as resource scarcity, degraded ecosystem services, lack of viable agricultural land or fresh water, flooding, drought, and hurricanes force many people to migrate into other areas. Droughts have long contributed to human migration, cultural separation, population dislocation and the collapse of prehistoric and early historic societies [21]. One-third of the people in Africa live in drought-prone areas and are vulnerable to the impacts of droughts [25]. In Africa, for example, several million people regularly suffer impacts from droughts and floods. These impacts are often further exacerbated by health problems, particularly diarrhea, cholera and malaria [7].

Many types of extreme events- hurricane, flooding, are becoming more frequent and severe because of climate change, which increases the rate of human migration and relocation of great mass of population to seek shelter in other places; indigenous people groups in the coastal region are greatly endangered by this threat. This will likely increase the numbers of people migrating during and after these types of events [1].

Deterioration in coastal conditions, such as beach erosion and coral bleaching, will likely affect local resources such as fisheries, as well as the value of tourism destinations. Coastal settlements and low-lying areas are particularly vulnerable to climate change impacts, such as sea level rise, erosion, and extreme storms. Rising ocean temperatures and acidity threatens coastal ecosystems [24]. As coastal habitats such as barrier islands, wetlands, deltas, and estuaries are destroyed, coastal settlements can become more vulnerable to flooding from storm surges and erosion. Climate change effects such as increases in coastal erosion, changes in the ranges of some fish, increased weather unpredictability are currently disrupting traditional hunting and subsistence practices of indigenous people communities in Africa, and may force relocation of many coastal villages.

Health

Climate variability and change may also interact with other existing stresses and vulnerabilities of Sub-Sahara Africa such as compromised populations (HIV/AIDS), conflict and war [9] in the future, resulting in increased susceptibility and risk of other infectious diseases (e.g., cholera, diarrhea), vector borne diseases (malaria) and malnutrition. Countries with low capacity to prevent and control sicknesses and epidemic are highly susceptible to climate-sensitive diseases with its attendant health impacts. Many health challenges are related to climate change, some of which include: frequent and severe heat stress linked to increases in temperatures; exacerbate respiratory and cardiovascular diseases due to worsened air quality that often accompanies heat waves or wildfires and increase of malnutrition and prevalence of food-borne illnesses [6,22]. Increases in the frequency or severity of some extreme weather events, such as extreme precipitation, flooding, droughts, and storms, threaten the health of people during and after the event. The people most at risk include young children, older adults, people with disabilities or medical conditions, and the poor.

Climate changes can influence the spread of infectious diseases. The spread of vector- borne diseases such as malaria, dengue, and West Nile virus may increase in areas projected to receive more rainfall and flooding. Mosquito pupation rates and larval-to-pupal development have been observed to be significantly faster in farmland habitats than in swamp and forest habitats [16]. Floods can also trigger malaria epidemics in arid and semi-arid areas [23]. Increases in rainfall and temperature can cause spreading of dengue fever. The spread of cholera and meningococcal (epidemic) meningitis is often linked to climate changes, especially as drought, very low humidity and a dusty condition predisposes population to its spread. Areas of Sub-Saharan Africa are sensitive to the spread of meningitis, and will be particularly at-risk if droughts become more frequent and severe [17].

The effects of global climate change on mental health and well-being are integral parts of the overall climate-related human health impacts. Mental health consequences of climate change range from minimal stress and distress symptoms to clinical disorders; such as anxiety, depression, post-traumatic stress, and suicidal thoughts [6]. Exposure to extreme heat can lead to heat stroke and dehydration, as well as cardiovascular, respiratory, and cerebrovascular disease [14]. Excessive heat is more likely to affect populations in northern latitudes with excessive temperatures, outdoor workers, student athletes and the homeless.

Climate change has increased the production of unhealthy levels of ground-level ozone, a harmful air pollutant, and a component in smog. It affects allergies and respiratory health. Ground-level ozone can damage lung tissue, reduce lung function, and inflame airways. This can aggravate asthma or other lung diseases. Children, older adults, outdoor workers, and those with asthma and other chronic lung diseases are particularly at risk of dying prematurely [6].

Changes in precipitation patterns and extreme weather events can lead to devastating health effects, particularly in low-income countries when power, water, or transportation systems are disrupted. Adverse health effects from climate change particularly diarrhoea diseases from contaminated water and food sources are a major concern to vulnerable populations especially children, older adults, urban people living in poverty, traditional societies, subsistence farmers, and coastal populations. Rural populations, older adults, outdoor workers, and those without access to air conditioning are often the most vulnerable to heat-related illness and death [22].

Water quality and availability

Climate change has the potential to impose additional pressures on water availability, accessibility and demand in Africa. Water quality is important for domestic purposes, agriculture, ecosystems, human health and sanitation. The water sector is strongly in-

fluenced by changes in climate. Increases in temperature, changes in precipitation, sea level rise, and extreme events can diminish water quality in many regions. Large rainstorms may introduce large amounts of pollutants into rivers and estuaries. Increased pollution as well as increasing water temperatures can cause algal blooms and potentially increase bacteria in water bodies [13]. In coastal areas and small islands, saltwater from rising sea level and storm surges threatens water supplies. These impacts greatly affect the availability of safe water resources for human and animal uses.

Particularly, semi-arid and arid areas of Africa are vulnerable to the impacts of climate change on water supply, especially areas already water-stressed due to droughts, population pressures, and water resource extraction. The availability of water is strongly related to the amount and timing of runoff and precipitation. With a 2.7°F rise in global mean temperature, annual average stream flow is projected to increase by 10-50% at high latitudes and in some wet tropical areas, but decrease by 10-50% in some dry regions at mid-latitudes and in the subtropics [13]. As temperatures increases, snowpack is reducing in many regions and glaciers are melting at unprecedented rates, making water less available in areas that depend on it from melting snow and glaciers during spring and summer; droughts and flooding are likely to become more widespread.

Agriculture

In many parts of Sub Sahara Africa, farmers and pastoralists are faced with the challenges of extreme natural-resource scarcity, poor soil fertility, pests, crop diseases, and a lack of access to inputs and improved seeds. These challenges are usually aggravated by periods of prolonged droughts and floods. Hence, the potential of climate change to affect global food security is important for food producers and consumers in Africa. Climate change is a detrimental factor that affects global, regional, and local food security by disrupting food availability, decreasing access to food, and making utilization more difficult. Climate risks to food security are greatest for poor populations and in tropical regions [11]. Changes in climate could have significant impacts on food production around the world. Temperature rises can reduce the productivity of major crops and increase their water requirements, thereby directly decreasing crop water-use efficiency. Heat stress, droughts, and flooding events may lead to reductions in crop yields and livestock productivity. Areas that are already affected by drought in Sub-Sahara Africa, will likely experience reductions in water available for irrigation; invariably, increasing the demand for irrigation. Additional risks that could be exacerbated by climate change include greater erosion, reductions in crop growth period and deficiencies in yields from rain-fed agriculture of up to 50% during the 2000-2020 period have been projected [2].

Climate change is affecting many fisheries around the world. Apparently, increasing ocean temperatures have shifted some marine species to cooler waters outside of their normal range; as a result of the adverse effect of climate change. Fisheries are important for the food supply and economy of many countries. Consequently, projected reductions in water flows and increases in sea level may negatively affect water quality and fish species in regions like these, affecting the food supply and the income generated for those communities depending on these resources.

Ecosystems

Ecosystems are critical in Africa, contributing significantly to biodiversity and human well-being [3,15]. The rich biodiversity in this region is experiencing ecosystem change induced by complex land-use/climate interactions, such as the migration of species, invasive species and land-use change and the interaction with fire [10]. Deforestation poses a great threat to Africa's forests due to over dependency on trees for fuel-wood and charcoal; a major source of energy in rural areas, and are estimated to contribute, about 80 to 90% of the residential energy needs of low-income households in the majority of Sub-Saharan countries. Moreover, fire incidents represent a huge threat to tropical forests in Africa. Bush fires are a particular threat to woodlands, causing enormous destruction of both flora and fauna. The ecosystem of African continent suffers greatly from the impacts of desertification. At present, almost half (46%) of Africa's land area is vulnerable to desertification [8].

Adaptation measures

There is a need to improve our understanding of the effect of complex socio-economic, socio-cultural and biophysical systems on environmental change and its links with climate change. In order to develop adaptation measures to combat climate change in Africa. The Intergovernmental Panel on Climate Change defines adaptation as the process of adjustment to actual or expected climate

and its effects. In human systems, adaptation seeks to moderate or avoid harm or exploit beneficial opportunities. In some natural systems, human intervention may facilitate adjustment to expected climate change and its effects. Adaptation is the adjustment in natural or human systems to a new or changing environment that takes advantage of beneficial opportunities or moderates negative effects. Some adaptation measures include:

- Educating people to help them avoid diseases that could become more prevalent as the climate changes such as malaria, cholera, diarrhoea, meningitis, heat stroke, dehydration respiratory and cardiovascular diseases due to worsened air quality that often accompanies heat waves or wildfires.
- Planting trees and expand green spaces in cities to reduce the "urban heat island" effect.
- Improve water use efficiency and build additional water storage capacity.
- Protect and restore stream and river banks to provide wildlife habitat and safeguard water resources.
- Protect and expand wildlife habitats to allow species to migrate as the climate changes.
- Reduce pollution, habitat loss, and other stressors that make ecosystems more vulnerable to climate change.
- Preserve wetlands and open spaces to protect coastal communities from flooding and erosion from storms and sea level rise.
- Develop crop varieties through plant breeding and biotechnology techniques that are more tolerant of heat, drought, or flooding from heavy rains.
- Provide more shade and air flow in barns to protect livestock from higher summer temperatures.

Conclusion

The extent of future climate change depends on what we do now to reduce greenhouse gas emissions. The more we emit greenhouse gas through indiscriminate human activities such as burning of fossil fuels (coal, natural gas, and oil) for energy and transportation and hazardous industrial processes the larger the future climate changes will be. Continuous emissions of greenhouse gases will lead to further climate changes. The future expected changes include a warmer atmosphere, a warmer and more acidic ocean, higher sea levels, and larger changes in precipitation patterns. Climate change will likely increasingly stress coastal communities and habitats, leading to displacement of settlement, migration of population and scarcity of quality water. These impacts would threaten human population, environmental health, vital infrastructure, ecosystem, settlements, and facilities that support the livelihood of indigenous communities. Hence, the need to adopt adap-

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