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Examining the impact of climate change on local ecosystems and communities

Evoundou Gigi Norgie *, Shen Zhou, Zhang Shiwen, Yakubu Yari Kate Dazagbyilo and Abubakar Sadiq Lawi

Anhui university of science and technology, school of Earth and Environment, China.

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Abstract

We examine the particular impacts of rising temperatures, changed precipitation patterns, and an increase in the frequency of extreme weather events using climate models, field data, and socioeconomic analysis. The results of our investigation show that phenology, biodiversity, and species distributions are all significantly changing in the local ecosystems. Ecosystem services including pollination, water purification, and carbon sequestration are being hampered by these changes. One of the most important environmental issues facing humanity in the twenty-first century is climate change. The world's wealthiest and poorest nations are both impacted by climate change. In areas that are susceptible, for instance, shorter growing seasons and more frequent droughts are reducing agricultural productivity and leading to food insecurity. In addition to the environmental effects, local residents have substantial financial challenges. According to economic assessments, climate-related calamities such as floods and droughts have a substantial financial impact on both infrastructure and people.

Particularly impacted are communities that depend on agriculture and natural resources, which has a big impact on their standard of living and economic stability. Our research also demonstrates how different adaptation tactics, including as water conservation and sustainable land management, can improve community resilience. Another important component of our research is the effects on health. We see a rise in climate-sensitive health outcomes, especially in areas with poor access to healthcare, such as vector-borne infections and heat-related illnesses. The mediating function of socioeconomic factors, such as income and education levels, on these health outcomes is significant. Our results highlight the necessity of focused interventions and policies to improve adaptive ability and reduce health risks. The study's finding highlights how intricately local ecosystems and communities are impacted by climate change. By providing a comprehensive analysis, our aim is to inform stakeholders and policymakers about workable mitigation and adaptation strategies. Future research should focus on longer observation periods and developing comprehensive approaches to address the complex issues caused by climate change. The paper concludes that although policy frameworks are necessary, their implementation and enforcement are hampered by Africa's poor governance structure and lack of political will.

Keywords: Climate Change; Ecosystem; Communities; Health; Agriculture; Biodiversity

1. Introduction

In human history, there has never been a more pressing national and global issue than the one we face today with regard to climate change. With its expected consequences on the environment and socioeconomic system, climate change is the biggest environmental problem facing humanity in the twenty-first century. There are two primary sources for the attention that climate change is currently receiving in international politics. The first is the frequency of extreme weather events that have occurred recently in many parts of the world, such as heat waves, droughts, floods, and cold waves, and the terrible effects that these weather conditions have had on people, property, and national economies?

* Corresponding author: Evoundou Gigi Norgie

Second, the realization that through his various socioeconomic endeavors, man may inadvertently alter the global environment for better or worse, but usually for the worst (Ayoade, 2003).

The rise in the average global temperature that has taken place since the early 1970s and the occurrence of weather anomalies such as drought and floods in various parts of the world suggest that a change in the current global climate is imminent. According to the 2007 Fourth Assessment Report of the Intergovernmental Panel on Climate Change, Africa would be severely impacted by climate change and global warming. By 2020, it is predicted that between 75 million and 250 million people would be more water stressed due to climate change. In many African nations and regions, agricultural productivity especially food access is predicted to be severely hampered by climate variability and change. The size of the growing season, the amount of land that may be used for agriculture, and the potential yield are all predicted to decrease, particularly in the areas that border arid and semi-arid zones. This article will discuss the concept of the climate system, the debate surrounding global warming, the facts and consequences of climate change, adaptation strategies, and the challenges associated with implementing them.

One of the most pressing issues facing humanity today is climate change, which is mostly caused by anthropogenic greenhouse gas emissions. The concentration of greenhouse gases, such carbon dioxide (CO_2), in the atmosphere is increasing, which has had a major impact on both regional and worldwide temperatures. Among these changes include rising temperatures, altered precipitation patterns, and a rise in the frequency and intensity of extreme weather events such as heatwaves, droughts, and storms (IPCC, 2021).

1.1. Climate Dynamics and Environmental Changes

The local environmental repercussions of climate change, which is brought on by greenhouse gas emissions from human activities, are one of the most pressing concerns facing humanity today. The concentration of greenhouse gases, such carbon dioxide (CO_2), in the atmosphere is increasing, which has had a major impact on both regional and worldwide temperatures. Among these changes include rising temperatures, altered precipitation patterns, and a rise in the frequency and intensity of extreme weather events such as heatwaves, droughts, and storms (IPCC, 2021).

The phenomenon of climate change is multifaceted. Variations in temperature affect the thermal regimes of ecosystems, which affect the distribution ranges of species and the ecological roles they play (Parmesan, 2006). As an illustration, several species are shifting poleward or upward in reaction to increasing temperatures; this phenomena has been noted in a wide range of taxa (Chen et al., 2011). Changes in precipitation patterns have an impact on soil moisture, water availability, and ultimately ecosystem structure and function. Longer droughts and stronger rainfall events are two examples of these variations (Dai, 2013).

1.2. Impacts on Biodiversity and Ecosystem Services

Biodiversity is particularly vulnerable to the effects of climate change. According to Thomas et al. (2004), species that are unable to migrate or adapt have a higher risk of extinction. Variations in the timing of biological processes, such as migration, breeding, and flowering, impair the provision of ecosystem services and ecological interactions (Visser & Both, 2005). For example, ocean warming and acidification are causing enormous bleaching events in coral reefs, threatening marine biodiversity and providing a means of subsistence for communities dependent on these ecosystems (Hoegh-Guldberg et al., 2007).

1.3. Socioeconomic Implications

Communities in the region, particularly those that rely heavily on agriculture and natural resources, are also heavily impacted by climate change. Climate change presents significant risks to agricultural productivity because of changes in temperature and precipitation, an increase in pest and disease outbreaks, and extreme weather events (Lobell et al., 2008). These implications endanger food security, especially in less developed countries with less resilient agricultural systems (Schmidhuber & Tubiello, 2007). Moreover, the financial costs associated with damages caused by climate change to infrastructure, health care systems, and economies are significant and sometimes worsen already-existing inequalities (Stern, 2006).

1.4. Health Effects

The potential effects of climate change on people's health are a serious concern. An increase in respiratory ailments, heat-related illnesses, and the emergence of vector-borne diseases like dengue fever and malaria are linked to rising temperatures and changing weather patterns (Patz et al., 2005). Vulnerable populations including children, the elderly, and those with underlying medical conditions are more at risk. To address the issues brought about by the intricate

interactions between socioeconomic variables and the effects of climate change, comprehensive public health measures are needed (McMichael et al., 2006).

1.5. Mitigation and adaptation

To address the effects of climate change on regional ecosystems and communities, a multimodal approach is required. The application of adaptation strategies, such as resilient agriculture practices, sustainable land and water management, and biodiversity protection, is necessary to improve the adaptive capacity of ecosystems and human systems (Adger et al., 2005). Mitigation efforts to lower greenhouse gas emissions are equally crucial for limiting the severity of future climate change and its repercussions (IPCC, 2014).

Objectives of the Study

- To understand how local weather patterns, temperature, precipitation, and extreme occurrences are impacted by climate change.
- To assess how local ecosystems are directly impacted by climate change, including changes to the quality of the air, water, and land.
- To ascertain the effects of climate change on ecosystem services, species diversity, and dispersion.
- To determine and measure the health hazards that local communities face as a result of climate change.
- To assess how local communities will be affected by climate change on an economic and social level.
- To evaluate the possibility of migration and displacement within and between communities brought on by climate change.

1.6. Research question Regarding the study

- How is the functioning of local ecosystems and biodiversity being impacted by climate change?
    - What effects are changes in temperature and precipitation patterns having on native species distribution and abundance?
    - What effects does climate change have on important species' phenology, such as when they flower and migrate?
    - What is the impact of these alterations on ecosystem services like carbon sequestration, water purification, and pollination?
- What Are Local Communities' Socioeconomic Effects of Climate Change and How Are They Adapting?
    - What impact is climate change having on local food security and agricultural productivity?
    - What are the monetary expenses linked to climate-related occurrences (such as floods, droughts, and heat waves) in nearby communities?
- What adaptation plans are local communities putting in place to deal with the effects of climate change, and what level of success do these plans have?
    - What Effects Does Climate Change Have on Local Populations' Health and Well-Being?
    - What are the patterns in the local population's climate-sensitive health outcomes (such as heat-related illnesses and vector-borne diseases)?
    - How do socioeconomic factors, such as income, education, and access to healthcare, influence the way that climate change affects people's health?
    - Which policies and actions work best to reduce the health hazards related to climate change in local communities?
    - These research questions seek to provide a thorough understanding of the complex effects of climate change on regional ecosystems and communities, offering guidance for practical mitigation and adaptation measures

2. Literature Review

Climate change, manifested in various forms such as variations in temperature, precipitation patterns, and extreme weather events, has a significant effect on the nearby ecosystems and communities. This review of the literature highlights the environmental, ecological, economical, and health consequences of the current research on these implications. Numerous studies have examined the effects of rising global temperatures, with local effects varying depending on geographic location. In order to protect their thermal niches, many species are moving their ranges to higher altitudes or the poles as temperatures rise, according to Parmesan (2006). It has been demonstrated that heatwaves are happening more frequently and intensely, which puts stress on both natural ecosystems and human populations (IPCC, 2021). In populations that are already vulnerable, heatwaves can increase mortality rates and have an impact on agricultural productivity.

Longer droughts and more intense rainfall episodes are being brought on by changes in precipitation patterns brought about by climate change (Dai, 2013). These changes have a major effect on soil moisture, water availability, and overall ecosystem health. Studies like the one done by Dai (2013) indicate that there is a global increase in the frequency and severity of droughts, which exacerbates the issue of water scarcity and impacts agriculture and natural ecosystems. The increasing sea level poses a major threat to the inhabitants and ecosystems along the shore. Hoegh-Guldberg et al. (2007) draw attention to the effects on mangrove forests and coral reefs, which provide essential ecosystem services and protect coastlines from erosion.

Organisms often respond to climate change by dispersing themselves. Species are migrating toward the poles at an average rate of 17 kilometers per decade, according to Chen et al. (2011). These modifications run the risk of upsetting well-established ecosystems and leading to an imbalance in ecological connections. An increase in the frequency and intensity of extreme weather events, such as hurricanes and storms, has a detrimental effect on ecosystems. Turner et al. (2003) found that these events have long-term ecological repercussions in addition to short-term habitat loss.

Climate change affects crop yield and food security. Lobell et al. (2008) provided a comprehensive analysis of the effects of temperature and precipitation fluctuations on global food production, along with the ensuing consequences on food prices and availability. Health-related consequences of climate change are substantial, particularly in relation to increased frequency of heatwaves and the spread of diseases. The rise in illnesses brought on by the heat and the expansion of diseases transmitted by vectors into new locations were highlighted by McMichael et al. (2006). Environmental changes and extreme weather have significant financial repercussions. Stern (2007) emphasized the long-term economic implications of climate change, such as loss of output and, in order to call for immediate mitigation and adaptation measures. Important societal concerns include conflicts over resources and displacement brought on by climate change. Adger et al. (2014) discussed how communities experience social and cultural upheavals when they are compelled to relocate as a result of rising sea levels and fluctuating resource availability.

Enacting conservation programs is necessary to improve the resilience of ecosystems. In their review, Hansen et al. (2010) looked at a variety of tactics, like protected areas and habitat restoration, to maintain biodiversity in the face of climate change. In order to prepare for the effects of climate change, local communities are developing flexible plans. Lowering vulnerability necessitates community-based adaptation, which involves resilient infrastructure and a range of livelihoods, according to Smit and Wandel (2006). Strong policy and governance are necessary to combat climate change. Ostrom (2010) underlined the importance of multilevel governance frameworks that integrate local, national, and international actions in order to address climate change holistically. A solid foundation in awareness-raising and education is necessary to build community resilience. Moser and Dilling (2011) emphasized the value of education and communication in raising public awareness and encouraging involvement in the adaptation and mitigation of climate change.

2.1. Initial Data

Gathering baseline data is a prerequisite for evaluating the impact of climate change on local ecosystems. Data collection on the condition of the environment, species distribution, and climate at this time is required. You'll need to have a clear concept of what 'normal' looks like in order to notice differences gradually. To do this, you can use field surveys, remote sensing methods, or an analysis of past ecological data. Given that it offers a standard against which future changes may be measured, baseline data is a crucial component of environmental impact assessments. To evaluate how climate change is influencing regional ecosystems, it is imperative to recognize that ecosystems and climate systems are inherently complex, and that the ways in which they interact further obscure our understanding. It is difficult to distinguish between natural climatic fluctuation and human impacts on these systems. A useful strategy is to specify the temporal and spatial modeling scales based on the quality of the available data. GIS maps and time series data are highly helpful. Tools that are freely accessible, such as Google Earth Engine, offer important resources for monitoring changes in ecosystems using a variety of proxies. In-depth field data collecting may be necessary for local ecosystems. Always take a comprehensive strategy.

2.2. Models of Climate

In order to forecast future circumstances and evaluate their possible effects on nearby ecosystems, climate models must be used. These models project changes depending on various scenarios of greenhouse gas emissions while simulating the Earth's climate system. You will analyze these forecasts as an environmental consultant to learn how local flora and fauna may be impacted by temperature rises, changed precipitation patterns, and extreme weather occurrences. It's critical to convey that, despite their use as tools, models have limitations and that one should evaluate their predictions in light of a more comprehensive understanding of ecology. Climate models are useful resources for investigating different situations. For example, you may design a situation to mimic extreme circumstances in a nearby forest. This

may highlight issues like changing tree species and an increase in wildfire frequency. You can find restrictions and important factors to take into account when deciding how to preserve biodiversity and increase climate resilience by using climate models.

2.3. Tracking Species

Species monitoring is a crucial method for identifying early warning signs of climate change. This means keeping an eye on the number, health, and distribution of various species within an ecosystem. You might detect phenological changes, such as modifications to migration patterns or timing of flowering. These adjustments can be a response to climatic fluctuations. By using long-term monitoring techniques, you can identify patterns that show how different species are responding to or adjusting to the effects of climate change, which can reveal crucial details about the overall health of the ecosystem. Monitoring species becomes crucial for spotting early indicators of climate change's effects. This entails closely monitoring the population dynamics, health, and distribution of species throughout ecosystems. Phenological changes when flowers bloom or migrate, for example show how a species is adjusting to climate variability. Regular, long-term monitoring procedures reveal patterns that indicate how acclimated or sensitive a species is to climatic changes. These findings offer critical assessments of ecosystem health that inform adaptive management strategies to mitigate adverse effects and foster resilience in the face of climate change challenges.

2.4. Assessment of Habitat

Understanding the ways in which climate change is affecting the environment requires an evaluation of habitats. We examine the physical changes in the environment, such as the amount of water available, soil erosion, and vegetation cover. These climate-related factors have a significant effect on the structure and operation of ecosystems. Through habitat analysis, it is feasible to identify areas that are more vulnerable to climatic stresses. In order to build resilience, these areas may require conservation or restoration programs. When assessing the health of an ecosystem, we focus mostly on components like soil, water, and plants. In order to understand how they might adjust to future climate change has improved as a result. Taking a comprehensive look at everything allows me to identify areas that require assistance and develop protective strategies.

2.5. Participation of the Community

Getting involved with the local community offers insightful information about how ecosystems are affected by climate change. Locals are frequently familiar with their environment and have access to observations that may not be possible to obtain using only scientific techniques. In your role as an environmental consultant, you will lead conversations, compile anecdotal data, and integrate community input into your analyses. This all-encompassing strategy guarantees that the social aspects of ecological shifts are taken into account. In order to comprehend how climate change affects ecosystems, local residents must be actively involved. Locals are usually more knowledgeable and understanding of the area than scientists are, and they can offer important insights that could be hard to get using purely scientific approaches. We devised a protocol for inquiring about climate change with my organization. Therefore built my climate change initiative utilizing the community's pooled expertise.

2.6. Strategies for Mitigation

Creating mitigation plans is essential to addressing how climate change is affecting ecosystems. Once the possible risks and vulnerabilities have been evaluated, you will suggest steps to lessen unfavorable consequences. This could entail establishing sustainable land-use practices, creating plans for the conservation of species, or restoring habitat. Your purpose is to support worldwide efforts to prevent climate change through carbon sequestration or lower emissions while simultaneously offering workable solutions that support ecosystems' ability to adapt to changing conditions.

2.7. The phenomenon known as global warming

The earth's temperature is unquestionably rising. Two issues, meanwhile, remain unresolved: the cause of global warming and the question of whether or not the process will be reversed. One school of thought held that greenhouse gases, primarily produced by human activity, such as CO2, methane, and nitrous oxide, were responsible for global warming. Therefore, the warming trend from the late 1880s to the mid-1940s has been attributed to the effect of carbon dioxide produced by industrialization following the late 19th-century industrial revolution. However, the cooling tendency that was noted between 1940 and 1960 was also attributed to the cooling effect of the aerosols produced during industrialization. Global warming has been attributed to increases in methane and nitrous oxide emissions caused by human activity during the 1970s. There is a minority opinion in the literature on the global warming dispute. They contend that either the extent of global warming has been significantly exaggerated or it does not exist (Ayoade, 2003). Additionally, it is suggested that during the previous century, the worldwide weather station surface network

has reported a rise in temperature of 0.5oC, with an additional +0.1oC since 1980. As for the last 20 years, or since 1980, for which data are available, NOAA satellites, which track the earth's surface temperature, have not detected an increase in global temperature. Furthermore, data from accessible radiosondes are said to corroborate NOAA satellite observations showing no trend in global temperature. Given that most surface weather stations are located in or near metropolitan areas, it is possible that the surface network is recording some degree of urban warming. It has also been observed that patterns of temperature increase in data pertaining to both land and ocean surfaces are similar. Furthermore, it has been stated that the scant radiosonde data now available indicates a warming of approximately 0.50 °C in the troposphere between 1958 and 1998, which is consistent with the surface records (Viner et al., 2000). As can be seen from the above, there is no plausible doubt that the earth's air temperature.

3. Temperature Changes

Temperature Anomalies: Calculate anomalies to assess deviations from a baseline period. This helps in understanding temperature trends over time.

$$T_{anom} = T - \bar{T}$$

where:

T is the observed temperature,

$\bar{T}$ is the average temperature over a baseline period (e.g., 30 years).

Linear Regression: Quantify long-term temperature trends.

$$T(t) = a + bt$$

$\boldsymbol{a}$ is the intercept (baseline temperature),

b is the slope (rate of temperature change),

t is time.

3.1. Statistical Significance:

- **Mann-Kendall Test:** A non-parametric test to evaluate the importance of trends in time series data.
- **t-test:** Tests the significance of the slope b in the linear regression model

3.1.1. Precipitation Patterns

Precipitation Anomalies: Calculate anomalies to measure deviations from a baseline period.

$$P_{anom} = P - \bar{P}$$

where:

P is the observed temperature,

$\bar{P}$ is the average temperature over a baseline period (e.g., 30 years).

Frequency Analysis: Assess changes in precipitation intensity and frequency using statistical methods such as frequency distribution analysis (e.g., Weibull distribution).

3.2. Weibull Distribution

$$F(x) = 1 - e^{-(x/\lambda)^k}$$

3.2.1. Extreme Weather Events

- **Severe Value Theory (EVT):** The distribution of severe events, like heat waves, storms, and floods, is modelled.
- **Generalized Extreme Value (GEV) Distribution**: Calculate the likelihood that severe events will occur more often than a certain threshold, x.

$$F(x) = \exp\{-[1 + \xi(\frac{x-\mu}{\sigma})]^{-1/\xi}\}$$

μ: location parameter

σ: scale parameter

ξ: shape parameters.

The return period T_r of an extreme event is calculated as:

$$T_r = \frac{k}{1 - \frac{1}{m+1}}$$

k: return level (threshold)

m: number of years of data.

- **The Principal Greenhouse Gases:** They Affect Global Warming Chlorofluorocarbons (CFCS), methane, nitrous oxides, and carbon dioxide (C02) are the main greenhouse gases that are created by human activity. The greenhouse gas emissions are sorted by nation and displayed as 1.

Table 1 Greenhouse gas emission country wise

Country	Change in Greenhouse fly Emission (2010-2023)	2023 per capital CO2 Emission (Metric tons per person)	Share of 2005 Worldwide CO2 Emissions
World Total	40.21%	5.51%	99.9%
China	155.52%	5.8%	22.02%
USA	20.21%	20.25%	22.08%
Russian	18.52%	15.86%	6.65%
India	115.0%	2.25%	5.87%
Japan	19.15%	10.80%	5.33%
Germany	22.78%	15.13%	3.89%
Canada	80.54%	18.90%	2.97%
UK	3.78%	10.69%	2.54%
South Korea	80.35%	11.70%	2.56%
Iran	110%	8.5%	2.78%
Italy	12.9%	2.98%	2.54%
Australia	68.34%	22.21%	2.45%
Mexico	45.56%	5.16%	2.45%
South Africa	44.21%	10.34%	2.25%
Saudi Arabia	85.30%	16.76%	2.45%
France	6.58%	7.63%	2.45%

Brazil	68.56%	3.05%	2.34%
Spain	55.45%	10.23%	2.23%
Ukraine	-34.9%	8.76%	2.38%
Indonesia	75.89%	2.45%	2.29%
Taiwan	135.02%	14.56%	2.06%
Poland	-7.91%	8.54%	2.01%1
Turkey	00%	4.51%	0.89%
Netherlands	23.45%	16.67%	1.00%
Thailand	2.34%	4.87%	1.02%
Kazakhstan	-18.98%	16.23%	0.87%
Venezuela	55.67%	7.7%	0.67%
UAE	68.45%	39.25%	0.67%
Argentina	52.24%	5.23%	0.66%
Egypt	74.45%	3.22%	0.45%
Malaysia	118.78%	7.98%	0.45%
Singapore	128.23%	35.45%	0.35%
Belgium	16.34%	14.45%	0.49%
Pakistan	98.34%	2.00%	0.47%
Uzbekistan	28.98%	5.67%	0.42%
Greece	38.50%	11.78%	0.38%
Nigeria	10.05%	0.89%	0.37%

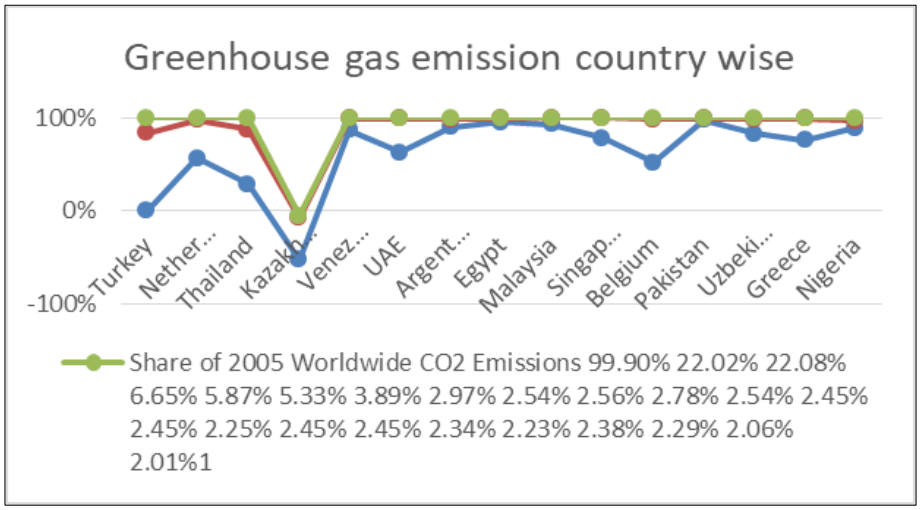

Figure 1 Graphical representation of Greenhouse gas emission country wise

Table 2 Major Greenhouse gases and their contributions

CO2	56%
Chlorofluorocarbons	26%
Methane	17%
Nitrous Oxide	8%

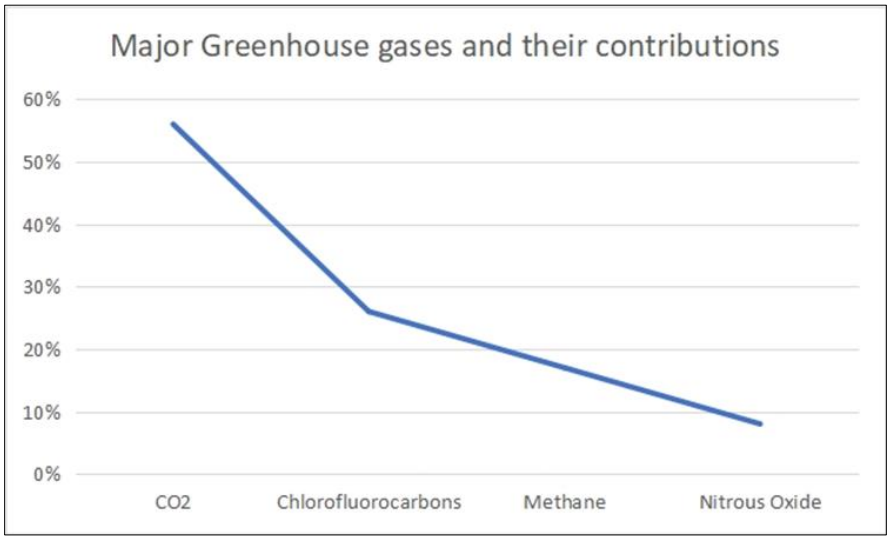

Figure 2 Graphical representation of major greenhouse gases and their contribution

Table 3 Stabilization of Atmosphere Concentrations: Reduction in Human Made Emissions of Greenhouse Gases Required to Stabilize Concentrations at Present Levels

Green House Gases	**Reduction Required**
	>70%
Carbon dioxide	16-21%
Methane	71-81%
Nitrous Oxide	71-76%
CFC-11	76-84%
CFC-12	41-51%
HCFC-22	39-45%

Table 4 Emission of Greenhouse Gases in Africa

S/N	Sources	Emission in Gigagrams		
		CO2	CH4	N2O
1.	Fossil Fuel Combustion	36793.335	6.047	1.02341
2.	Industrial Process	985.286	0.000	0.000
3.	Oil and Gas systems	35736.978	116.876	0.94
4.	Biomass burning	0.000	0.38	0.94
5.	Savannah burning	0.000	49.872	5.976
6.	Agriculture wastes	0.000	70.681	0.987
7.	Rice Production	0.000	48.345	2.144
8.	Ruminants	0.000	20.220	0.000
9.	Non-Ruminants	0.000	40.321	0.000
10.	Animal wastes	0.000	84.876	0.000
11.	Land use changes	0.000	188.871	0.000
12.	Municipal solid wastes	0.000	118.99	0.045
13.	Agriculture solids	0.000	0.000	0.000
14.	Natural	1145.875	68.336	0.000
15.	Coal Mining	0.000	0.567	0.000

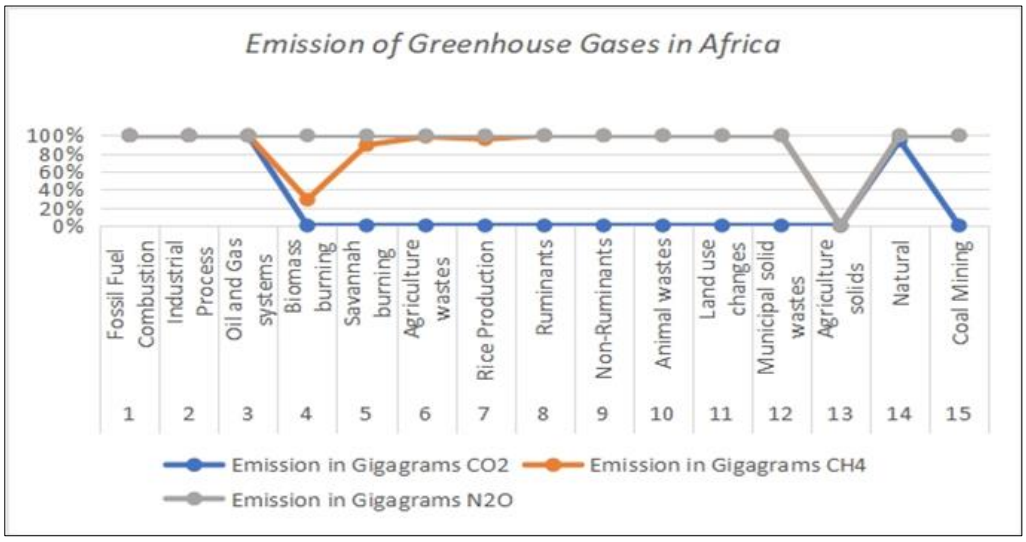

Figure 3 Graphical representation of Emission of Greenhouse Gases in Africa

Table 5 Emission of Greenhouse Gases by Sectors

S/N	Sources	Emission in Gigagrams		
		CO2	CH4	N2O
1.	Household	4012.88	164.46	3.67
2.	Agriculture/Forestry	0.40	763.19	3.67
3.	Service	46.84	0.0002	000
4.	Industry	11794.54	34.34	0.45
5.	Transportation	15669.92	5.06	0.30
6.	Energy Conversion	35786.47	118.48	0.49
7.	Primary Energy Conversion	35746.46	118.48	0.49
8.	Natural Resource	1149.87	77.34	0.00
	Total	75324.84	1142.05	11.83

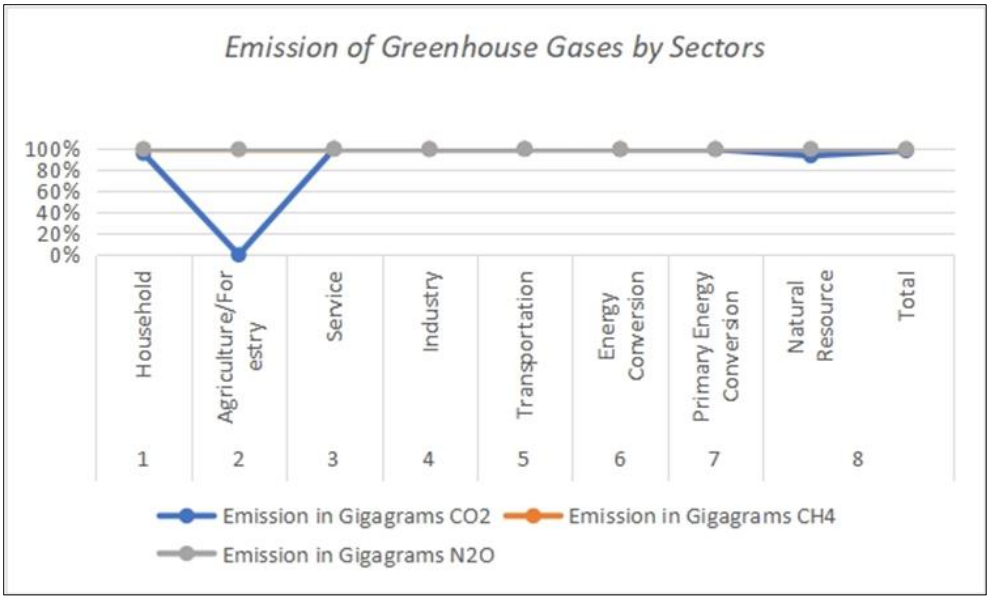

Figure 4 Graphical Representation of Emission of Greenhouse Gases by Sectors

Tables 2 and 3 show the proportionate contribution of greenhouse gases to global warming. Chlorofluorocarbons are another element that contributes to the stratospheric ozone hole. More than 80% of global warming is caused by carbon monoxide, CH4 (chlorofluorocarbon), and CO2 (primarily from burning fossil fuels like coal and oil). Thus, emissions from thermal power plants, factories, and cars are the primary human-caused sources of carbon dioxide (CO2) in the atmosphere. Table 4 shows the amount of reduction required to maintain the concentration at its current level.

3.3. Impact of Climate Change Projected in Africa

The IPCC 2020 estimates that by 2023, water stress would increase for 75–250 million more people living in Africa due to climate change. This will have a detrimental effect on livelihood and exacerbate problems related to water when coupled with increased demand. It is expected that the area suitable for agriculture, the length of growing seasons, and the potential yield will all decrease, especially on the boundaries of semi-arid and arid regions. This would exacerbate the hunger problem in Africa and further jeopardize food security.

- Reduced fishing Rising water temperatures are predicted to have a major impact on big lake resources; persistent overfishing may exacerbate this effect.

- Sea level rise is predicted to have an effect on low-lying coastal locations with dense populations by the end of the twenty-first century. It's possible that the cost of adaption will range from two to ten percent of GDP.
- Mangroves and coral reefs are expected to keep declining, which will have a growing impact on fisheries and tourism.

3.3.1. Health

- Projected exposures linked to climate change are predicted to have an impact on the health of millions of individuals, particularly those with low capacity for adaptation.
- An increase in malnutrition and the disorders that result from it, which may affect children's development and growth.
- An increase in diseases, accidents, and deaths brought on by storms, droughts, floods, and fires.
- The rising frequency of cardio-respiratory diseases due to their concentration of ground level ozone linked to climate change,
- The shifting spatial distribution of different infectious disease vectors.

3.3.2. Low-lying areas and coastal systems

- Coastal areas are predicted to be more susceptible to risks such coastal erosion due to sea level rise and climate change. The effects on the coastal region will deteriorate as stress levels caused by humans rise. Sea level rise is predicted to have a detrimental effect on coastal wetlands, such as salt marshes and mangroves, especially if they are constrained on their landward side or lack sediment.
- An increase in the frequency of large-scale coral bleaching episodes and death.
- Sea level rise is expected to cause millions more people to be flooded every year by the 2080s.
- Asia and Africa's Mega Deltas will be most affected, and small islands are especially at risk.

3.3.3. Ecosystems

- The resistance of many ecosystems is expected to be surpassed this century by an unprecedented combination of climate change-related disturbances (such as flooding, droughts, wildfires, insects, and ocean acidification) and other drivers of global change (such as changes in land use, pollution, and over-exploitation of resources).
- If the average global temperature rises by more than 1.5–2.50 degrees Celsius, an estimated 20–30 percent of the plant and animal species that have been assessed so far are more susceptible to extinction.
- Corals and other marine organisms that form shells are expected to suffer from the steady acidification of waters brought on by growing atmospheric carbon dioxide levels, as are species that rely on them.

3.3.4. Security Issues

Climate change will put livelihood and food in jeopardy. This would lead to populist movements and/or military coups in a number of countries. throughout particular, this will cause persistent instability throughout Africa. According to Brown, Hamil, and Mcleman (2007), 33 percent of the 95 coup attempts that took place in Africa between 2010 and 2023 were successful. Public dissatisfaction with the security of their means of subsistence was a significant contributing factor in a number of crises. In fact, it might even spark hostilities. For example, research released in June 2023 by the United Nations Environment Programme (UNEP) suggested that the violence outbreak in Sudan's Darfur region may have been influenced by environmental degradation and climate change.

Table 6 Total Estimated Land Loss from Erosion

Low Emission				**High Emission**				
SLR	0.2m	0.5m	1.0m	2.0m	0.2m	0.5m	1.0m	2.0m
Barrier	188	278	695	1287	119	290	703	1305
Mud	504	1107	2127	3567	402	1104	2127	3567
Delta	2956	7564	16236	19488	2976	7600	16443	19904
Strand	80	201	490	686	86	313	556	766
Total	4556	9053	19230	244,688	3,582	10009	19,497	25,250

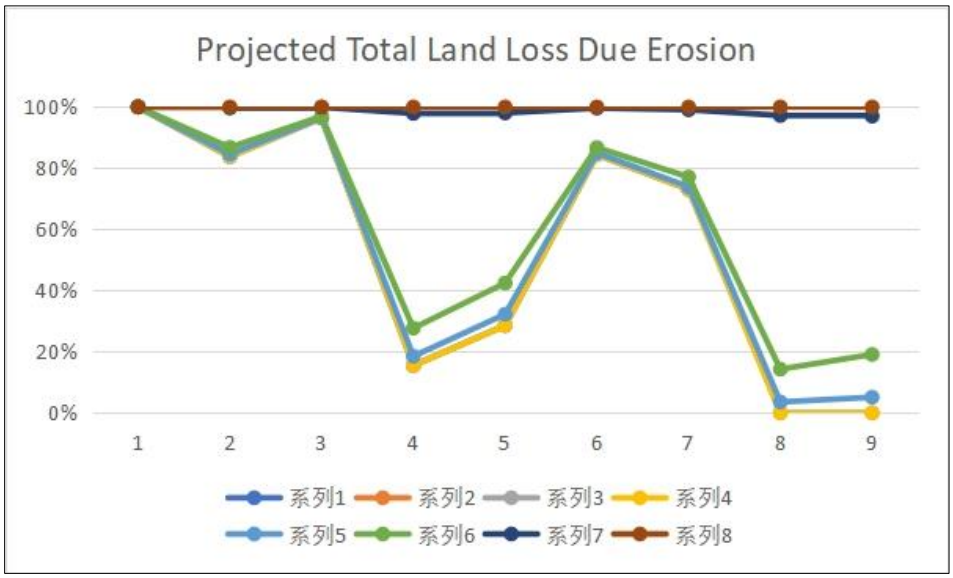

Figure 5 Graphical representation of Total Estimated Land Loss from Erosion

3.4. Strategies of Adaptation Changes in Climate Human

3.4.1. Health

Examples of general adaptation strategies include improved Medicare services, health monitoring and sanitation initiatives, improved water purification and pollution management, and health education. The increasing incidence of vector-borne diseases must be addressed by increasing the use of insecticides and concentrating on immunizing vulnerable groups. Communities can consider strategies to cool their environment (such as shade trees and white roofs) in order to prevent heat-related illnesses.

3.4.2. Agriculture

- Farmers have the option to switch to more salt- and drought-resistant crop varieties while planting their crops.
- Fertilizer usage may be raised and irrigation and water management systems might be strengthened.
- Farmers might adjust their tillage and planning schedules; adopt better land use planning and watershed management techniques; and enhance their food distribution and storage infrastructure.

3.4.3. Wildlife and Biodiversity in Forestry

- Managers of managed forests may vary the species and types of wildlife that are planted and harvested in order to better adapt to the potential effects of climate change.
- Integrated pest management is another tool that forest managers may employ to manage species resistance to potential or anticipated increases in exposure to dangerous pests. It might be possible to change the product mix to include species other than raw materials and increase the efficiency of raw material consumption.
- Managers could assist with disease and invasion control techniques, reforestation or ecosystem restoration, and species movement or reintroduction in relation to biodiversity and animals.
- Water managers and policy makers have a range of supply and demand modifications and policy choices at their disposal to prepare for the effects of climate change.
- Examples of supply adaptation include building new water infrastructure, making changes to the physical infrastructure that already exists, and creating alternative management plans for the water supply systems that already exist.
- Demand adjustments could come in many different ways, including conservation efforts, technological breakthroughs, and higher productivity in homes, businesses, and agriculture in addition to market- and price-driven water transfers to other uses.
- Examples of policy approaches for adaptation include demand side control, tariffs, the elimination of subsidies to promote discussion, and improved water management regulations.

3.4.4. Resources and Coastal Region

Coastal resource adaptation options include: Making plans to retreat from rising sea levels and potentially enacting laws prohibiting further coastal development; preserving the resources by constructing wetlands and dams; adapting to the change by adopting new building rules and preserving endangered ecosystems. strengthening fisheries management, and finally, improving the design specifications for offshore projects that may be susceptible to sea level rise.

Additional Techniques Incorporate

- Reducing poverty and addressing gaps in capabilities are two ways to address sources of vulnerability.
- Increasing response capability (through better techniques for managing water resources and weather).
- Controlling climate risk (drought-resistant crop introduction, catastrophe risk reduction, and climate proofing investment plans and programs).
- tackling climate change (by taking actions that are limited to tackling particular effects, such moving fields and communities or constructing dykes to halt the rise in sea level, among other things).

Therefore, all sector policies, development initiatives, and policies for eliminating poverty at the local and national levels that are now in place should include adaptation. Investment plans in vital areas including infrastructure, agriculture, water resource management, and disaster preparedness must take the economy into consideration. Comprehensive planning and multifaceted measures are required for adaptation. Among them are:

- Fostering political commitment across the continent via the Africa Union/NEPAD African Partnership Forum.
- Encouraging regional early warning systems, research, cooperative management, and knowledge and information sharing (e.g., trans-bounding river basin organizations). including policies, budgets, and plans for the country that address climate change.
- Locally, this includes disaster preparedness, integrating adaptation into planning for both urban and rural regions, and
- To increase resilience, each household should bear the cost of adaptation.

4. Conclusion

Developing countries must get ready for the effects of climate change, especially those in Africa. They must invest heavily in adaptation strategies if they are to protect their population from threats associated with climate change. They should construct institutions, invest in capacity building, integrate climate change into their development agenda, and design and implement all applicable environmental and climatic rules in order to ensure sustainable development. A better future can only be imagined in Africa if the continent successfully fights poverty, bad governance, political marginalization, and a lack of basic infrastructure. According to Ologunorisa (2023), the primary responsibility at the local level is to provide the framework and capacity for:

- Assessing the sectors' and sections' vulnerability to different scenarios of the effects of climate change.
- Develop, assess, and implement adaptation and mitigation strategies; and
- improve one's capacity for negotiation in climate change transactions. Africa may be forced to imitate the wealthy nations that took unsustainable paths to reach their current stage of prosperity if the developed nations are unable to provide the capital, technology, and capacity building required for adaptation

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

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