THE CLIMATE CRISIS IN AFRICA AND PATHWAYS TO SUSTAINABILITY – A REVIEW

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Abstract

Climate change presents significant challenges for Africa, as it does the rest of the world. The continent faces a diverse array of crises associated with extreme weather events, including increasingly frequent and severe floods and droughts. These extreme weather events adversely impact on infrastructure, human health, food and water security, and socioeconomic development. African coastal countries face accelerated sea level rise, leading to devastating flooding and loss of lives and properties. In East Africa drought has worsened, leading to acute food insecurity for millions of people. Urbanisation and poverty-driven deforestation are eroding Africa's natural carbon sinks. The widespread use of fossil fuel in electricity generators due to unreliable power supply in many African countries has further escalated carbon emissions. This review explores the carbon emission drivers and climate crisis in Africa, examining its consequences, and possible solutions. In particular, the review highlights the complex causal effects between poor transportation, chaotic urban development, poverty, corruption, and climate change. To address these challenges, a multilayered approach is essential. This should include enforcing land use regulations, investing in renewable energy, adopting circular economy practices, promoting sustainable agriculture, and tackling systemic corruption. Awareness campaigns to educate communities about the consequences of deforestation and the importance of sustainable development are crucial for African countries striving to meet their United Nations Sustainable Development Goals.

Keywords: Africa, Carbon Emissions, Climate Action, Climate Change, Sustainability

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1.0 INTRODUCTION

For decades, and with increasing intensity, the world has faced a wide range of crises resulting from climate change, significantly impacting developing countries including the most parts of Africa. Climate change has directly led to environmental and socioeconomic challenges such as food shortage and escalating food prices, damage to infrastructure, air and water pollution. This precarious situation puts many developing nations on the brink of poverty in the event of any major natural disaster (World Bank, 2024). The United Nations Environment Programme (UNEP) recently issued a stark warning in its latest Emissions Gap report, stating that global efforts to cut greenhouse gas emissions are completely inadequate. According to the United Nations Secretary General, the world is heading towards a 3.1°C temperature increase by the end of the century if global climate action remains inadequate (Anderson, 2024).

Africa, which accounts for 73.3% of the least developed countries in the world, is significantly impacted by climate change, according to the United Nations Conference on Trade and Development (2023). Climate-related risks are increasingly prevalent and severe across Africa. Extreme weather events and their impacts remain a threat to the continent's progress toward achieving the United Nations Sustainable Development Goals (SDGs) and the African Union Agenda 2063 (Africa Development Bank, 2022; Lin and Sai, 2022; World Meteorological Organization, 2022). Africa feels the impacts of the climate crisis more than other continents, even though it contributes the least to it (Dearden, 2017). Of the total global greenhouse gas emissions, China, the United States, and the countries comprising the European Union are the top three emitters in absolute terms (Centre for Climate and Energy Solutions, undated; United States Environmental Protection Agency [US EPA], 2022) while Africa contributes only 3.6%. However, the continent is overly impacted by climate change. For instance, the continental vulnerability to global warming impacts under all climate scenarios is above 1.5 °C (Baraibar and Babiker, 2021; African Development Bank, 2022).

In 2015, out of 10 countries most affected by climate change globally, four African countries were named: Mozambique (1st), Malawi (3rd), Ghana and Madagascar (joint 8th position). These countries, among others across the continent, have been adversely impacted by extreme weather events due to prevalent poverty, which makes them more vulnerable; further damaging inadequate and dilapidated infrastructure. In addition, human health and safety, food and water security, and socioeconomic development are being severely threatened by the climate crisis (United Nations Climate Change, 2020)

Scientific studies, research publications, and non-technical discussions on carbon emission and climate variability have continued unabated due to their evident extreme impacts on ecosystems, support infrastructure, and people's livelihoods across the world. Carbon dioxide (CO_2) emissions remain a key contributor to climate risks, accounting for approximately 64% of the climate's warming effect (World Meteorological Organization, 2023) and up to 75% of the net global greenhouse gases (US EPA, 2024). As the world population grows, so does the demand for natural resources (food, clothing, and shelter) and infrastructure. Without mitigation, the associated impacts will continue to worsen. For example, the extraction and processing of materials, fuels, and food are responsible for half of the world's total greenhouse gas emissions and cause more than 90% of the loss in biodiversity and water scarcity (United Nations Environment Programme, 2019). From Western Sahara to Somalia and northern Africa through the Sahara to the southern part of the continent, cities and rural communities have been ravaged by ecological disasters and socioeconomic crises which are the direct consequences of emitted carbon, uncaptured

and stranded in the atmosphere (Fritts, 2024; Royle, 2024). This is a major threat to the commitment of Africa toward the actualization of some of the SDGs.

2.0 METHODOLOGY

For this study a wide range of publications and materials on carbon emission, climate change and related matters mostly published between 2020 and 2024 were extensively reviewed while older but relevant sources were used to provide some background information. Sources included peer-reviewed journal articles and reports from reputable international organizations such as the African Development Bank (AfDB), World Meteorological Organization (WMO), United States Environmental Protection Agency (US EPA), World Bank, and United Nations Environment Programme (UNEP). Additionally, non-technical sources, such as news articles, were considered and assessed to provide broader context and real-time perspectives on climate change. The review also considered the control and recovery measures to address the climate change and its effects in Africa. Some data were processed using ArcGIS tool for graphical illustration of carbon emissions in different African countries. Findings from different sources were compared to understand the variations and commonalities in the data. This helps in identifying the overall impact of carbon emissions on the African continent and the effectiveness of various mitigation strategies.

3.0 DISCUSSION

3.1 Climate Impacts Across Africa

Sea levels are rising faster along the coastlines of Africa than the global average, especially in the Red Sea and southwest Indian Ocean, where the rate is around 4 mm/year. This is one of the major impacts of global warming on the continent, particularly African coastal countries including Nigeria (World Meteorological Organization, 2022; Bedair et al., 2023). This trend is expected to persist, leading to more frequent and severe coastal flooding in low-lying cities and increased saltwater intrusion, affecting the groundwater. By 2030, an estimated 108-116 million people in Africa will face the risks associated with rising sea levels (World Meteorological Organization, 2022). The second-largest freshwater lake in the world, Lake Tanganyika, is experiencing record-high water levels, resulting in floods that have displaced thousands of people in the world's poorest country and have also affected three other African nations. Eastern and central Africa have been hit by severe weather due to intense rains in April and May, which were exacerbated by El Niño (United Nations High Commissioner for Refugees, 2024). These extreme weather events have caused significant fatalities, with Kenya reporting at least 260 deaths, Tanzania reporting 155 deaths, and Burundi, the country with the lowest GDP per capita globally, reporting 29 deaths (Nimubona, 2024). Rising temperatures, shifts in precipitation patterns, and more frequent natural disasters are escalating health and environmental challenges across Africa. These impacts contribute to the spread of diseases, threaten food security and malnutrition, restrict access to clean water and sanitation, increase the risk of waterborne illnesses, and lead to conditions like heat stroke and mental health issues (Viglione, 2023; World Health Organisation, 2024).

The drought in East Africa has become more severe due to back-to-back poor rainy seasons and corona virus disease (COVID-19) restrictions. Elevated food prices have hindered the availability and access to food, resulting in over 58 million people facing acute food insecurity. The situation began to deteriorate in 2022, particularly in Ethiopia, Somalia, and certain areas of Kenya. South Sudan was reported in 2022 as the most at-risk country from climate change in the world and had the least capability to cope with its impacts. The climate emergency in South Sudan is strongly

connected to concerns about prolonged drought, water security, and instability. South Sudan encounters substantial difficulties in overseeing its water supplies, which are essential for its development (World Meteorological Organization, 2022; World Bank, 2023).

Climate change is complicating challenges in already arid North African countries such as Algeria, Morocco, and Tunisia, which collectively have a population of around 91.2 million. The predominant climate change effects are intricately connected and evident in escalating temperatures, fluctuating rainfall patterns, and increased frequency of extreme weather events. These interconnected impacts pose significant challenges to the region's agricultural economy (Desmidt, 2021). In 2016, the World Bank reported Morocco was "already bearing the brunt of climate change, with a severe drought in 2015 affecting the harvest and depressing the economy". Temperature was rising, precipitation was declining, and there was prevalent drought which was fiercely upsetting the water requirements of its population. Some provinces are experiencing storm surges and coastal flooding (World Bank, 2016). Morocco's northeastern rural coast, including Nador and Berkane provinces, is increasingly vulnerable to the effects of climate change, including sea level rise, storm surges, and coastal flooding. Some areas of the north coast are already eroding at a rate of 1 meter per year and the average global sea level rise (SLR) predicted by the IPCC (up to 59 cm by 2100) will worsen erosion.

Major cities in East Africa have experienced temperature increases nearly double the global average of 1.1°C warming since pre-industrial times. Addis Ababa has experienced a temperature increase of 2.2°C since 1860. Khartoum has warmed by 2.09°C, Dar es Salaam by 1.9°C, Mogadishu by 1.9°C, and Nairobi by 1.9°C (Baraibar and Babiker, 2021). Africa's highest peak, the famed Mount Kilimanjaro in Tanzania has not been spared from the effect of climate change. Alongside Mount Kenya, and the Rwenzori Mountains in East Africa, the tropical glaciers on top of the mountain are fast disappearing, and they will completely vanish by the year 2033 (Vastag, 2009; Sommers, 2021; Chacko, 2024) and most likely by 2050, according to a recent UNESCO report based on a forecast by climate experts. This emerging scenario has been predicted to have profound, lasting impacts on the mountainous landscapes of East Africa in years to come. These changes are expected to significantly alter water availability, increase slope instability and geohazards, affect ecosystems and the services they provide, and impact the socioeconomic activities and cultural heritage of human communities in these regions (Knight, 2023). In addition, this will inevitably and immensely impact tourism, which is a huge source of revenue for the region.

Severe drought and the impacts of global climate change are continuously worsening the situation in Ethiopia; a country experiencing its worst hunger crisis in 20 years (Byrne, 2021). The Agency for Technical Cooperation and Development (ACTED) in a recent survey reported that up to 85 percent of displaced persons in the Somali region of Ethiopia are victims of persistent droughts which affected their means of livelihood. In the Somali Region of Ethiopia, pastoral and agro-pastoral communities are experiencing a severe emergency due to prolonged droughts, which have significantly impacted their livelihoods and food security for millions of households (World Food Programme, 2022). Rwanda is equally highly susceptible to climate risk; having experienced high-temperature occurrences over the last decades (Ngarukiyimana *et al.*, 2021). The East African country largely dependent on rain-fed agriculture, is highly vulnerable to climate-related challenges due to the high levels of

poverty and low degree of development, which limit the capacity of underprivileged households and poor communities to manage climate risk (World Bank, 2021).

The West African Subregion is experiencing its share of climate impacts. In Nigeria, for example, climate impacts have been apparent - evident in extreme temperature; variable rainfall; rise in sea level and excessive flooding in recent years; drought and desertification; land degradation; more frequent extreme weather events; affected freshwater resources, and loss of biodiversity" (Haider, 2019). In northern Nigeria, floods have been destroying a vast expanse of farmlands in recent years; impacting livelihood and threatening national food security. There have been cases of severe droughts and flooding in the last 20 years in Ghana with severe socioeconomic impacts. A new report suggests that the West African country risks losing an estimated $3.9 billion worth of transport infrastructural damages by 2050 due to extreme climatic hazards (African Development Bank, 2022). The impact of climate change on Lake Chad has spiraled into other concerning regional issues in the four African countries bordering the lake. The Lake is shrinking due to rising water demand and the climate impact (Li, 2024). The United Nations weather agency had earlier highlighted the lake basin's high susceptibility to climate-induced extremes like floods and droughts, noting that such events are likely to increase, significantly affecting food security and overall safety in the area (Voice of America, 2023).

It is noteworthy that irregular rainfall and intense drought conditions in the Sahel have led to African herders' migration from areas with increased frequency of drought and lower availability of natural resources to the southern forest zone of West Africa which has better resources for their livestock and has increased in recent years (Daniel, 2021). The herders' group attributed livestock transhumance to desertification and climate change effects (Popoola *et al.*, 2020). A similar scenario has been reported in Ghana (Kugbega and Aboagye, 2021). The remote consequence of this climate-induced migration has led to frequent bloody clashes between nomadic pastoralists and crop farmers. Although the farmers-herders conflict predates the climate change phenomenon, and this has been a major social issue before the colonial era (Bello and Abdullahi, 2021); it has become a disturbing and recurring climate-related problem across the region (Figure 1). The rise of farmer-herder violence in Africa is more pernicious than fatality figures alone since it is often amplified by the emotionally potent issues of ethnicity, religion, culture, and land. This situation is not peculiar to the West African country. It is possibly worse in other African countries. Between 2010 and 2020, more than 15,000 people have lost their lives to farmer-herder and Nigeria has experienced the highest number of farmer-herder fatalities in West or Central Africa over that same period with 2,000 deaths recorded in 2018 alone (Brottem, 2021).

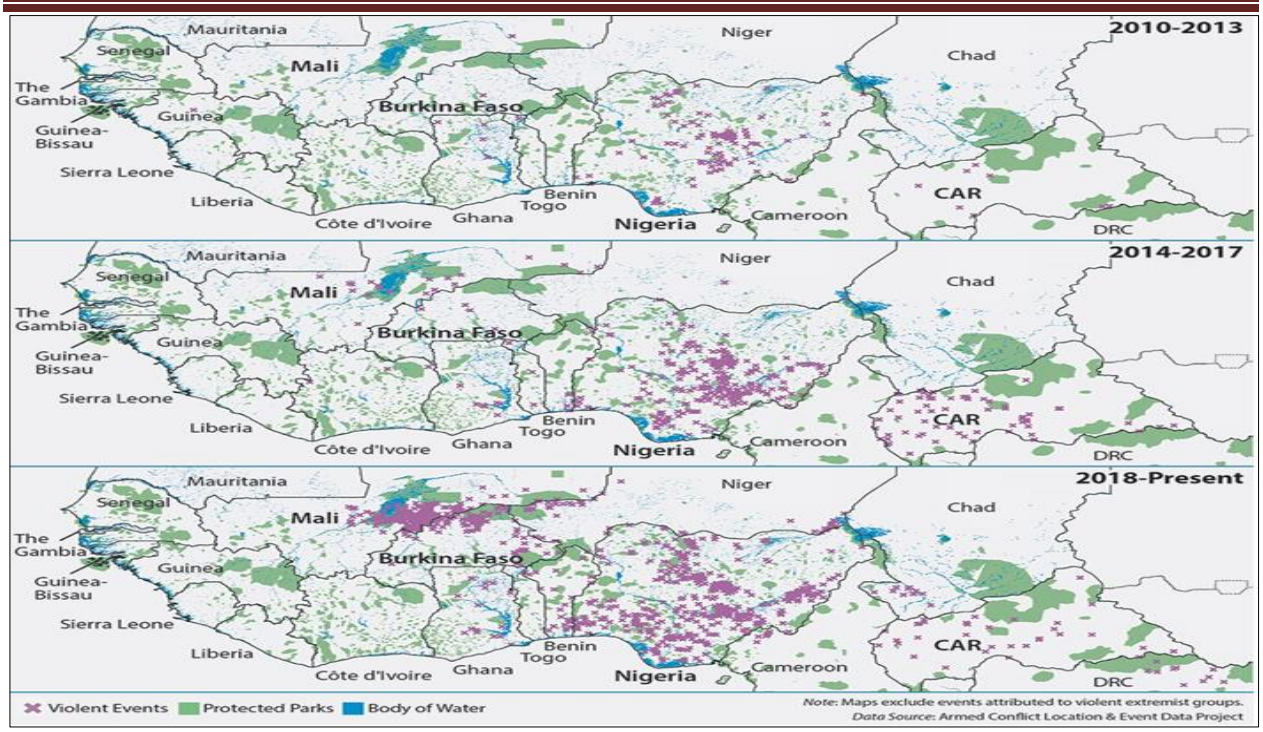

Figure 1: Map showing areas of farmer-herder clashes due to climate impact in West and Central Africa. Source: Brottem (2021)

3.2 Africa's Contribution to the Climate Change

African countries contribute varying levels of greenhouse gases to the climate. Of interest is the annual CO_2 emissions per capita across the continent (Figure 2). Most African countries show low CO_2 emissions, ranging from 0.1 to 1.0 metric tons per capita. These include Benin, Burkina Faso, Cameroon, Central African Republic, and Guinea. Others include Ethiopia, Gambia, Ghana, Kenya, Madagascar, Mali, Nigeria, and Rwanda. Libya on the other hand had the highest average annual CO_2 emissions per capita in Africa, with a significant 7.3 metric tons of CO_2 emission per annum. This significant figure underscores the country's extensive industrial activities and substantial fossil fuel consumption. South Africa also has a remarkably high emission rate per capita, reflecting its energy-intensive sectors. Equatorial Guinea, Botswana, and Algeria are some of the countries with moderate levels of emissions.

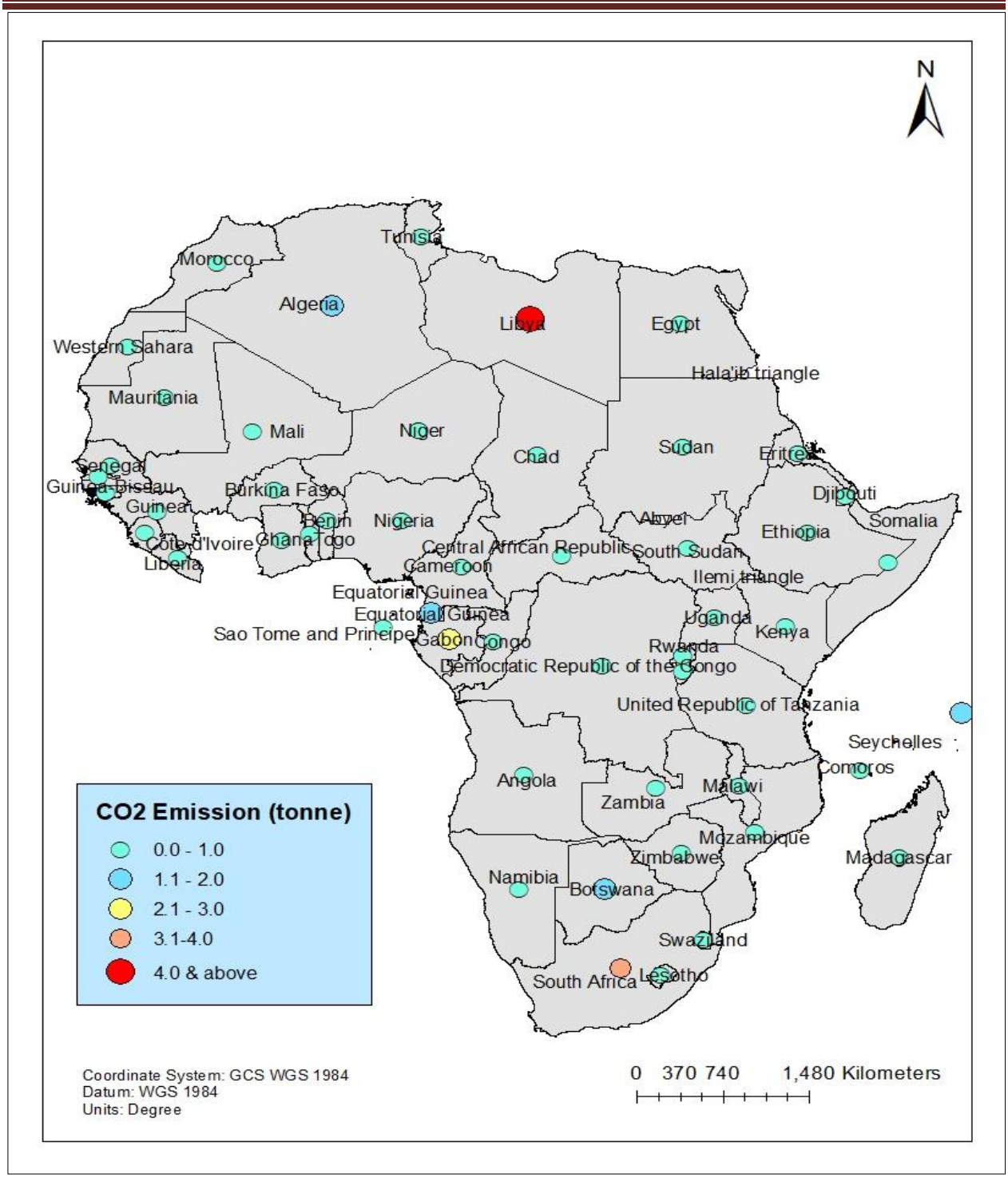

Figure 2: Map showing annual average CO_2 emissions (in tonnes) per capita across Africa in 2023 Data source: https://ourworldindata.org/co2-emissions

3.2.1 Energy Shortfalls in Africa: Drivers of Carbon Emission Trends

Throughout Africa, fossil fuel for generator alone constitutes 24% of consumer spending on electricity, yet it contributes only 7% to the overall electricity supply while accounting for an equivalence of 20% of the CO_2 emissions from vehicles in the region (International Finance Corporation, 2019). The continent generates only 2% of the world's electricity while over 30 countries across Africa currently face power shortages, prompting the widespread dependence on generators as a temporary solution (African Development Bank, 2024). Nigeria, for example, has been experiencing perennial lack of access to steady electricity. About "85 million Nigerians (43% of the population) do not have access to grid electricity, according to the World Bank, making it the country with the largest energy access deficit globally (Agbetiloye, 2023). This has resulted in the widespread use of electric generators of different sizes and types in households, offices, commercial centres, and industries across the country. As of 2013, an estimated 60 million people depended on fossil fuel-powered electricity generators as an alternative source of power for their businesses and homes (BBC, 2013). In a study by Schatz Energy Research Center at Humboldt State University, Nigeria is one of the top six countries in the world with the highest use of generator (IFC, 2019). As of 2024, Nigeria is still facing challenges in its power sector. In Nigeria, approximately 84% of urban households and 86% of businesses use backup power systems, mostly run by fossil fuels, due to the unreliable electricity grid (Williams et al., 2024).

Historically, Northern Africa has relied heavily on fossil gas, a trend that is now spreading to other African countries (Ember, 2024). This is reflected in the comparative carbon intensity rating of electricity generation of countries in different regions of Africa (Figure 3). The countries at the extremes are noteworthy for their comparison. Libya has the highest carbon intensity at 819 gCO_2eq/kWh, indicating that the electricity production in Libya results in a relatively high amount of CO_2 emissions per unit of electricity generated. This is indicative of an intense reliance on fossil fuels (Ember, 2024).

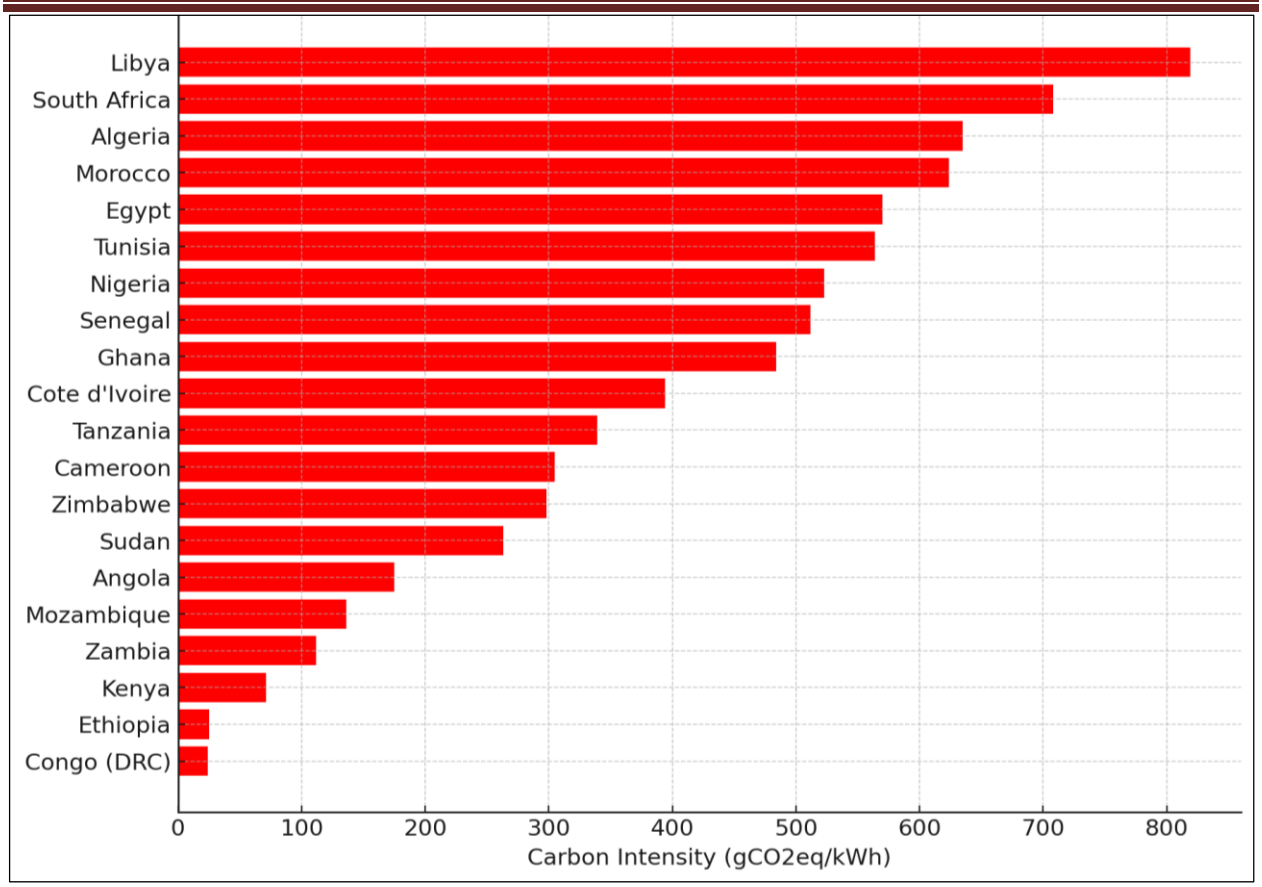

Figure 3: Chart showing the carbon intensity of electricity production in various African countries as of 2023 (Source: Ember, 2024 - modified)

Apart from the fact that heavy dependence on generator for electricity is unsustainable due to its direct and indirect socioeconomic and environmental implications, daily carbon emissions from millions of generators across Nigeria are disturbing. As a result, the country and many African countries cannot easily achieve minimal or zero-carbon target without a strong commitment and deliberate efforts to revamp the power sector.

3.2.2 Urbanization and Haphazard Housing

Forested areas and agricultural lands are being cleared and converted for housing purposes, exacerbating the problem of deforestation. Rapid population growth has been noted as a major contributor to this problem, as seen in Nigeria; and chaotic urbanization, characterized by the haphazard construction of houses in many developing countries is a key driver of forest depletion (Oyetunji *et al.*, 2020; Pandya, 2021). With an average annual urban growth rate of 3.5% over the past 20 years, Africa has experienced the highest rate of urbanization globally, a trend expected to persist through 2050. The figure of Africans living in urban areas is projected to reach 50% by 2030 and 60% by 2050 (African Union, 2024). Unsustainable housing development to meet the housing needs of the projected population will adversely impact African countries' climate action because individuals will continue to meet their housing needs through indiscriminate building. This will result in indiscriminate bush-clearing and continuous depletion of carbon sinks. The rising temperature in the city of Kigali, for example, has been rightly attributed to the population

explosion, and the resulting rapid urban growth (Ngarukiyimana *et al.*, 2021).

3.2.3 Africa Transportation System

Transportation is critical to the economic development of every nation, and it is an integral part of day-to-day life activities. Transportation in general contributes a significant amount of carbon emissions responsible for global warming and climate change. Unlike the developed economies of the world where railway transport, for example, has reached an advanced level, Africa is lagging in railway infrastructure development. Across the continent, much of the existing railway infrastructure and rolling stock are outdated, poor, and inadequate. Poor institutional frameworks and maintenance challenges led to the decay; and this shortfall has been linked to slow economic development which inadvertently contributes to high poverty levels (African Development Bank, 2015). In Ghana, for instance, there is a significant decline in the operational rail line from an initial 947 km in 1960 to 160 km by the year 2020 (Akwetteh *et al.*, 2021; Obeng *et al.*, 2022). Until recent intervention in the rail transport infrastructure, Nigeria's rail transport was in a state of despair (Ogochukwu *et al.*, 2022).

Globally, most vehicles are still powered by fossil fuel, and the adoption of electric vehicles in Africa is not widespread unlike in China, Europe, and North America (International Energy Agency, 2024). In addition to the high number of hydrocarbon-powered vehicles in Africa, the continent is the biggest destination for used vehicles from Europe and North America and a significant number of these used vehicles have poor emission standards and are below Euro 4 vehicles emission standard (Mbugua, 2018; Kazeem, 2020; Ayetor et al., 2021).

Additionally, public access to efficient mass transportation, which could minimize the contribution of vehicular emissions to climate change, is inadequate. This may have led to a rapid rise in private vehicle ownership and a decline in the use of existing public buses in Subsaharan African cities, many of which are rickety and unsafe. In addition to these factors, Mashiri *et al.* (2010) reported access to public transport was poor due to long walking distances, prolonged waiting time at bus stations, and minimal coverage area of public buses, as cited in a later study by Tembe *et al.* (2019). An increase in the number of private vehicle owners has also been associated with societal status (Tembe *et al.*, 2019).

3.2.4 Influence of Corruption on Emissions and Climate Action

Government institutions, departments, and agencies responsible for environmental protection in developing countries are often less efficient due to the corrupt practices of some regulatory officials, compared to their counterparts in developed countries (Lopez and Mitra, 2000). Instances of bribery involving enforcement officers allow industrial facilities to ignore environmental standards and regulations on air emissions. Vehicles that are unfit for the roads and visibly emitting smoke are often overlooked by officials of concerned government agencies responsible for enforcing road safety, public health, and vehicle roadworthiness. In many cases, officers of these agencies prefer to accept bribes from drivers of polluting, defective vehicles operating on public highways and streets (Alade, 2012). Similarly, many industrial facilities have been observed to continuously emit black smoke despite regulatory oversight, indicating lapses in enforcement or the involvement of compromised regulatory officials (Ijaya, 2014). In addition, illegal logging and unsustainable exploitation of forest reserves, driven by corrupt practices reported among forest management officials (Leitao, 2016), have contributed to degradation of carbon sink continued to degrade carbon sink. Corrupt practices

among regulators responsible for environmental protection and conservation in developing countries has continued to undermine efforts to combat environmental degradation and its effects such as climate change (Tacconi and Williams, 2020). The instances are many and beyond the scope of this discussion. However, this menace is an indirect contributor to climate change.

3.2.5 Poverty Driving Climate Crisis

Widespread poverty has been identified as a major contributor to deforestation (Blokland, 2021); and this has been the case in many African countries (Bhardwaj and Owusu-Addai, 2018). For example, the Akure-Ofosu Forest Reserve, which was established to protect rainforest areas in Nigeria, has experienced regular fire and logging, losing 44% of its primary forest cover in two decades. This has largely been attributed to poverty affecting four in 10 Nigerians as of 2019, according to the World Bank (World Economic Forum, 2022). In addition, most rural dwellers rely on wood and forest materials daily as sources of cooking fuel because they are poor and are unable to afford alternative energy sources for cooking (Oyetunji *et al.*, 2020); and their dependence on forest resources due to poverty is contributing significantly to deforestation (Butler, 2020). Based on these submissions and the World Bank report, which suggests that about 80 million Nigerians, representing 40% of the total population, are living below the poverty line; the natural carbon sink in Nigeria, which is needed to neutralise its local emissions, will continue to decline through over-exploitation. It has also been reported that approximately 80% of the original forest cover in Côte d'Ivoire – another West African country – has disappeared , and replaced with cocoa and coffee plantations (Okanla, 2020). In Kenya, despite being a protected area within the Mau Forest, the Olpusimoru Forest Reserve has seen significant reductions in its forest cover due to logging, fuelwood collection, and other human pressures linked to poverty. By 2010, the forest reserve had diminished by about 30 square kilometers and satellite data showed an additional 9% primary forest loss from 2011 to 2021, with trends in 2022 indicating ongoing deforestation (Silale, 2022).

4.0 APPROACHES TO ADDRESSING CLIMATE IMPACTS

4.1 Addressing the Root Causes

Effective solution to any challenge begins with a clear understanding of its root causes. In risk management including climate risk management, root cause analysis (RCA) is an important step required to identify all underlying factors contributing to potential risks and challenges. Therefore, all the identified contributors to climate change need to be effectively addressed. Raising awareness of the dangers that are inherent in irresponsible activities that contribute to climate change should be a top priority. This should be a collective and collaborative effort of government agencies, corporate and non-government organizations. The commitment of individuals to principles of sustainability is equally important. To combat the chaotic development of housing units and rapid conversion of forested areas, a multifaceted approach is required. Stricter land use regulations are essential to protect green spaces from being developed. Urban planning must be re-envisioned to ensure it is sustainable, possibly through the integration of vertical housing designs and the preservation of green spaces, to ensure compact and efficient use of land. Public awareness campaigns are essential in educating communities about the consequences of deforestation and the importance of sustainable development. Additionally, efforts should be made to invest in reforestation projects that restore and expand carbon sinks, counterbalancing the effects of urban expansion. Collectively,

these strategies can help manage the ecological challenges associated with climate change confronting the continent.

African countries facing perennial electricity problems need to double down on efforts to address this by exploring their renewable energy potentials. Poverty, being a critical driver of activities leading to climate change, should be tackled. Systemic corruption which hinders the enforcement of standards and regulations on industrial and vehicular emissions should be addressed. Access to reliable, clean, and affordable energy can help reduce poverty, which can serve as an effective strategy for forest preservation (Miyamoto, 2020). Nigeria, for example, receives on average up to 20MJ/M2 per day of solar radiation except during environmental fluxes and intermittencies (Ukoba *et al.*, 2017). According to Bugaje (1999), it is estimated that the total energy consumption of about 21x109 Kwh could be made by converting only 0.1% of the total solar radiation incident in the country at a conversion efficiency of 1%.

Tackling Africa's transportation issues requires a multi-faceted approach. Rail transport is an important tool for decarbonization and a proper climate transition (Lawrence and Bullock 2022; Association of American Railroads, 2023). Therefore, governments across Africa need to make substantial investments in mass transportation and infrastructure. The existing railway infrastructure, which can provide a more sustainable and efficient mode of transportation compared to roadways, should be upgraded. Bilateral or regional cooperation to build transnational rail networks is a critical step in addressing public transportation challenges. This would help in reducing the continent's carbon footprint and boost economic development. Expanding public transportation networks would decrease reliance on private vehicles, reduce congestion, and lower overall emissions.

In Europe and China, approximately 60% and 72% of rail networks, respectively, are powered by electricity, significantly reducing public transport-related carbon emissions (Barnard, 2023). However, in African countries, the prevalence of fossil fuel-powered trains and unreliable electricity supplies deter investors from pursuing electric options. Using diesel engine trains for mass transportation is currently feasible, prompting investment in a transnational standard gauge rail project to connect northern Nigeria with Maradi in the Niger Republic (African Development Bank, 2024). Although the construction of rail lines is a potential source of carbon emission, high-speed trains in the operation phase have been reported to be an effective instrument in minimizing carbon emissions associated with transportation. A study by Lin *et al.* (2021) suggests that the new high-speed rail routes in China led to a 20.5 log-point reduction in the number of passenger vehicles and a 15.7 log-point reduction in freight vehicles running on parallel highways. These translate into an annual reduction of 11.183 million tons of CO_2 equivalent of greenhouse gas emissions or 1.33% of GHG emissions in China's transport sector. Additionally, promoting research in developing electric and low-emission vehicles is important. This is an achievable feat considering the immense talents and human capital in the higher institutions across the continent. This approach can be supported by implementing stringent emission standards for hydrocarbon-powered vehicles and incentivising the use of cleaner technologies. In addition, regulatory frameworks need to be improved to limit the importation of older, inefficient vehicles.

To mitigate transboundary emissions beyond the continent's control, negotiations with developed nations at climate conferences are essential. The world leaders of thought in climate action also need to lead by example. The UN Climate Change Conference

(COP26) brought together 120 world leaders and over 40,000 registered participants, including 22,274 party delegates, 14.124 observers, and 3.886 media representatives. In November 2022, the 27th Conference of the Parties of the United Nations Framework Convention on Climate Change (UNFCCC-COP 27) brought together about 200 country leaders and participants for discussion on how to effectively tackle the global challenge of climate change. Most of the participants, if not all, travelled by air to Egypt for the conference. This is a contradiction of climate action objectives that should be considered. For example, the aviation sector contributes significant greenhouse gas emissions responsible for global warming, and as much as 70 % of aircraft emissions are CO_2 (Overton, 2022); accounting for approximately 2.4 to 2.5% of global CO_2 emissions (Ritchie, 2020; Timperley, 2020). As much as practicable, virtual meetings and electronic signing of attendance should be adopted for such conferences as a model for others to follow. Similarly, corporate organizations should support hybrid and remote work options for computer-based roles. This sustainable approach offers multiple benefits, including enhanced productivity, decreased fuel costs, lower Scope 3 emissions, and reduced travel-related accident risks, among others.

The following climate actions and climate adaptation strategies are being taken by some countries in different sectors of Africa, and they are worthy of mention.

4.2 Embracing Sustainable Agriculture

Agricultural policies and progammes need to be reformed to encourage a shift toward climate-smart agriculture, enhancing both profitability and social well-being. Tanzania's sustainable agricultural programme is a model to embrace as the country is making notable efforts to incorporate climate change adaptation and mitigation into agriculture and food security policies (Amwata *et al.*, 2020). The country has a strong institutional capacity and a solid policy base to help improve food and nutrition security and manage the impacts of climate change (Jalango *et al.*, 2021). The production of major crops, apart from rice, is projected to be lower than the no climate change benchmark by 2%-4% in 2030, and by 3%-6% in 2050. Beans, a major source of plant protein, have shown high vulnerability to climate change while rice is known to be highly resilient to climate change, as indicated by increased production under the climate change scenario. This may be due to climatic conditions that are increasingly favourable for rice production or improved rice varieties that can withstand harsh climatic conditions (Jalango *et al.*, 2021). Efforts should be directed towards increasing production of climate resilient food, and adaptive strategies in agricultural production should be embraced to ensure sustainable food production.

4.3 Adoption of Circular Economy

In many parts of Africa, the economic system is mostly linear economic model where raw materials are extracted, turned into products, which are eventually discarded at the end of their lifecycle. This economic model leads to having huge waste materials, which could have been cycled back into the economy as raw materials, recycled, reused or repurposed, are being burnt or hauled to dumpsites where they eventually degrade to emit greenhouse gases. This is especially so for organic wastes that can serve as a source of biogas or green manure for agricultural purposes. A study by the US EPA showed that approximately 40% of the national greenhouse gas emission results from production, transportation, use and disposal of goods (US EPA, 2024). Therefore, circular economy is a crucial strategy for reducing greenhouse gas emissions and climate change by optimizing material flows and improving

resource efficiency (Yang et al., 2022); and every country can minimise their contribution to global warming by integrating circular economy actions into its national climate policies (European Environment Agency, 2024). Rwanda, for example, is showing strong leadership in this direction. The country has put in place National Action Plan and Roadmap for the Circular Economy to help achieve its goal of becoming a carbon-neutral and climate-resilient nation by 2050 (Resource Productivity and Recovery Authority, 2023). The circular economy model should be adopted by all stakeholders across all industries for African countries to achieve their net zero objectives.

4.4 Research Limitation

This review has some limitations. While it draws on a wide range of information and data sources, there may be potential biases due to some non-scientific sources such as news content and inconsistencies of reporting standards. This is in addition to some sources dating back to 1999 due to their perceived relevance to the review. In addition, the scope of the review focuses essentially on the climate crisis and mitigation measures African countries can adopt. Further localised research studies to understand the specific impacts of climate change in different countries and subregions are recommended.

5.0 CONCLUSION

The climate crisis is a pressing universal issue, especially for African nations that are overly impacted despite contributing minimally to global greenhouse gas emissions. The impacts are severe, ranging from extreme weather events, rising sea levels and regular incidents of flooding in African coastal areas, to persistent droughts and their socioeconomic effects such as poor agricultural yield and farmer-herder conflicts. These challenges may be a major hindrance to Africa's progress towards achieving the UN SDGs and the African Union Agenda 2063. Africa's heavy reliance on fossil fuels, particularly in countries like Nigeria with inadequate electricity infrastructure, intensifies greenhouse gas emissions. Urbanization and deforestation, driven by population growth and poverty, further erode natural carbon sinks. To address these issues, land use regulations must promote sustainable urban planning, and investment in renewable energy is crucial. Reducing fossil fuel dependence and improving public transportation, especially rail networks, are key steps towards achieving the climate goal. Tackling corruption that has become institutionalised in some regulatory bodies and raising public awareness on emission reduction are also urgent priorities. International cooperation and fair support from developed nations are essential for managing emissions and fostering sustainable development in Africa. Regardless of the level of greenhouse gas emission from the continent based on the identified drivers, each of the nations in Africa needs to demonstrate strong renewed and strong commitments to nationally determined contributions to meet the Paris Target that was set in 2015. This is one of the most important pathways to sustainability.

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