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The Anthropocene and its Implications for Sustainable Development in Sub-Saharan Africa: Scoping Review

Samuel Bangura
Department of Human Resource Management
Faculty of Management Science,
Mangosuthu University of Technology,
Umlazi 4031, Durban, Republic of South Africa

*Corresponding e-mail: Bangura.samuel@mut.ac.za

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ABSTRACT

The Anthropocene, defined by significant human-induced changes to Earth's systems, poses unique challenges for sustainable development in Sub-Saharan Africa (SSA), a region with over 1.4 billion people facing socio-economic, environmental, and governance constraints. The Sustainable Development Goals (SDGs) aim to address poverty, inequality, and climate resilience by 2030, yet SSA lags due to structural barriers. This scoping review examines the Anthropocene's implications for sustainable development in SSA, focusing on how anthropogenic drivers like climate change, urbanization, and resource extraction affect SDG attainment. A systematic search of peer-reviewed literature from PubMed, Scopus, Web of Science, and Google Scholar, supplemented by grey literature, was conducted. Search terms included "Anthropocene," "climate change," "sustainable development," and "Sub-Saharan Africa." Studies addressing SDGs and Anthropocene-related themes in SSA were included, with data extracted on objectives, methods, findings, and implications. Anthropogenic impacts, including deforestation, soil erosion, and extreme weather, threaten food security, health, and economic stability in SSA. Climate change reduces crop yields, exacerbating malnutrition and poverty. Adaptive strategies like Climate-Smart Agriculture and renewable energy show promise but face adoption barriers due to limited resources and governance issues. Financial constraints and knowledge gaps further hinder progress. SSA should integrate climate-resilient policies into national frameworks, scale adaptive innovations through enhanced governance, and secure international funding. Multidisciplinary approaches combining agriculture, renewable energy, and community-based strategies are critical to advancing SDGs while safeguarding ecosystems and livelihoods. Theoretically, the Anthropocene demands interdisciplinary approaches linking human and ecological systems. Practically, policy alignment, technology dissemination, and stakeholder collaboration are critical for sustainable, equitable development in SSA.

Introduction

The Anthropocene, a proposed geochronological epoch characterised by substantial anthropogenic alterations to Earth's biogeophysical systems, presents complex challenges and strategic opportunities for advancing sustainable development initiatives, particularly within Sub-Saharan Africa (SSA) (Crutzen, 2002; Lewis & Maslin, 2015). This region, with a population exceeding 1.4 billion inhabitants, is confronted with distinct socio-economic, environmental, and governance limitations that intensify its susceptibility to global environmental perturbations (United Nations, 2023a). The Sustainable Development Goals (SDGs), ratified by the United Nations in 2015 and targeted for achievement by 2030, encompass objectives related to poverty alleviation, inequality reduction, climate resilience, and environmental preservation. Nonetheless, Sub-Saharan Africa (SSA) exhibits delayed progress relative to other regions, attributable to entrenched structural issues such as pervasive poverty, limited energy infrastructure, and climate variability impacts (Sachs et al., 2024). The Anthropocene paradigm emphasises the critical need for interdisciplinary integration of human and ecological systems to effectively promote sustainable development trajectories in Sub-Saharan Africa (SSA). This scoping review analyses the implications of the Anthropocene epoch for sustainable development in Sub-Saharan Africa (SSA), focusing on scholarly publications. It systematically assesses how anthropogenic drivers, including climate change, urbanisation, and resource extraction, interact with and influence the attainment of Sustainable Development Goals (SDGs) in the region. Through the synthesis of recent empirical and conceptual studies, this review delineates primary barriers, enabling factors, and knowledge gaps impacting the implementation of sustainable development strategies within the Anthropocene framework.

Literature Review

What is Anthropocene in Theory?

Paul J. Crutzen, a Dutch chemist and Nobel laureate in 1995, proposed in 2002 that humanity and the Earth have entered a new geological epoch, which he termed the Anthropocene. He contended that approximately 300 years ago, during the late 18th-century Industrial Revolution, human activities began to induce substantial changes to the Earth's physical and geological systems. This assertion is supported by increased atmospheric concentrations of carbon dioxide and methane, which contributed to the transition from the Holocene to the Anthropocene (Crutzen,2006). Building on this perspective, the intensified utilisation of Earth's resources has driven significant environmental transformations, leading to challenges such as climate change and biodiversity loss (Biermann et al., 2012). The extent of human influence on the planet now surpasses that observed during the Holocene, and it is broadly accepted that we are currently within the Anthropocene epoch. In this era, humans have become a primary force affecting various Earth system processes.

A key challenge in the Anthropocene is addressing the wide array of environmental, social, and economic issues that threaten global stability. These include climate change, increased frequency and severity of extreme weather events, food security concerns, and poverty, all of which undermine human well-being and hinder progress toward sustainable development (Fu et al., 2019). Furthermore, the rapid pace of industrialisation marks a significant feature of this transitional period. It is also vital to recognise how human capacities to modify and interact with natural systems have expanded. Concurrently, population growth driven by urbanisation and increased energy consumption primarily through the extensive use of fossil fuels such as coal and oil has elevated levels of greenhouse gases like carbon dioxide and methane in the atmosphere. This forms a core

aspect of the ongoing Anthropocene discourse. Crutzen (2002) asserts that human activities have profoundly disrupted the Earth's natural geological cycles.

The Anthropocene (climate change) and Sustainable Development in Sub-Saharan Africa

The Anthropocene paradigm emphasises human-driven modifications to Earth's climate systems, biosphere, and lithosphere (Steffen et al., 2020). In Sub-Saharan Africa (SSA), these anthropogenic impacts are evidenced through deforestation, soil erosion, and increased frequency of extreme meteorological events, substantially jeopardising food security and economic livelihoods (IPCC, 2022). Achieving sustainable development within this region necessitates an integrated approach that equilibrates economic expansion with environmental conservation and social equity, as delineated by the Sustainable Development goals (SDGs) framework (United Nations, 2023). Recent empirical analyses indicate that Sub-Saharan Africa's (SSA's) dependence on primary commodities, specifically agriculture and mineral extraction, is a significant factor intensifying environmental degradation, thereby posing considerable obstacles to the attainment of sustainable development goals (SDGs) targets (Olaoye et al., 2025). Furthermore, the environmental challenges associated with the Anthropocene exert considerable influence on sustainable development planning in sub-Saharan Africa. Despite the region's substantial renewable energy potential, exploitation is hampered by technical, financial, and institutional constraints (Bishoge et al., 2020).

Based on the preceding discussion, the combustion of fossil fuels impairs sustainable development objectives, whereas renewable energy utilisation and natural resource management exhibit positive but statistically insignificant effects on development outcomes and environmental degradation, predominantly driven by misguided development policies, which jeopardise both developmental progress and critical ecosystems (Ogujiuba & Jumare, 2012). However, contrary to prevailing assumptions, small-scale landholders have demonstrated investments aimed at mitigating environmental deterioration on their properties. This is because advancing sustainable development necessitates strengthening institutional governance, enhancing capacity building initiatives, and mobilising investment flows. (Guo et al., 2023). Furthermore, prioritising poverty reduction, infrastructure development, and educational advancement tailored to the specific socio-economic contexts of individual countries is essential for sustainable progress in the region (Ogujiuba, & Jumare, 2012).

Implications of Anthropocene (Climate Change) and Sustainable Development Goals in Sub-Saharan Africa

Climate change constitutes a critical impediment to the attainment of Sustainable Development Goals (SDGs) in Sub-Saharan Africa (SSA), particularly within the Sahara region. The increasing frequency and severity of extreme hydrometeorological events, including floods, heatwaves, and droughts, pose significant threats to progress in SDGs related to food security, public health, education, water resource management, and sustainable urban development (Codjoe & Atiglo, 2020). Anthropogenic climate variations influence key agricultural productivity metrics, compromise human health, and undermine nutritional stability, thus obstructing efforts to eradicate hunger and advance sustainable agricultural practices (Mugambiwa & Tirivangasi, 2017). Despite ongoing initiatives by governmental and non-governmental entities, SSA nations face urgent challenges in fully implementing SDGs, particularly those delineated in targets 1–9, 16, and 17 (Berhanu & Wolde, 2019). Land resources are integral to the realisation of multiple SDGs across the continent, requiring a transformational paradigm that aligns developmental objectives with sustainability imperatives (Mbow, 2020). Addressing these multidimensional challenges necessitates the integration of resilience-building strategies into

national development frameworks, the adoption of terrestrial innovation systems, and the establishment of collaborative learning networks to facilitate sustainable transformation pathways (Codjoe & Atiglo, 2020; Mbow, 2020).

Anthropocene (Climate Change) and Food Security

Climate change, a defining characteristic of the Anthropocene epoch, exerts substantial influence on Sub-Saharan Africa's (SSA) agricultural systems. Brown et al. (2020) highlight that the region's predominantly rain-fed agricultural practices exhibit high sensitivity to rising temperatures and fluctuations in precipitation patterns, with projections indicating a 10–20% reduction in rainfall across southern Africa by 2050. Conservation Agriculture (CA), characterised by practices such as minimal soil disturbance (no-tillage), crop rotation, and residue retention, has been advocated to bolster system resilience; however, its diffusion is constrained by socio-economic obstacles, including limited access to resources and knowledge among smallholder farmers (Mugandani & Mafongoya, 2019). Climate-Smart Agriculture (CSA), which integrates adaptive strategies alongside mitigation efforts, presents an alternative approach; nonetheless, its widespread implementation is impeded by deficiencies in extension service infrastructure and farmer literacy regarding CSA principles (Abegunde et al., 2019).

Premised on the ongoing discussion, Anthropocene (climate change) has a substantial influence on agricultural productivity and food security in sub-Saharan Africa. Elevated ambient temperatures and shifts in precipitation regimes are anticipated to diminish yields of staple crops, notably maize, with pronounced effects in Central and West Africa (Ringler et al., 2016). Although tropical cereal varieties may exhibit some resilience, overall crop yields are expected to decline across numerous agrarian zones (Stuch et al., 2020). These agro-climatic alterations, coupled with demographic expansion, are likely to reduce food availability and elevate market prices, thereby decreasing caloric intake and exacerbating childhood malnutrition rates (Ringler et al., 2016; Defrance et al., 2020). Food security stability may also be undermined due to heightened yield variability and increased frequency of production shocks (Stuch et al., 2020). By 2050, agro-production in certain West African nations may decline to below 50 kg per capita annually, potentially affecting food import dependency and triggering regional migration flows (Defrance et al., 2020). In line with the preceding assertion, Climate change in the Anthropocene epoch presents substantial threats to food security in Sub-Saharan Africa, characterised by consistent projections of declines in crop yields, land degradation, escalated market prices, and heightened malnutrition prevalence (Zewdie, 2014; Berhanu & Wolde, 2019). The region's susceptibility is primarily attributable to its reliance on climate-sensitive agricultural systems and limited adaptive capacity (Connolly-Boutin & Smit, 2016). Climatic variables, including temperature, precipitation patterns, atmospheric CO_2 concentrations, and frequency of extreme weather events, exert direct influence on food availability, accessibility, and nutritional utilisation (Zewdie, 2014). Projections for future scenarios suggest exacerbation of these adverse conditions in the absence of targeted adaptation and mitigation interventions (Zewdie, 2014). Adaptive capacity is essential for mitigating negative climatic impacts and fostering sustainable development outcomes (Berhanu & Wolde, 2019). Addressing these complex, interconnected issues necessitates integrated policy frameworks and multidisciplinary approaches to enhance the effectiveness of adaptation and mitigation strategies (Connolly-Boutin & Smit, 2016). Furthermore, implementing adaptation measures such as the development of climate-resilient cultivars and the promotion of regional market integration will be essential for mitigating these impacts (Stuch et al., 2020; Berhanu & Wolde, 2019).

Mitigating and Adapting the Implications of Anthropocene (Climate Change) and Sustainable Development Goals in Sub-Saharan Africa

Climate change constitutes a significant perturbation affecting the Sahara, South Africa, with profound implications for agriculture, nutritional security, and economic development (Adenuga et al., 2021). A variety of adaptation and mitigation strategies have been implemented to mitigate these impacts. Indigenous technological interventions, including precision planting, agroforestry systems, and modifications in conservation agriculture practices, have demonstrated efficacy in reducing climate vulnerability (Durugbo et al., 2021). Governmental initiatives have been developed to produce climate policy instruments aimed at fulfilling international contractual commitments and fostering coordinated mitigation and adaptation efforts (Afokpe et al., 2022). Integration of climate adaptation and mitigation measures within sustainable development planning has been documented in countries such as Botswana, Malawi, and Tanzania (Alemaw & Simatele, 2020). Nonetheless, there is a pressing need to expand climate innovation activities by facilitating the dissemination of standardised guidelines, capacity-building frameworks, climate-resilient technologies, and informational resources, especially in remote and underserved regions (Afokpe et al., 2022). Enhancing resilience and adaptive capacity remains critical to fortifying local communities against climate-related risks and ensuring effective climate adaptation.

Premised on the ongoing Sub-Saharan Africa (SSA) encounters significant climate change-related challenges, often regarded as a hallmark of the Anthropocene epoch, which exacerbate existing vulnerabilities linked to dependence on rain-fed agriculture, infrastructural deficits, and socioeconomic limitations. This review offers some integrated strategies aimed at climate change mitigation and adaptation, concurrently supporting the attainment of Sustainable Development Goals (SDGs). Climate-smart agriculture (CSA) has been identified as a critical intervention, emphasising the deployment of resilient crop varieties, agroforestry systems, and soil fertility enhancement practices to improve food security (SDG 2) and minimise greenhouse gas emissions (SDG 13). Partey et al. (2020) underscore CSA's potential to elevate productivity and socioeconomic well-being in SSA; however, adoption barriers such as inadequate extension services and low farmer awareness persist. Adaptive measures, including the deployment of improved seed varieties and irrigation infrastructure, are essential, given climate variability's adverse effects on crop yields, particularly among smallholder farmers (Brempong et al., 2023). Financial provisioning for climate adaptation presents considerable challenges, with annual expenditure estimates ranging from $30 to $50 billion; nevertheless, proactive resilience investments are projected to be cost-effective relative to disaster response expenditures (UNECA, 2020). Mitigation initiatives, notably the expansion of renewable energy capacity (SDG 7), are gaining momentum, with SSA's substantial untapped hydropower potential identified as a strategic resource for economic resilience (Acheampong, Dzator, & Savage, 2021). Urban climate mitigation strategies in cities like Accra and Nairobi encompass decarbonization efforts driven by policy innovation, aligning climate objectives with localised development priorities (Haile et al., 2020). However, governance quality appears to exert limited influence on emission reductions, indicating a need for institutional reforms to facilitate SDG 13 achievement (Acheampong, Dzator, and Savage 2021). Water security, a core component of SDG 6, requires comprehensive policies integrating disaster risk reduction (DRR) and sustainable development frameworks; practical execution remains inadequate (Guo et al., 2023). Climate-related health burdens, including those from air pollution, with mortality and economic losses amounting to billions annually, highlight the importance of integrating climate and health

policy domains (Godfrey & Tunhuma, 2020). Strengthening community-based health systems and facilitating technology transfer improves adaptive capacity, especially among vulnerable populations (Codjoe & Atiglo, 2020). Despite measurable progress, SSA's development trajectory exhibits disparities; climate-induced food insecurity and poverty threaten to undermine existing achievements (Baptista et.al. 2022). The 2023 Africa Sustainable Development Report advocates for accelerated policy efforts to synchronise climate action with Agenda 2063, emphasising multi-stakeholder engagement. Persistent challenges include fiscal constraints due to debt vulnerabilities, which limit public investment capacity in climate initiatives, and the necessity for international financial support to bridge funding gaps (UNECA, 2020). A multidisciplinary approach promoting synergistic policies, such as integrating CSA practices with renewable energy deployment, can enhance resilience and promote equitable development. Embedding climate considerations within national frameworks equips SSA to address Anthropocene-related challenges and advance SDGs while safeguarding ecosystems and livelihoods.

Existing Variation of Sustainable Development Policies Addressing the Anthropocene across Different BRICS+ Member States

The ongoing discussions emphasise that the BRICS nations are confronting significant challenges related to climate change, environmental degradation, and human rights issues, specifically the Anthropocene. Addressing these concerns requires the development of robust legal frameworks and effective enforcement mechanisms. While these countries possess considerable economic influence, their rapid industrialisation has exacerbated environmental and social disparities. To align with Sustainable Development Goal 13, they need to adopt sustainable development strategies. This can be achieved through the utilisation of international legal instruments to harmonise legislation and the dissemination of best practices (Thiébaut, 2024). Key actions include implementing stringent environmental regulations, promoting renewable energy use (Zhu, 2025), managing resources sustainably (Riaz, 2024), and leveraging information and communication technologies to foster innovation and efficiency (Riaz et al., 2024). These measures are crucial for advancing environmental sustainability and minimising ecological impact. Urgent international cooperation and shared responsibility are vital, given the escalating severity of these challenges.

Although the BRICS countries are emerging economic powers, they exhibit considerable variability in their approaches to environmental governance and human rights protection. Such differences hinder effective collaboration on global issues such as climate change and social equity. Frequently, environmental laws within these nations suffer from weak enforcement, inefficient institutions, and conflicts with economic objectives, resulting in significant gaps in achieving the Sustainable Development Goals. Similarly, despite the signing of key human rights agreements, discrepancies, resource limitations, and political considerations often impede the full realisation of these commitments within national legislations. This complex landscape necessitates comprehensive analysis to identify gaps, share successful practices, and explore areas for improvement. Without such efforts, there is a risk of aggravating environmental and social inequalities, potentially undermining the BRICS countries' roles as leaders in global sustainable development.

The BRICS nations face multiple environmental challenges that demand coordinated strategies and investment to effectively address and progress toward sustainable development. Bondarenko (2024) highlights that their environmental policies encompass various joint initiatives alongside national programs aimed at reducing

greenhouse gas emissions, safeguarding water resources, managing waste, and conserving biodiversity. While notable progress has been made in expanding renewable energy, protecting water resources, and improving air quality, persistent issues remain, including industrial pollution, elevated carbon dioxide emissions, and inadequate waste recycling infrastructure. Russia stands out as a key BRICS member actively engaged in developing and implementing a cohesive environmental strategy to address these challenges.

Methodology

This scoping review systematically investigates the implications of the Anthropocene epoch on sustainable development within Sub-Saharan Africa (SSA) through comprehensive topic mapping and identification of research deficiencies. A rigorous search protocol was implemented across multiple bibliographic databases, including PubMed, Scopus, Web of Science, and Google Scholar, targeting peer-reviewed literaturee. Search queries incorporated Boolean operators and controlled vocabulary: ("Anthropocene" OR "climate change" OR "environmental change") and ("sustainable development" OR "SDGS") AND ("Sub-Saharan Africa"). Additionally, grey literature sources such as reports from the United Nations and the World Bank were incorporated. Inclusion criteria encompassed peer-reviewed publications that addressed the Anthropocene or related environmental transformations, their influence on sustainable development in Sub-Saharan Africa (SSA) and explicitly referenced at least one Sustainable Development Goal (SDG). Exclusion criteria eliminated studies conducted outside SSA, publications and documents lacking explicit focus on sustainability or Anthropocene-related themes. Data extraction involved screening titles and abstracts, followed by full-text assessments. Extracted variables included study objectives, methodologies, principal findings, and implications for sustainable development.

Results

The Anthropocene, a proposed geochronological epoch characterised by profound anthropogenic modifications to Earth's biogeophysical systems, imposes multifaceted challenges and strategic opportunities for sustainable development in Sub-Saharan Africa (SSA). This region, with a population exceeding 1.4 billion, confronts distinctive socio-economic, environmental, and governance constraints that exacerbate its susceptibility to global environmental shifts (Crutzen, 2002; Lewis & Maslin, 2015; United Nations, 2023a). These constraints impede progress toward the Sustainable Development Goals (SDGs), which aim to eradicate poverty, address inequality, enhance climate resilience, and preserve ecosystems by 2030 (Sachs et al., 2024). Anthropogenic drivers, including climate change, rapid urbanisation, and resource extraction, significantly influence SDG achievement by intensifying issues such as widespread poverty, deficient energy infrastructure, and climate variability (Sachs et al., 2024). This review consolidates recent empirical and theoretical research to elucidate the implications of the Anthropocene for sustainable development in SSA, highlighting critical barriers, enabling factors, and existing knowledge gaps affecting the region’s developmental trajectory. In SSA, Anthropocene manifestations such as deforestation, soil erosion, and heightened frequency of extreme weather events pose significant threats to food security and economic stability (IPCC, 2022). The region’s dependence on primary commodities, namely agriculture and mineral extraction, accelerates environmental degradation, thereby hindering progress toward SDG targets (Olaoye et al., 2025). Climate projections indicate a 10–20% decline in rainfall in southern Africa by 2050, jeopardising rain-fed agricultural systems and reducing productivity (Brown et al., 2020). Adaptive agricultural practices like Conservation Agriculture (CA) and Climate-Smart Agriculture (CSA) demonstrate resilience potential but face adoption barriers rooted in limited resource availability and

knowledge dissemination among farmers (Mugandani & Mafongoya, 2019; Abegunde et al., 2019). While SSA possesses considerable renewable energy resources, particularly hydropower, exploitation remains constrained by technological, financial, and institutional capacity limitations (Bishoge et al., 2020). Smallholder efforts to mitigate environmental degradation are ongoing; however, scaling such initiatives necessitates strengthened governance frameworks, capacity development, and increased investments (Guo et al., 2023).

Climate change, as a defining characteristic of the Anthropocene, directly jeopardises SDGs related to food security, health, education, water management, and sustainable urban development in SSA (Codjoe & Atiglo, 2020). Elevated temperatures and altered precipitation patterns threaten staple crop yields, notably maize, in Central and West Africa, leading to escalated food prices and increased malnutrition rates among children (Ringler et al., 2016; Defrance et al., 2020). Projections suggest that by 2050, per capita agro-production in certain West African nations could decline below 50 kg annually, potentially increasing dependency on food imports and stimulating regional migration flows (Defrance et al., 2020). Effective adaptation strategies, including climate-resilient crop varieties and regional market integration, are essential but require robust policy frameworks and enhanced adaptive capacities (Berhanu & Wolde, 2019).

Solutions and Recommendations

To mitigate these impacts, SSA has adopted adaptation and mitigation interventions such as precision agriculture, agroforestry, and CSA initiatives, which aim to improve food security (SDG 2) and reduce greenhouse gas emissions (SDG 13) (Partey et al., 2020). Nonetheless, obstacles like inadequate extension services and limited farmer awareness hinder widespread adoption (Brempong et al., 2023). The expansion of renewable energy sources, especially leveraging SSA's extensive hydropower potential, supports economic resilience and progress toward SDG 7 (Acheampong et al., 2021).

In addition, Urban decarbonisation initiatives in cities like Accra and Nairobi illustrate attempts to align climate mitigation with localised development priorities; however, governance deficiencies often restrict emission reduction efforts (Haile et al., 2020). Challenges related to water security (SDG 6) and public health, including mortality due to air pollution, underscore the necessity for integrated disaster risk reduction, water resource management, and climate-health policies (Godfrey & Tunhuma, 2020).

Despite advancements, fiscal austerity and debt vulnerabilities limit public sector investments in climate resilience initiatives, emphasising the need for international financial support (UNECA, 2020). However, an integrated, multidisciplinary approach embodying CSA, renewable energy development, and collaborative governance frameworks is essential for bolstering resilience, advancing Agenda 2063 objectives, and promoting equitable, sustainable development while preserving ecosystems and livelihoods within SSA’s Anthropocene epoch.

Conclusion

The Anthropocene epoch, characterised by substantial anthropogenic modifications to Earth's biogeophysical systems, critically influences the trajectory of sustainable development in Sub-Saharan Africa (SSA). This scoping review identifies key anthropogenic drivers, including climate change, urban expansion, and resource exploitation, as amplifiers of SSA's socio-economic, environmental, and governance vulnerabilities, thereby

impeding progress toward the Sustainable Development Goals (SDGs). Principal constraints comprise persistent poverty, deficient energy infrastructure, climate variability, and limited institutional capacity, collectively exacerbating susceptibilities to environmental disturbances. Climate change, quintessential to the Anthropocene, poses risks to food security, public health, water resource management, and urban resilience, with projections indicating substantial reductions in agricultural productivity and surges in malnutrition by 2050. Nonetheless, strategic adaptive interventions such as Climate-Smart Agriculture (CSA), conservation initiatives, and renewable energy deployment (notably hydropower) offer substantive opportunities; however, their implementation is hindered by financial, technical, and knowledge dissemination barriers. Smallholder-driven resilience measures demonstrate localised adaptive capacity, yet scaling these requires strengthened governance structures, capacity development, and increased international financial inflows to overcome fiscal limitations. Facilitating factors encompass integrated policy frameworks, multidisciplinary approaches, and community-based strategies that synchronise climate resilience with developmental objectives. Persistent knowledge gaps involve effective dissemination of climate-resilient technologies, governance reforms aimed at emission mitigation, and context-specific adaptation methodologies. This review emphasises the imperative for SSA to embed climate considerations into national development strategies, cultivate multi-stakeholder collaborations, and harness indigenous innovations to advance SDGs and Agenda 2063. Addressing these challenges through synergistic approaches integrating CSA, renewable energy solutions, and strengthened governance will enable SSA to effectively navigate Anthropocene dynamics, fostering equitable, sustainable development while conserving ecosystems and livelihoods for its projected 1.4 billion inhabitants.

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