

# Ecosystem Services, Climate Change, And Human Well-Being In Africa: Integrating Health And Economic Perspectives For Resilient Socio-Ecological Systems

Daniel Chigudu

College of Economic Management Sciences, University of South Africa, [chigud@unisa.ac.za](mailto:chigud@unisa.ac.za)

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## **Abstract**

*Socio-ecological systems across Africa are becoming more stressed due to climate change, presenting considerable risk to human health and economic/financial prospects; ecosystems that deliver essential ecosystem services are deteriorating. Increasingly more people are acknowledging these complex problems, but the challenges of integrating ecological, health, and financial issues across different disciplines, sectors, and geographies are still mostly unrealised. This review synthesises current evidence on how climate change impacts ecosystem services in Africa, with cascading effects on human health. It examines the interrelationships among biodiversity loss, water regulation, food production, public health outcomes, and livelihoods. Urban areas, already grappling with the compounded effects of ecosystem degradation, play a critical role in influencing rural communities, often resulting in heightened disease burdens and reduced agricultural productivity. The review highlights the urgent need for improved collaboration and co-management across sectors. Emphasising nature-based solutions and adaptive governance, it argues that embedding public health and economic considerations into ecosystem management can strengthen resilience and responsiveness to climate-driven risks. Building resilient socio-ecological systems in Africa demands a systems-oriented approach that integrates the sustainable provision of ecosystem services with health and economic planning to enhance adaptive capacity, protect human well-being and maintain the viability of both natural and human systems into the future, in the context of the continuing pressures of climate change.*

**Keywords:** climate change, human well-being, Africa, health, economic resilience, adaptation

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## **1. INTRODUCTION**

Africa has some of the world's most diverse and unique ecosystems, ranging from dense tropical rainforests and expansive savannas to arid deserts and rich coastal zones. These ecosystems generate essential services—including water regulation, food provision, disease control, and climate regulation—that underpin the continent's food security, public health, energy supply, and livelihoods (IPBES, 2018) (UNEP, 2024). Over 62% of Africa's rural population depends on these ecosystem services, while urban populations rely on them for income, energy, and health needs (Wangai, Burkhard, & Müller, 2016). The Congo Basin, for example, stores more than 60 billion metric tons of carbon, highlighting Africa's critical role in global ecological stability (IPBES, 2018).

However, the capacity of these ecosystems to sustain vital services is increasingly threatened by climate change. Rising temperatures, shifting rainfall patterns, and more frequent extreme weather events alter ecosystem structure and functioning, leading to biodiversity loss, reduced agricultural productivity, and heightened vulnerability to diseases and water scarcity. (Higgins, Scheiter, & Langan, 2020) (Archer, et al., 2021) (Saito, Kranjac-Berisavljevic, Takeuchi, & Gyasi, 2017). Climate projections for Africa indicate profound uncertainties in future biome distributions, with scenarios forecasting both woody encroachment in savannas and shifts in vegetation patterns, underscoring the need for flexible adaptation strategies. (Higgins, Scheiter, & Langan, 2020). These environmental changes directly and indirectly impact human health, such as heat-related illnesses, malnutrition, and the spread of infectious diseases, and place additional strain on already fragile health systems. (Ogu & Okoh, 2024) (ASSAF, 2024).

The linkages between ecosystem services, human health, and economic development are particularly pronounced in Africa. Disruptions in ecosystem services can undermine food and water security, reduce economic productivity, and increase healthcare costs, especially for vulnerable populations such as rural communities, low-income groups, and those living in fragile environments. (Wangai, Burkhard, & Müller, 2016) (Archer, et al., 2021). For instance, climate-related declines in agricultural yields and fisheries threaten livelihoods and exacerbate poverty. At the same time, increased disease burdens can discourage tourism and divert public resources from development to disaster relief. (Ogu & Okoh, 2024). Because of the interlinked nature of our challenges, it is critical to develop integrated systems approaches that combine the ecological, health, and economic facets of our challenges. Achieving resilient socio-

ecological systems by 2030 requires new cross-sector systems approaches that incorporate nature-based solutions, adaptive governance, community engagement, and community ways of enhancing ecosystem and human resilience. (Nyika & Dinka, 2022) (Collins, 2025) (Hossain, Basak, Amin, & al., 2023). Such systems approaches are increasingly recognised as essential to meeting the Sustainable Development Goals, while achieving long-term well-being across the continent. (CBD, 2018) (Saito, Kranjac-Berisavljevic, Takeuchi, & Gyasi, 2017).

This study aims to:

- Conduct a systematic assessment of how climate change has affected ecosystem services in Africa.
- Evaluate the impacts of climate change on ecosystem services for human health and economic well-being.
- Identify and discuss opportunities for integrating strategies to improve resilience and sustainability in African socio-ecological systems.

In the following sections, the paper provides a systematic assessment of the evidence of how climate change is impacting the provision of ecosystem services across Africa, assesses the consequences of changes in ecosystem services in terms of human health and economic well-being, and explores integrated strategies that might promote resilience and sustainability in African socio-ecological systems. This systematic analysis is intended to inform policy, research, and practice for developing adaptive capacity and maintaining well-being in increasingly changeable environments.

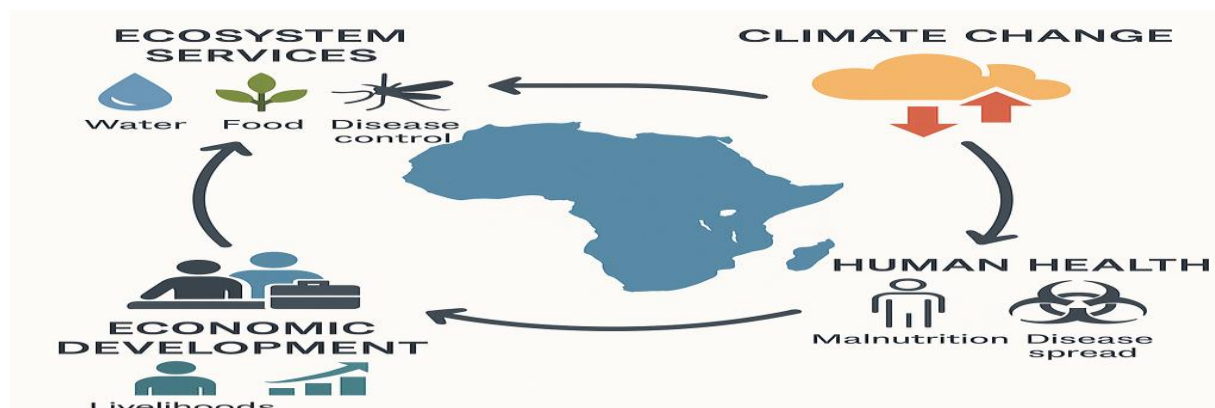
## 2. METHODOLOGY

This study employed a systematic review protocol to synthesise evidence on the impacts of climate change on ecosystem services, human health, and economic well-being in Africa. The methodology was guided by established systematic review frameworks, including PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines, to ensure transparency and rigour in the selection, appraisal, and synthesis of literature (Gaoh, Laube, Abbey, & Waongo, 2024) (EQUINET, 2023). The literature search was conducted across multiple databases, including Web of Science, Scopus, PubMed, and African Journals Online, as well as grey literature sources and policy documents from organisations such as the United Nations and regional bodies (Wangai, Burkhard, & Müller, 2016) (EQUINET, 2023). Studies published between 2000 and 2025 were included if they focused on African contexts and addressed ecosystem services related to climate change, health, and/or economic outcomes. Peer-reviewed articles and relevant grey literature were considered (Wangai, Burkhard, & Müller, 2016) (Gaoh, Laube, Abbey, & Waongo, 2024). Studies were excluded if they were conducted outside Africa or did not integrate at least two key focus areas: ecosystem services, climate change, health, or economic development. The search utilised combinations of keywords such as “ecosystem services,” “climate change,” “health,” “economic development,” “resilience,” and “Africa.” Boolean operators and database-specific filters were applied to refine the search results (Wangai, Burkhard, & Müller, 2016) (Gaoh, Laube, Abbey, & Waongo, 2024). Relevant data were extracted using a standardised form capturing study characteristics, region, ecosystem type, sector, and key findings. Thematic analysis was conducted to synthesise results by ecosystem type, region, and sector, allowing for the identification of patterns and gaps across the literature (EQUINET, 2023) (Wangai, Burkhard, & Müller, 2016). The quality of included studies was appraised using PRISMA guidelines and critical appraisal tools tailored to climate change and health research, such as the CHANGE (Climate Health Analysis Grading Evaluation) tool, to ensure objectivity and comparability (Gaoh, Laube, Abbey, & Waongo, 2024). This systematic approach provides a robust foundation for analysing Africa's complex interactions between climate change, ecosystem services, and human well-being.

### 3.0 Conceptual Framework and Application

The interconnections between ecosystem services, climate change, human health, and economic development form a dynamic and multifaceted nexus that is especially critical in Africa, as shown in Figure 1 below. Ecosystem services—such as freshwater provision, food production, climate regulation, and disease control—are foundational to human survival and societal well-being (WHO, Ecosystems and Human Well-being: Health Synthesis., 2005). These services directly support health by ensuring clean water, nutritious food, and a stable environment while underpinning economic activities like agriculture, fisheries, and tourism. (Chiabai, Quiroga, Martinez-Juarez, Higgins, & Taylor, 2018).

**Figure 1:** The Nexus Between Ecosystems, Climate Change, Human Health and Economic Development in Africa.



Climate change, however, disrupts these essential services through shifts in temperature, precipitation patterns, and the frequency of extreme events. Such disruptions can lead to reduced agricultural yields, water scarcity, increased prevalence of vector-borne diseases, and loss of livelihoods, thereby threatening health and economic stability. (Locatelli, 2016). For example, declining freshwater availability impacts drinking water and sanitation, jeopardises food security and economic productivity, and has cascading effects on public health and development (WHO, Ecosystems and Human Well-being: Health Synthesis., 2005). The links are further complicated by feedback loops: ecosystem degradation due to human activities (e.g., deforestation, land conversion) exacerbates vulnerability to climate change, while climate impacts can accelerate ecosystem decline, creating a cycle that undermines resilience. (Chiabai, Quiroga, Martinez-Juarez, Higgins, & Taylor, 2018). These interactions are direct, indirect, and displaced in time and space, making them challenging to manage without integrated approaches. (WHO, Ecosystems and Human Well-being: Health Synthesis., 2005). Ecosystem-based approaches to climate change acknowledge these connections and advocate for ecosystem functions for both mitigation (e.g., carbon sequestration) and adaptation (e.g., flood regulation, disease buffering) (Locatelli, 2016). Therefore, it is vital to maintain ecosystems for continuing economic growth and public health, especially given the increasing climate risks.

### 3.1 Theoretical Models and Frameworks for Socio-Ecological Resilience

Socio-ecological resilience is the capacity of interconnected human and natural systems to absorb disturbances, adapt, and transform while retaining essential functions, structures, and feedbacks (Daly, 2022). This concept is foundational for managing the complex challenges of climate change, biodiversity loss, and social inequality in Africa and beyond. Several frameworks guide the assessment and strengthening of socio-ecological resilience, including:

Socio-Ecological Resilience Frameworks (SERF) provides a structured approach to define system boundaries, identify key variables (such as biodiversity, social equity, and economic diversity), assess vulnerabilities, analyse feedbacks and thresholds, and develop adaptive management strategies. These frameworks help anticipate, absorb, adapt, and transform in response to environmental, social, and economic stresses. (PSD, 2025). The Social-Ecological Systems (SES) Framework integrates ecological and social components, emphasising their dynamic interactions and feedback. It analyses system resilience, vulnerability, and adaptive capacity at multiple scales. The Social-Ecological Model of Resilience, tested in African contexts, highlights resilience as a relational process between individuals and their environments, incorporating personal, social, cultural, and institutional resources and risks. (van-Rensburg, Theron, & Rothmann, 2018). Planetary Boundaries and Doughnut Economics link planetary boundaries (the ecological limits within which humanity can safely operate) to social foundations, advocating for a “safe and just space” for humanity that ensures well-being without exceeding Earth’s carrying capacity. (JFW, 2023).

### 3.2 Relevance to Sustainable Development Goals (SDGs) and Africa’s Agenda 2063

Socio-ecological resilience is central to achieving the United Nations Sustainable Development Goals (SDGs), especially those focused on environmental sustainability, health, and economic developments such as SDGs 2 (Zero Hunger), 6 (Clean Water and Sanitation), 13 (Climate Action), 14 (Life Below Water), and 15 (Life on Land) (Scown, et al., 2023). Research indicates that these SDGs have the strongest links with resilience factors such as biodiversity conservation, ecosystem service management, and adaptive capacity, but their implementation often remains disconnected. (Scown, et al., 2023). Africa’s Agenda 2063, the continent’s inclusive growth and sustainable development framework, strongly

emphasises climate-resilient agriculture, renewable energy, regional cooperation, and climate risk management for inclusive prosperity and unity amidst increasing climate impacts. (Naidoo, Dahir, & Gulati, 2023). Integrating socio-ecological resilience frameworks into national and regional policies should be a priority in realising these objectives and enabling sustainability.

### **3.3 Application in Policy and Practice**

Socio-ecological resilience frameworks are increasingly applied in African contexts by managing forests, fisheries, and water resources to sustain both ecological integrity and community livelihoods, such as in the Southern African Program on Ecosystem Change and Society (SAPECS) (RA). Initiatives like the AE+6 program in the Sahel demonstrate how integrating agroecological practices with social equity, women's empowerment, and nutrition can build resilience among smallholder farmers facing climate shocks. (GI, 2020). Community-based approaches in the Horn of Africa and Sahel regions focus on participatory risk assessments, cross-border collaboration, and adaptive governance to enhance resilience to droughts and other hazards. (CI, Building Resilience in a Complex Environment, 2012) (FAO, 2016). Socio-ecological frameworks inform the design of cities and infrastructure to withstand climate extremes, promote social equity, and sustain ecosystem services. (SADC, 2020).

These applications underscore the value of resilience thinking for achieving sustainable development and adapting to ongoing environmental change.

## **4.0 LITERATURE REVIEW**

### **Regional and Ecosystem Variability**

The vulnerability and impacts of climate change on ecosystem services vary widely across Africa's diverse landscapes. Savannas are experiencing altered rainfall regimes and increased fire frequency, leading to shifts in vegetation and loss of biodiversity (Xu, 2024). Forests, particularly montane and tropical forests, face severe threats from deforestation and climate change, resulting in rising temperatures, reduced water capture, and biodiversity loss. Wetlands and coastal zones are among the most vulnerable, with sea level rise, saltwater intrusion, and increased erosion threatening their capacity to provide water purification, flood regulation, and habitat for wildlife (Kitula, Larwanou, Munishi, Muoghalu, & Popoola, 2015). Regional differences are also evident, with southern Africa projected to become more arid due to declining rainfall and increased evapotranspiration. At the same time, parts of East Africa may experience increased rainfall but with high uncertainty. Ecoregional vulnerability assessments indicate that montane forest-grasslands and flooded savannas are particularly at risk, with high biodiversity areas facing disproportionate impacts (Twumasi-Ankrah, Zhan, & Asamoah, 2024).

### **Feedback and Thresholds**

Ecosystem degradation can amplify climate impacts through feedback loops and the crossing of ecological thresholds. For example, deforestation reduces carbon sequestration and accelerates local warming and cloud base height rise, which diminishes water capture and further stresses forest ecosystems. (Twumasi-Ankrah, Zhan, & Asamoah, 2024). Loss of biodiversity and ecosystem function can push systems past tipping points, resulting in irreversible changes such as desertification, collapse of fisheries, or permanent loss of wetlands. (Sintayehu, 2018). This feedback reduces the adaptive capacity of ecosystems and human communities, making recovery more difficult and increasing the risk of cascading failures across agriculture, water, and health. (Leal, et al., 2021). Protecting and restoring ecosystem services is critical for direct benefits and maintaining the resilience needed to adapt to ongoing and future climate change.

### **Human Health and Economic Outcomes**

The degradation and loss of ecosystem services in Africa directly and indirectly affect human health, particularly regarding nutrition, disease prevalence, and water and air quality. Declining agricultural productivity due to environmental degradation and biodiversity loss reduces the availability of diverse and nutritious foods, contributing to malnutrition and stunted growth, especially among children. (Antwi-Agyei & Stringer, 2025). Water scarcity and pollution, exacerbated by ecosystem disruption, are linked to increased incidence of waterborne diseases such as cholera and dysentery and impaired hygiene and sanitation, further compromising public health. (WHO, Biodiversity, 2025) (WHO, Ecosystems and Human Well-being: Health Synthesis., 2005). Inadequate access to clean water and poor sanitation are significant factors in Africa's high burden of infectious diseases and adverse pregnancy and birth outcomes. Moreover, air pollution from ecosystem degradation and unsustainable land use is associated with rising rates of respiratory and cardiovascular diseases. (UNEP, 2024). The loss of regulating

ecosystem services, such as disease control and water purification, increases vulnerability to communicable and non-communicable diseases. (WHO, Biodiversity, 2025).

Ecosystem service loss has significant economic repercussions for agriculture, fisheries, tourism, and rural livelihoods. Agriculture, which employs most of Africa's workforce, is particularly vulnerable to land degradation, declining soil fertility, and erratic rainfall, reducing yields and food insecurity. (Antwi-Agyei & Stringer, 2025). The degradation of aquatic habitats and overexploitation threaten fisheries, undermining food security and income for millions of people. (UN, 2002). As another important driver of economic growth and diversification, tourism is threatened by biodiversity loss and ecosystem degradation, which will curtail Africa's attractiveness for ecotourism and wildlife-based activities. Furthermore, rural and marginalised communities that depend on natural resources become even more vulnerable as ecosystem services decline, leading to poverty and migration. (Andeltoová, Catacutan, Wünscher, & Holm-Müller, 2020). The global economic cost of biodiversity loss and ecosystem degradation is estimated to reach trillions of dollars, with Africa at the most significant risk due to its reliance on natural capital. (WHO, Ecosystems and Human Well-being: Health Synthesis., 2005).

### **Equity and Gender Dimensions**

The effects of ecosystem service loss are not equally experienced across groups. Women, children, and other marginalised populations are disproportionately impacted because of inequality in existing social, economic, and political rights. (CI, Gender Inequality, Biodiversity Loss, and Environmental Degradation, 2021). Women are often responsible for food, water, fuel, and, parenting, so when these natural resources are scarce, women, and by extension, children and the elderly, become disproportionately affected, which increases their risk of gender-based violence, causes educational opportunities for child girls to disappear, and heightens food insecurity. Gendered differences in access and control of land and resources exacerbate vulnerability; women have less decision-making power and benefit less from the positive benefits of ecosystem services. (Kiptot, Catacutan, Wünscher, & Holm-Müller, 2019). Children are also at greater risk of malnutrition, disease, and disrupted education, particularly in regions affected by climate-induced disasters and ecosystem collapse. Addressing these disparities requires inclusive and gender-responsive approaches to ecosystem management and climate adaptation.

### **Integrated Strategies for Socio-Ecological Resilience**

Nature-based solutions (NbS) and ecosystem-based adaptation (EbA) are increasingly recognised as effective strategies for enhancing socio-ecological resilience in Africa. These approaches involve the restoration, conservation, and sustainable management of ecosystems to deliver co-benefits for climate adaptation, human health, and economic development (Nyika & Dinka, 2022). For example, forest restoration and agroforestry sequester carbon, regulate water cycles, support biodiversity, improve food security, and reduce disaster risk (WWF, 2023). Large-scale initiatives such as the Great Green Wall in the Sahel region illustrate how ecosystem restoration can combat desertification, enhance livelihoods, and promote resilience to climate extremes. Evidence from African projects demonstrates that NbS can reduce vulnerability to floods and droughts, support sustainable agriculture, and improve community well-being (Nyika & Dinka, 2022).

### **Policy and Institutional Integration**

Effective resilience-building requires integrated policy and institutional frameworks that link environmental, health, and economic sectors. Many African countries have begun mainstreaming climate adaptation and environmental health into their Nationally Determined Contributions (NDCs), National Adaptation Plans (NAPs), and sectoral strategies. (GCA, 2023) (WHO, Regional Strategy for the Management of Environmental Determinants of Human Health in the African Region 2022–2032, 2022). For instance, Kenya, Uganda, and Tanzania have prioritised forest restoration and ecosystem management in their national climate strategies, aligning these efforts with health and economic objectives. Regional strategies, such as the Libreville Declaration and the updated Regional Strategy for the Management of Environmental Determinants of Human Health (2022–2032), emphasise cross-sectoral collaboration and the establishment of 'One Health' platforms to address the interconnectedness of human, animal, and ecosystem health. (WHO, Regional Strategy for the Management of Environmental Determinants of Human Health in the African Region 2022–2032, 2022). However, challenges remain regarding finance, capacity, and coordination, highlighting the need for robust institutional arrangements and monitoring systems. (GCA, 2023).

### **Community-Based and Participatory Approaches**

Community-based and participatory approaches are fundamental to strengthening socio-ecological resilience, particularly by integrating local knowledge, indigenous knowledge, and engaging multiple stakeholders (Africoli, 2024) (Mugabirwe & Turyamureeba, 2025). The indigenous knowledge systems provide contextual, culturally-embedded solutions for managing resources, making early warning and adaptation more effective and sustainable formal interventions in some cases. Many examples of traditional harvesting policies that are very successful initiatives, such as traditional water harvesting interventions in Ethiopia (Mugabirwe & Turyamureeba, 2025) or climate-smart agricultural policies in West Africa that improved adaptive capacity and reduced vulnerability, demonstrate the effective adaptation of knowledge systems. Engaging multiple stakeholders by enabling inclusive and participatory approaches, such as participatory planning and incorporating community radio for climate information to support local innovation ecosystems early on, helps to develop ownership and social cohesion to enhance the overall impact and social sustainability of resilience initiatives over the long term.

## 4.0 FINDINGS AND DISCUSSION

### Case Studies and Best Practices

Several African initiatives show how ecological, health, and economic aims can be successfully integrated. The Great Green Wall in the Sahel is a flagship example of large-scale ecosystem restoration for climate adaptation, food security, and job creation. The initiative has been improving soil fertility, increasing agricultural crop production, generating green jobs, and improving local community resilience to droughts and desertification through the restoration of degraded land and an emphasis on agroforestry. (EQUINET., 2025). In East Africa, integrating health care and industrial policies in Kenya and Tanzania has strengthened local pharmaceutical supply chains, improved access to essential medicines, and stimulated local economic development. (McSherry, 2017).

Urban health interventions in southern and eastern Africa—such as multisectoral partnerships for climate-adapted food systems, waste management, and clean energy—demonstrate the benefits of holistic, multi-actor approaches that improve health outcomes while supporting sustainable urban economies. Community-based and One Health approaches have also shown promise. In Kenya, Uganda, and Ethiopia, the operationalisation of the One Health framework has fostered collaboration across human, animal, and environmental health sectors, improving zoonotic disease surveillance and reducing outbreak risks. Local “Living Labs” in West Africa have piloted integrated financing for projects linking ecosystem restoration to public health and food security, demonstrating the value of innovative, context-driven solutions.

### Lessons Learned

Success factors for these interventions include strong political will, sustained stakeholder engagement, and alignment with local priorities. Practical projects often leverage local knowledge, build coalitions across sectors, and adapt to evolving community needs. Barriers to scaling include fragmented institutional arrangements, insufficient financing, and limited cross-sectoral coordination. (WHO-Africa, 2017). Lessons from the One Health experience highlight the need for high-level leadership, legal frameworks, and resource allocation within state budgets to institutionalise cross-sectoral collaboration. Scaling up best practices requires building on successful pilots, strengthening policy coherence, investing in digital health ecosystems, and prioritising equity and local ownership. (EQUINET., 2025). The growing emphasis on African-led innovation and integrated health and economic strategies—such as the AUDA-NEPAD Collaborating Centre for Health Market Development—signals a shift toward sustainable, home-grown solutions that can be adapted and replicated across the continent.

#### 4.3.0 Barriers, Enablers, and Research Gaps

Several persistent barriers hamper socio-ecological resilience efforts in Africa. Institutional silos and fragmented governance structures often result in disjointed policies and inefficient implementation, as seen in the separation of environmental, health, and economic mandates across government levels. Policy fragmentation and lack of coordination between agencies lead to duplication, conflicting regulations, and missed opportunities for integrated action. Funding constraints are acute: adaptation finance in Africa falls far short of needs, with current flows covering less than a quarter of what is required to meet Nationally Determined Contributions by 2030 (GCA, 2023). Limited data availability and monitoring systems, especially for ecosystem service dynamics and long-term outcomes, further restrict evidence-based

planning and adaptive management. (Wangai, Burkhard, & Müller, 2016). Social-psychological barriers—indifference, lack of trust, and competing priorities—impede collective action and recovery after shocks. Significant enablers for resilience-building are international partnerships and financial innovation, including the Adaptation Benefits Mechanism, which leverages public and private finance for climate adaptation (ADB, 2025). Building capacity at the individual, institutional, and community levels is necessary for implementing policies, transferring knowledge, and managing adaptive management effectively. Good governance and stakeholder engagement—ensuring the participation of marginalised individuals, women, and youth—will build legitimacy and enhance the effectiveness of policy interventions (UNDP, 2024). Policies must be based on evidence, supported by strong monitoring, evaluation and learning frameworks to enable adaptive management of initiatives and scale successful practices.

Despite much discourse and some progress, important knowledge gaps still exist. In particular, there is a need for long-term and multi-scale monitoring of ecosystem services and resilience outcomes, as very little is known about these outcomes in under-researched areas and ecosystems. (Wangai, Burkhard, & Müller, 2016). Additionally, not many integrated assessment tools can amalgamate biophysical, social, and economic indicators, resulting in a limited understanding of trade-offs and synergies across these sectors. The application of participatory research methods, which enhance local voices, integrate indigenous knowledge, and capture gender dynamics, remains limited. However, they are essential for being done systematically when designing context-appropriate and equitable intervention measures. (UNDP, 2024). The gaps in knowledge will need a long-term commitment to investment in research infrastructure, cross-sectoral partnerships, and co-production of knowledge.

#### **Key Findings**

Evidence from multiple sites in Africa shows that integrated, multi-sectoral approaches that link ecosystem services, climate adaptation, health, and economic development are key to building resilient socio-ecological systems. Success stories providing co-benefits for livelihoods, food security, public health, and biodiversity include nature-based solutions, cross-border and regional policy harmonisation, and community-led adaptation. However, significant barriers and constraints (eg. institutional silos, funding gaps, weak data) continue to restrict potential gains. Enablers of scaling effective practices and transformative resilience include inclusive governance, international partnerships, and enhancing capacity.

#### **5.0 Policy Recommendations and Future Directions**

**For African Governments:** Integrate ecosystem services and resilience into national climate, health, and economic planning by adopting integrated policy and cross-sector coordination mechanisms. Invest in ecosystem restoration, conservation, and sustainable management for the long term, building on initiatives such as the Pan-African Action Agenda on Ecosystem Restoration, AFR100, and the Great Green Wall. Strengthen national monitoring, data systems, and research capacity to allow for evidence-based decisions and monitor progress on resilience measures. Prioritise inclusive and participatory governance that captures the voices of women, youth, indigenous peoples, and marginalised communities in policy development and implementation.

**For Regional Bodies (e.g., African Union, Regional Economic Communities):** Bring together and organise regional strategies on climate, health and biodiversity, using frameworks like the African Union Climate Change and Resilient Development Strategy and Action Plan (2022–2032). Encourage international collaboration, knowledge sharing and scaling of best practices through regional platforms and networks. Mobilise and coordinate climate finance and technical support to enhance resilience in priority sectors, including agriculture, water, and health.

**For International Partners:** Support African-led resilience actions with ongoing funding support, technology transfer and capacity building, while acknowledging local priorities and knowledge systems. Encourage collaborations between research, policy, and practice, and facilitate South-South and triangular cooperation for knowledge sharing and innovations. Align development assistance efforts with Africa's Agenda 2063 and Sustainable Development Goals (SDGs) through climate justice, equity, and long-term sustainability.

#### **6.0 Implications for Sustainable Development**

Incorporating ecosystem services and resilience thinking into policy and practice is essential in delivering the SDGs and Africa's Agenda 2063. Integrated and inclusive pathways, informed by evidence and local

context, can generate transformative outcomes towards food and nutritional security, water security, a healthy population, sustainable and inclusive economies, and effective natural systems by 2030. Transformative change requires courageous leadership, collaboration across sectors, and resource investment—people, institutions, and ecosystem. By addressing the needed changes, Africa can build pathways to resilient, sustainable, and equitable development (present and future).

## 7.0 CONCLUSIONS

Ecosystem Services provide critical building blocks for health and well-being, food production and security, water security and sustainability, and economic development across Africa, and these services are becoming increasingly threatened by climate change and environmental degradation. The consequences of disrupting ecosystem services such as water regulation, food generation and provision, health (disease) control, and climate regulation significantly impact human well-being and livelihoods. It will take collaborative and integrated approaches across sectors (nature-based solutions, inclusive governance, and evidence-based policy) to strengthen resilience and benefit people and the environment. To secure a resilient and sustainable future, researchers, policymakers, and practitioners will need to break out of established (institutional) silos and work collaboratively across multiple sectors—range of species in bloom. Invest in ecosystem restoration; support community-led innovations; integrate ecosystem services across climate, health, and economic planning. Suppose Africa adopts an integrated approach, emphasising equity and embedding community engagement in the normative agenda. In that case, it can make strides in achieving the Sustainable Development Goals and building resilient socio-ecological systems with the impending challenges and realities of climate change and adaptation.

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### Declarations

- No Funding Sources
- Ethics approval and consent to participate: This study did not involve human participants, human data, or human tissue. Therefore, ethics approval and consent to participate were not required.
- Consent for Publication- Not applicable.
- Availability of data and materials: This study did not generate new data. All data referenced are available in the cited publications.
- Competing interests: The author declares that there are no competing interests
- Funding: This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.
- Authors' contributions: The author was solely responsible for the conception, literature review, analysis, and writing of this manuscript. The author read and approved the final version of the manuscript.
- Acknowledgements: The author would like to thank all individuals and institutions who provided support and valuable insights during the preparation of this manuscript. No additional assistance was received beyond what is acknowledged here.