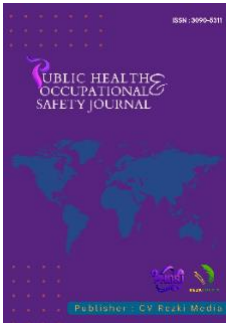


# Climate change and public health in Africa: A narrative review of resilience strategies for health systems



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## ABSTRACT

**Background:** Climate change poses an escalating threat to public health in Africa, a continent responsible for less than 10% of global greenhouse gas emissions yet disproportionately bearing the burden of its consequences. Existing health systems remain fragile, under-resourced, and ill-equipped to absorb climate-related shocks.

**Objectives:** To synthesize evidence on the health impacts of climate change in Africa and identify strategies for building climate-resilient health systems.

**Methods:** This study is a narrative literature review. A comprehensive search of peer-reviewed databases and gray literature was conducted. Sources were screened against predefined inclusion criteria and synthesized thematically across six domains: climate science, contextual vulnerabilities, health systems strengthening, governance, community engagement, and financing. A total of 22 studies and reports were included and analyzed using thematic synthesis following Thomas and Harden's (2008) three-step approach.

**Results:** Climate change intensifies the burden of infectious and non-communicable diseases, disrupts health infrastructure, and deepens health inequities across African regions. Resilience-building requires strengthened governance, sustained domestic and international financing, multisectoral partnerships, community engagement, and climate-adaptive health information systems.

**Conclusions:** Concerted, context-sensitive action that integrates climate adaptation into health policy frameworks is urgently needed to protect the health and well-being of African populations from the accelerating impacts of climate change. Practical implications include strengthening health system governance, mobilizing climate finance, investing in climate-adaptive surveillance systems, and fostering community engagement and multisectoral collaboration to build durable climate resilience across African health systems.

**Keywords:** Africa, climate adaptation, climate-sensitive diseases, health financing, health systems resilience, primary health care.

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## INTRODUCTION

Climate change is widely recognized as one of the most consequential threats to global health in the twenty-first century. In Africa, its effects cascade across ecological, social, and cultural systems, exacerbating vulnerabilities in communities that are already resource-constrained (Rublee et al., 2021). Although the literature has increasingly documented the health consequences of climate change (Ebi & Hess, 2020; Evans et al., 2023; Rahman et al., 2019; Rocque et al., 2021), comparatively little attention has been devoted to systematically appraising the strengths and limitations of current responses to climate-related health threats. Africa's substantial heterogeneity—in geography, governance, and health system capacity—means that preparedness and resilience-building vary considerably across countries (Wright et al., 2024). Recognizing this, the African Academy of Sciences, the University of Cape Town, the World Health Organization (WHO), and partner institutions convened representatives from 25 African countries to exchange lessons and identify actionable opportunities for climate-health integration. However, previous studies have not comprehensively synthesized the full spectrum of climate-health adaptation strategies across Africa's diverse regional contexts, nor integrated findings on governance, financing, and community engagement into an actionable resilience framework. This review addresses that gap by synthesizing evidence across six interconnected domains, identifying context-sensitive, evidence-based strategies for building climate-resilient health systems on the continent.

The adverse consequences of climate change are distributed inequitably: those contributing the least to global greenhouse gas emissions bear the greatest burden (Rublee et al., 2021). Africa accounts for less than 10% of global emissions, yet it faces heightened risks due to limited technological capacity and underdeveloped adaptive infrastructure. Climate hazards threaten progress across multiple sectors, and the continent risks the irreversible loss of natural resources and ecosystem services unless resilient, coordinated action is taken (Wright et al., 2024). African cities already contend with flooding, drought-induced water scarcity, landslides, and extreme heat events—phenomena that destroy health facilities, displace health workers, heighten exposure to communicable diseases, and increase maternal and child health complications. Health systems must therefore address both immediate climate impacts and the longer-term structural vulnerabilities that amplify them (Campbell-Lendrum et al., 2023). However, few policies currently integrate climate mitigation or adaptation into health sector planning, and global agendas remain constrained by data deficits, inadequate stakeholder engagement, limited access to technology and financing, and persistent inequities in climate-related health impacts.

This study examines the complex interplay between climate change and health across multiple sectors, recognizing that as scientific understanding deepens, health risks and opportunities will continue to evolve spatially and temporally. Although the discussion draws substantially on evidence from Sub-Saharan Africa, climate change affects regions differentially (Wright et al., 2024). Africa confronts compounded challenges shaped by demographic transition, persistent underdevelopment, and a changing climate. Climate-induced shifts in temperature, precipitation, and sea levels intensify long-standing health burdens. This review delineates the principal climate-related health impacts and dimensions of population vulnerability across Africa, situates them within the broader context of economic

resilience, and identifies evidence-based interventions to prevent or reduce harm to health and well-being.

## **METHODS**

### **Study Design**

A narrative literature review was conducted to synthesize evidence on the health impacts of climate change in Africa, the vulnerabilities of existing health systems, and strategies to strengthen climate-resilient health systems. This design facilitated the integration of evidence from epidemiology, environmental health, health policy, and systems science. Narrative reviews afford flexibility in selecting diverse source types—including conceptual papers, policy documents, commentaries, and empirical studies—that collectively illuminate the climate-health relationship (Snyder, 2019).

### **Ethical approval statement**

As a secondary analysis of published literature, the study did not require formal ethical approval. All sources are appropriately cited, findings are faithfully represented, and conflicts or evidential gaps are acknowledged to ensure transparency.

### **Search Strategy**

A comprehensive literature search was conducted across PubMed/MEDLINE, Scopus, Web of Science, Google Scholar, and the WHO Institutional Repository for Information Sharing (IRIS). Grey literature sources included the WHO, the African Development Bank (AfDB), the Intergovernmental Panel on Climate Change (IPCC), the United Nations Environment Program (UNEP), and national health ministries. Search terms encompassed "climate change," "global warming," "public health," "health systems," "Africa," "Sub-Saharan Africa," "climate-sensitive diseases," "extreme weather events," "health adaptation," "mitigation," and related terminology. Boolean operators were applied to enhance specificity. Priority was accorded to literature published between 2010 and 2024.

### **Inclusion and Exclusion Criteria**

Sources were included if they were published in English in peer-reviewed journals, institutional reports, or policy briefs; focused on the health impacts of climate change, climate-health adaptation strategies, or health system resilience in African countries or in LMICs with comparative relevance to Africa; addressed at least one of the following themes: climate change trends, direct and indirect health impacts, health systems strengthening, governance and policy frameworks, community engagement, financing mechanisms, research and innovation, or monitoring and evaluation; and provided substantive empirical, theoretical, or policy-relevant insights applicable to the African context.

Literature was excluded if it focused exclusively on high-income country settings with no transferable lessons for Africa; addressed climate change from a purely physical science perspective without linkage to public health outcomes; or was inaccessible in full text or of insufficient quality to meaningfully inform the review.

### **Quality Assessment**

Given the diversity of source types, a uniform appraisal instrument was not applied. Instead, structured critical appraisal assessed relevance, methodological

rigor, source credibility, and thematic alignment. Priority was accorded to peer-reviewed empirical studies, high-quality systematic reviews, and reputable institutional reports. Sources with unsupported conclusions or potential conflicts of interest were treated with appropriate caution. Appraisal was informed by the Critical Appraisal Skills Program (CASP) framework, adapted to the heterogeneous source types included, enabling assessment of internal validity, relevance to the African context, and the adequacy of conclusions.

## Data Analysis

Sources were screened at the title and abstract level, followed by full-text review. Extracted data included study design, geographic focus, thematic domain, key findings, and identified barriers or enablers. An extraction matrix facilitated systematic comparison. Thematic synthesis followed [Thomas & Harden's \(2008\)](#) three-step approach: free coding, development of descriptive themes, and generation of analytical themes aligned with six domains: climate science and health implications; African vulnerabilities; health system resilience; governance and policy; community engagement; and financing and collaboration. A total of 22 peer-reviewed articles, institutional reports, and policy documents were included. The flow of study identification, screening, and inclusion followed PRISMA-aligned principles: an initial pool of over 120 records was identified, 56 were retrieved for full-text review, and 22 met all inclusion criteria. Free coding was applied iteratively; codes were grouped into descriptive themes and refined into the six analytical domains.

## RESULTS

A total of 22 studies and reports were included and analyzed using thematic synthesis following [Thomas & Harden's \(2008\)](#) three-step approach as detailed in [Table 1](#).

**Table 1.** Summary of Key Studies Included in the Narrative Review

Author (Year)	Study Focus	Key Findings
<a href="#">Banwell et al. (2018)</a>	Disaster and climate change risk commonalities	Proposed a theoretical framework linking shared pathways between disaster events and climate change to health outcomes.
<a href="#">English et al. (2009)</a>	Environmental health indicators for climate change	Developed climate change environmental health indicators; methods are transferable to LMIC monitoring systems.
<a href="#">Borghi et al. (2024)</a>	Climate finance opportunities for health systems	Mapped financing gaps and opportunities; identified limited health-sector access to Green Climate Fund mechanisms.
<a href="#">Thomson et al. (2014)</a>	Climate and health in Africa	Reviewed climate-health linkages across Africa; highlighted data gaps and need for integrated early warning systems.

*Continued Table 1. Summary of Key Studies...*

Dos Santos et al. (2022)	Climate-health nexus, South Africa	Qualitative expert analysis revealing governance gaps, policy incoherence, and underfunded adaptation in South Africa.
Chersich et al. (2018)	Climate change health impacts, South Africa	Documented heat-related mortality, vector-borne disease expansion, and mental health impacts; called for an integrated national response.
Gould & Rudolph (2015)	Climate change and public health practice	Reviewed barriers and enablers to integrating climate action into public health; emphasized community engagement.
Hambling et al. (2011)	Environmental health indicator frameworks	Reviewed frameworks for developing climate-health indicators applicable to M&E system design in LMICs.
Hanefeld et al. (2018)	Health system resilience	Conceptualized resilience as absorb-adapt-transform capacity; core framework for climate-responsive health system strengthening.
Bowen et al. (2011)	Governance for healthy populations under climate change	Argued for coherent multi-level governance linking climate and health policy; identified key decision-making gaps.
Hess et al. (2011)	Climate change adaptation in public health	Proposed adaptive management framework for integrating climate adaptation into public health practice.
Pongsiri & Bassi (2021)	Systems thinking at the climate-health nexus	Advocated for systems-level understanding to address complex climate-health interactions and support multi-sectoral approaches.
Ebi et al. (2018)	M&E indicators for climate-health resilience	Developed indicators across six resilience elements; applicable to tracking adaptation effectiveness in LMICs.
Ebi & Del Barrio (2017)	Health adaptation in LMICs	Synthesized lessons from 11 countries; identified governance, financing, and technical capacity as key enablers.
Madrigano et al. (2021)	Climate-health research policy	Outlined a policy agenda for climate-health research;

		methods and frameworks transferable to African contexts.
Mayhew et al. (2014)	Climate-responsive health system readiness	Examined readiness to build climate-aware health systems; identified structural and organizational barriers.
Mosadeghrad et al. (2023)	Strategies for climate-resilient health systems (scoping review)	Identified 12 strategies across governance, financing, infrastructure, and workforce for climate resilience in health systems.
Ray et al. (2022)	Climate change, disaster management, and PHC in Zimbabwe	Documented PHC vulnerabilities to climate shocks; highlighted importance of community health workers in resilience.
Quintana et al. (2024)	Climate-health policy coherence, South Africa	Found incoherence between national adaptation policy and health sector implementation; lack of accountability mechanisms identified.
Wright et al. (2024)	Climate change and human health in Africa	Synthesized climate-health evidence across Africa; proposed strategies for strengthening mitigating potential and adaptive capacity.
Wright et al. (2021)	Transdisciplinary climate-health adaptation, Africa	Argued for transdisciplinary, community-co-designed approaches to climate adaptation for health and well-being across Africa.

*Note. The 22 studies above represent all sources directly consulted and cited in this review, presented in reference-list order.*

## DISCUSSION

### Understanding Climate Change and Its Health Impacts

A fundamental imperative exists to identify pathways for transitioning toward low-carbon, sustainable, and equitable development while simultaneously building resilience to a changing climate (Chersich et al., 2018). Climate change is projected to adversely affect vital ecosystems and global temperatures, with particularly severe consequences for vulnerable populations—including those in low-income countries, infants, children, women, older adults, and individuals with pre-existing illness or disability (Ruble et al., 2021). These projections underscore the need to deepen understanding of how climate change cuts across the entire health sector—extending well beyond infectious disease to encompass health facility functionality and health system resilience. Across the included studies, there is strong convergence that climate change disproportionately affects vulnerable populations in Africa, although

mechanisms differ across ecological and socio-political contexts (Wright et al., 2024; Rublee et al., 2021; Chersich et al., 2018). Several studies consistently report that climate change exacerbates infectious disease burdens in Sub-Saharan Africa, particularly through vector expansion, water insecurity, and health infrastructure disruption (Wright et al., 2024; Mosadeghrad et al., 2023; Dos Santos et al., 2022).

Climate change directly affects ambient temperatures, precipitation, and the frequency and severity of extreme weather events, while indirectly influencing the social determinants of health. The continuum of climate-related health risk begins with climate change itself, proceeds through exposure and intermediary health risks, and culminates in measurable health impacts. A sound understanding of this causal chain is indispensable for designing effective policy responses.

### **Climate Change Science and Key Concepts**

Climate change science continues to advance rapidly, generating a substantial and growing evidence base on causes, mechanisms, projections, and impacts (Wright et al., 2024). Regardless of the indicator employed, atmospheric CO<sub>2</sub> concentrations continue to rise. Climate change is formally defined as a statistically significant variation in the mean state or variability of climatic properties that persists for an extended period, typically decades or longer—encompassing both natural variability and anthropogenic contributions. Climate models project future conditions based on greenhouse gas emissions scenarios, drawing on techniques such as tree-ring analysis, glacial ice cores, and ocean sediment cores (Rublee et al., 2021). Contemporary modeling frameworks account for a broad range of greenhouse gases—including black carbon aerosol, ozone, methane, and CO<sub>2</sub>—and operate across spatial and temporal scales.

### **Direct and Indirect Health Impacts**

Anthropogenic climate change—encompassing long-term climatic shifts and increased extreme weather events—has far-reaching consequences for public health. At the most fundamental level, climate change directly impairs the natural systems that sustain life: air, water, land, food, and shelter. Prolonged heat and cold extremes, extreme precipitation, flooding, drought, and temperature fluctuations produce severe direct health consequences, including elevated morbidity and mortality, particularly among populations with limited adaptive capacity (Wright et al., 2024). Climate-related environmental shocks can also precipitate poverty traps and compound existing health deficits, affecting both the physical and psychological well-being of communities (Banwell et al., 2018).

Direct health impacts include a projected rise in heat-related illnesses—heat rash, heat exhaustion, and heat stroke—as well as deteriorating air quality and increased incidence of asthma, chronic obstructive pulmonary disease, and allergic conditions. Extreme weather events also inflict significant mental health consequences, contributing to anxiety, depression, and post-traumatic stress disorder in affected communities.

Indirect impacts operate through multiple pathways. Climate variability affects water quality, quantity, and accessibility. Altered precipitation patterns may permanently reduce stream flow and degrade water security for communities dependent on surface water sources. As temperatures rise and evaporation intensifies, competition for diminishing water and food supplies intensifies, with attendant increases in morbidity, mortality, and population displacement.

## **The African Context: Vulnerabilities and Challenges**

The health impacts of climate change in Africa are already manifest across a broad spectrum of outcomes. Particularly vulnerable groups include children, women, and populations in conflict-affected areas—such as parts of Uganda and the Democratic Republic of Congo—where population displacement and health service disruption have been documented (Wright et al., 2024). While conditions such as malaria and urban heat-related mortality are relatively well studied, others—including rodent-borne diseases and climate-induced stresses on fragile health infrastructure—require further investigation. Projections indicate that climate-attributable costs of malnutrition, respiratory infections, and diarrheal disease will reach USD 283 billion by 2030 (2012 prices)—a figure that starkly contrasts with Africa's total health expenditure of USD 84.4 billion in 2014, of which 38% was externally financed (Ruble et al., 2021).

Africa's diverse cultural, linguistic, and livelihood landscape is overlaid with exposure to flooding, famine, drought, desertification, temperature rise, sea-level rise, and political instability—all of which carry health consequences. Observed climate trends include a mean annual temperature increase of 1.2°C since the 1900s, with projections exceeding 2°C in some regions by 2080, alongside a 5–10% decline in rainfall in certain areas and an increase in drought frequency (Ruble et al., 2021). Climate-driven land degradation and food insecurity further erode health outcomes, while approximately 20% of the population residing in politically unstable or conflict-affected areas face compounded vulnerability. Compared with higher-income settings, African evidence reveals a distinctive pattern: climate impacts are amplified not merely by hazard exposure but by structural fragility and near-absence of climate-adaptive financing. Unlike high-income health systems, where adaptation can be incrementally added, African systems require transformative reform (Mosadeghrad et al., 2023; Ebi & Del Barrio, 2017).

### **Climate Change Trends in Africa**

Both natural and anthropogenic factors drive climatic change in Africa. Natural drivers include variations in solar output, orbital cycles, continental drift, volcanic activity, and phases of the El Niño Southern Oscillation (ENSO). Anthropogenic drivers include greenhouse gas emissions, land cover and land use changes, altered biophysical land surface properties, anthropogenic aerosols, and sea surface temperature anomalies in the tropical Atlantic and Indian Oceans (Wright et al., 2024). All six African regions recorded increases in average temperature between 1901 and 1930 and 1991 and 2021. The number of extreme warm days increased significantly between 1979 and 2017, with some regions—including the Arabian Peninsula, northeastern Africa, and southern Africa—recording increases of more than 20 additional extreme warm days annually (Ruble et al., 2021). Africa's climate is projected to warm by 1.5–7.0°C, with summer precipitation potentially declining by 40–60%, while equatorial and tropical regions have already experienced temperature increases of 1–3°C over the past five decades.

### **Existing Health Systems and Infrastructure**

Africa faces a chronic and severe deficit in health system capacity and infrastructure. Sub-Saharan Africa accounts for only 30% of the global health workforce, and five of the ten countries with the most acute personnel shortages are located in Africa. Despite demonstrated strengths in addressing health and development priorities, improvements remain constrained by pervasive deficiencies

in infrastructure and human resources (Ruble et al., 2021). Most health systems are poorly equipped to manage the growing burden of climate-related health risks and to adapt to climate-sensitive conditions—such as expanding transmission zones for malaria and dengue—making adaptation extremely challenging (Wright et al., 2024).

### **Building Resilient Health Systems**

Climate change is projected to disproportionately affect vulnerable populations in Africa, with impacts mediated by social, economic, cultural, behavioral, and geopolitical determinants (Mosadeghrad et al., 2023). Early manifestations include increased illness and mortality from extreme weather events, a rising burden of climate-sensitive diseases, and altered patterns of infectious disease transmission. Strengthening the key building blocks of the health system—leadership and governance, health financing, infrastructure, health information systems, workforce, and service delivery—is therefore essential (Wright et al., 2021). Specific interventions include: developing climate change and health strategic plans; strengthening interdepartmental coordination; increasing investments for climate-related health impact mitigation; establishing standardized economic assessment tools; mobilizing domestic and international financing; adapting health facilities using climate-proof design; incorporating climate variables into disease surveillance systems; training the health workforce on climate-sensitive risks; and establishing mobile emergency services, heat-health action plans, and continuity protocols for essential services during climate-related shocks.

### **Key Components of Resilient Health Systems**

Resilience denotes the capacity of systems to absorb disturbances, adapt to new conditions, and learn from experience. Primary Health Care (PHC) systems are particularly well-positioned to demonstrate resilience, given their proximity to communities and their role in addressing the social determinants of health (Mosadeghrad et al., 2023). Resilient health systems must perform effectively under normal conditions while remaining robust enough to respond during crises and capable of transforming in ways that reinforce adaptive capacity (Hanefeld et al., 2018).

### **Adaptation Strategies and Best Practices**

Most adaptation strategies are implemented at the local level but require national policy mandates, integration with climate risk assessments, and dedicated financing. Conservation and restoration of coastal ecosystems—including dunes, wetlands, and mangroves—yield co-benefits for public health and water quality (Wright et al., 2024). Innovative solutions such as the Earth Enable program in Rwanda—which replaces dirt floors with durable, waterproof materials to confer flood resilience—demonstrate the potential of context-appropriate technologies to reduce climate-related health risks at the household level (Wright et al., 2024).

### **Policy and Governance Frameworks**

Establishing climate-resilient health systems requires coherent policy and governance architecture spanning four domains: health system structures, operations, and interactions; information for policy; risk assessment; and governance frameworks (Bowen et al., 2011). Coherence across policies, legislation, and strategies affecting health systems is essential, as is the alignment of governance arrangements across multiple levels of jurisdiction. South Africa's National Climate Change Response Policy (NCCRP), developed in 2012, and the seven associated

Climate Action Plans illustrate promising legislative intent. However, implementation at provincial and local levels remains inconsistent (Quintana et al., 2024).

### **Integration of Climate and Health Policies**

Significant governance gaps persist in the climate-health nexus. Climate and health policies must be co-developed to maximize synergies, given that improved population health is a major co-benefit of effective climate action (Pongsiri & Bassi, 2021). Empirical evidence increasingly supports the establishment of global and national climate-health policy networks, monitoring observatories, and evaluation frameworks to track progress and inform adaptive management (Wright et al., 2021).

### **Community Engagement and Capacity Building**

Public health forums convened by local government provide valuable platforms for community engagement in climate-health policy development and implementation (Gould & Rudolph, 2015). Effective community involvement is foundational to resilience: communities on the frontlines of climate impacts possess local knowledge that is critical for contextualizing climate events and calibrating health responses. Community-based organizations strengthen public health surveillance, improve health data quality, motivate local health workers, and advocate for equitable health systems—though their sustainability may be constrained by dependence on external donor funding (Gould & Rudolph, 2015). Capacity-building initiatives equip individuals and communities with the knowledge and skills needed to respond to climate-induced health challenges. Landscape and climate scenario tools support anticipatory governance. At the same time, case studies developed through EU-funded initiatives offer actionable insights for enhancing adaptive capacity in health systems, particularly in contexts of drought, extreme heat, vector-borne disease, and malnutrition (Hess et al., 2011).

### **Research and Innovation in Climate-Health Resilience**

The complex, wide-ranging, and temporally diverse nature of climate-induced health impacts demands ongoing investment in research, innovation, and novel technologies (Wright et al., 2024). Climate-smart health systems must apply innovative approaches to manage complex datasets, enhance epidemiological modeling, and contextualize surveillance information. Climate-adapted disease surveillance systems require integration of local vector, host, and pathogen dynamics with climate data across scales—necessitating sustained investment in climate monitoring infrastructure, modeling capacity, and multidisciplinary research collaboration (Dos Santos et al., 2022). Priority research gaps include a deeper understanding of differential vulnerabilities across health systems and regions, and the development of broader integrated human assessment models that capture dynamic interactions among climate change, environmental exposures, and health outcomes—spanning health, non-health environmental, and socioeconomic domains (Wright et al., 2024; Madrigano et al., 2021).

### **Lessons from African Case Studies**

Case studies across Africa highlight five cross-cutting themes: the centrality of multi-sectoral collaboration; the value of innovative data use and technology; the imperative of prioritizing vulnerable populations; the effectiveness of integrated planning; and the importance of mobilizing diverse financing. The South African Health and Climate Change Adaptation Plan (SAHCCAP) exemplifies meaningful

cross-sectoral collaboration. At the same time, a multi-sectoral, contract-based approach with local authorities has demonstrated potential for promoting accountability, community engagement, and sustained investment.

### **Challenges and Barriers to Implementation**

Despite the compelling evidence base, implementation of climate-resilient health systems faces significant obstacles. Climate change is often accorded low socio-political priority in countries where health systems are already overwhelmed by poverty, malnutrition, and endemic disease (Ebi & Del Barrio, 2017). The multi-sectoral nature of the challenge complicates coordination, while differences between global adaptation frameworks and local framings of climate risk impede adoption. Limited technical capacity, inadequate human resources, and financing shortfalls further hinder efforts to scale interventions. Overcoming these barriers demands sustained political will, broad stakeholder engagement, and governance structures capable of mobilizing and sustaining financing for climate-health system strengthening (Dos Santos et al., 2022; Gould & Rudolph, 2015).

### **Monitoring and Evaluation**

Robust monitoring and evaluation (M&E) are indispensable for ensuring that climate-health adaptation investments yield measurable outcomes (Ebi et al., 2018). The UNFCCC Warsaw Mechanism and the 2030 International Development Agenda both recognize the imperative to track the effectiveness of climate-health interventions (Thomson et al., 2014). An indicators and metrics framework tracking six elements of climate-health resilience—monitoring, assessment, understanding, management, intervention support, and enabling environments—provides a structured approach applicable to LMICs. Despite the escalating health costs of climate change, no comprehensive global system currently monitors the effectiveness of programs designed to address these risks, representing a critical gap.

### **Financing Climate-Resilient Health Systems**

The Paris Agreement, UNFCCC, WHO, and multilateral climate initiatives advocate for substantially increased climate finance for health (Borghi et al., 2024). Multiple financing mechanisms exist, including the Green Climate Fund, the World Bank, the Adaptation Fund, the Global Environment Facility, and the Climate Investment Funds. However, climate-smart global health funding has yet to be placed on a permanent trajectory, and vulnerable countries must actively engage in 2030 financing negotiations to secure climate-resilient health financing provisions. Domestic resource mobilization is equally critical. Governments are urged to prioritize climate-resilient health investments within national fiscal frameworks, shifting public expenditures toward climate-adaptive development (Borghi et al., 2024; Wright et al., 2021). Multi-sectoral and international partnerships—encompassing academia, civil society, the private sector, and South-South cooperation—are also essential for sustaining the research, knowledge, and financing flows required to build durable resilience (Wright et al., 2024).

### **Comparison with Previous Research**

The findings of this review align with, yet extend, prior narratives on climate and health in Africa. Earlier reviews focused primarily on disease burden and climate exposure pathways, with limited attention to health system resilience or financing mechanisms (Chersich et al., 2018; Thomson et al., 2014). More recent work by Wright et al. (2024) and Mosadeghrad et al. (2023) has begun to address system-level

responses but tended to treat individual building blocks in isolation. This review offers a more comprehensive, cross-domain synthesis that explicitly links climate adaptation to all six WHO health system building blocks, contextualized within Africa's governance and financing realities.

### **Implications**

Governments across Africa should explicitly incorporate climate adaptation into national health strategies and ensure climate finance mechanisms are accessible to health ministries. Health system managers need tools and training to embed climate risk assessment into routine planning, facility design, and surveillance. Priority research gaps remain in understanding how governance structures and financing arrangements enable or constrain climate-resilient health system development; future studies should adopt mixed-methods designs capturing both quantitative health outcomes and qualitative governance processes.

### **Limitations of the study**

This review has several methodological limitations. Restriction to English-language sources may have excluded relevant evidence from francophone and lusophone African contexts. Narrative synthesis is susceptible to selection bias and subjectivity in thematic interpretation. The heterogeneity of source types makes direct comparison difficult. Additionally, given the rapid evolution of the evidence base, some findings may have been superseded by research published after the search period (2010–2024).

Notwithstanding the formidable challenges posed by climate change, viable and evidence-informed solutions exist. Successful interventions demonstrate that meaningful progress is achievable when responses are grounded in local context and attentive to the needs of people, ecosystems, and cultures (Wright et al., 2024). Simplistic, decontextualized, or globally uniform responses will prove insufficient. Although Africa faces disproportionate adverse consequences, its youthful demographics and deep reservoir of contextual knowledge may position it to develop innovative, regionally appropriate solutions (Ruble et al., 2021). Governments, civil society organizations, universities, health teaching institutions, and technical colleges must modernize education systems to equip successive generations with the interdisciplinary competencies required to navigate the climate change challenge. Youth engagement and empowerment are not peripheral concerns—they are central to long-term resilience. The rapid adaptation of global educational institutions during the COVID-19 pandemic offers a meaningful precedent for the systemic transformation needed to address the existential threat of climate change (Wright et al., 2024).

Africa has already experienced significant climate-related changes and is projected to be among the regions most severely affected. Disruptions to mental and physical health and threats to the public health architecture underscore the urgent need for a whole-of-systems approach in vulnerable nations (Wright et al., 2024). Future efforts should maximize the mobilization of climate finance, strengthen the relevance of climate services to public health decision-making, and deepen co-design between health systems and affected communities. Human and financial resource capacity should be developed through Africa-for-Africa initiatives, and academic institutions should collaborate to produce accessible, multilingual research evidence that informs inclusive climate adaptation strategies across the continent (Ruble et al., 2021).

## CONCLUSIONS

Despite the complex challenges posed by climate change, viable solutions exist, and action can be taken. Literature and successful interventions offer approaches to responses and adaptation grounded in local context and an understanding of people, ecosystems, and cultures. Simplistic responses that ignore this context or rely entirely on global mechanisms will fail. Although Africa has and will experience greater adverse consequences, it may also be best placed to provide solutions due to its youth and understanding of local contexts. Governments, civil society, universities, health teaching institutions, and technical colleges must transform education to equip generations to address the climate change challenge and collaborate across disciplines. Young people need to be inspired and empowered. Local actions harnessing indigenous knowledge may create safer environments. Educational institutions globally pivoted in response to COVID-19, offering hope for adaptation to the existential threat of climate change if dealt with immediately and realistically.

Africa has experienced numerous climate-related changes and is projected to be among the regions most affected. Poor mental well-being and physical effects are evident, and health system disruptions threaten the public health architecture. There is an urgent need for a "whole-of-systems" approach in vulnerable nations. Future efforts should maximize climate financing, increase the relevance of climate services to public health, and strengthen co-design. Human and financial resource capacity should be built via "Africa for Africa" initiatives. Academic institutions should collaborate to develop accessible research evidence in African languages, and inclusive climate adaptation strategies should be further developed.

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## DATA AVAILABILITY

The data supporting the findings of this narrative review were obtained from previously published studies and publicly available sources cited within the article. No new primary data were generated during this study. Further information regarding the reviewed sources can be obtained from the corresponding author upon reasonable request.

## AI DISCLOSURE STATEMENT

During the preparation of this manuscript, the authors used Grammarly to support language refinement, grammar checking, and manuscript improvement. All outputs generated by the AI tool were carefully reviewed and edited by the authors to ensure accuracy, clarity, and compliance with academic standards. The authors take full responsibility for the content of this manuscript.

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## CONFLICT OF INTEREST

The authors hereby declares that this research is free from conflicts of interest with any party.

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