AFRICA RESEARCH & IMPACT NETWORK

AFRICA STATE OF EVIDENCE REPORT – 2024:

A FOCUS ON CLIMATE AND HEALTH

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Contributing Authors: Joanes Atela, PhD, Akinyi J. Eurallyah, Humphrey Agevi, PhD, Ann S.W. Irungu, Ezekiel G. Gogo, Washington Kanyangi, and Florence Onyango

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List of Acronyms

ACHA – Africa Climate and Health Alliance

ACPC – Africa and the African Climate Policy Centre

Africa CDC – Africa Centres for Disease Control and Prevention

ARC – African Risk Capacity

ARIN – Africa Research and Impact Network

ATACH – Alliance for Transformative Action on Climate and Health

AU – African Union

C&H – Climate and Health

CAPCHA – Consultative Platform on Climate and Health in Africa

CHANCE – Climate-Health Africa Network for Collaboration and Engagement

COP – Community of Practice

CSA – Climate-Smart Agriculture

CSOs – Civil Society Organizations

ENSO – El Niño Southern Oscillation

EWARS – Early Warning and Response Systems

FAO – Food and Agriculture Organization

GCF – Green Climate Fund

GGW – Great Green Wall

GIS – Geographic Information Systems

HEAT – Healthy Environment Assessment Tool

HICs – High-Income Countries

HNAPs – Health National Adaptation Plans

IDRC – International Development Research Centre

IPCC – Intergovernmental Panel on Climate Change

ITCZ – Inter-tropical Convergence Zone

KCCAP – Kenya's Climate Change Adaptation Programme

LMICs – Low- and Middle-Income Countries

M&E – Monitoring and Evaluation

MRF – Medical Research Foundation

NAPAs – National Adaptation Programmes of Action

NAPs – National Adaptation Plans

NCCAPs – National Climate Change Action Plans

NDCs – Nationally Determined Contributions

NGO – Non-Governmental Organization

NHAPs – National Health Adaptation Plans

PA – Paris Agreement

PAPPHACC – Pan-African Programme for Public Health Adaptation to Climate Change

PPPs – Public-Private Partnerships

PTSD – Post-Traumatic Stress Disorder

UNESCO – United Nations Educational, Scientific and Cultural Organization

UNFCCC – United Nations Framework Convention on Climate Change

Urban-LEDS – Urban Low-Emission Development Strategies

WAM – West Africa Monsoon

WASH – Water, Sanitation, and Hygiene

WHO – World Health Organization

WMO – World Meteorological Organization

Foreword

Dr. Joanes Atela
Executive Director, Africa Research and Impact Network (ARIN)

The intertwined challenges of climate change and health have become some of the most pressing issues of our time, and Africa stands at the epicenter of their impacts. Rising temperatures are increasing heat-related illnesses, and unpredictable rainfall patterns are intensifying waterborne diseases and malnutrition. These challenges threaten not only human well-being and livelihoods but also the broader quest for sustainable development. Addressing them demands solutions rooted in evidence and tailored to Africa's unique realities.

The Africa State of Evidence Report 2024: A Focus on Climate and Health marks a pivotal step in closing the gap between knowledge and action. This report offers decision-makers, researchers, and practitioners a valuable tool for navigating the intricate climate-health nexus. By synthesizing the latest research, analysing policy landscapes, and highlighting actionable solutions, it provides a roadmap for designing policies, guiding investments, and implementing programs that protect vulnerable communities and strengthen climate-resilient health systems across the continent.

Africa's reliance on climate-sensitive sectors like agriculture, water resources, and public health systems makes it especially vulnerable to climate-induced health challenges. Rising temperatures are expanding the reach of vector-borne diseases, while erratic weather patterns are worsening food insecurity and malnutrition. These impacts not only deepen existing health inequities but also threaten the progress toward achieving broader development goals. Urgent and evidence-based interventions are crucial to mitigate these risks and safeguard the health and future of Africa's people.

The report emphasizes the need for integrated, collaborative approaches to address the climate-health crisis. At ARIN, we are honoured to contribute to this effort through initiatives like the Consultative Platform on Climate and Health in Africa (CAPCHA), which brings together African researchers and policymakers to co-create solutions. Our work focuses on translating research into scalable, impactful actions that reflect the lived experiences of affected communities. By fostering partnerships and amplifying evidence-based practices, we aim to bridge the gap between research and real-world implementation.

This report exemplifies the strength of collaboration and the power of shared knowledge. It draws on expertise from across the continent to showcase best practices, propose funding pathways, and champion inclusive, community-driven approaches to tackling climate-health challenges. It serves as a foundation for creating policies and investments that prioritize resilience and place the health of Africa's people at the center of climate action.

More than just a collection of insights, this report is a call to action. It urges policymakers, researchers, and stakeholders to engage with its findings, champion integrated solutions, and drive transformative change. By uniting our efforts, we can pave the way for a healthier, more resilient future for Africa and its ecosystems.

We encourage all actors—governments, development partners, researchers, and civil society—to use this report as both a resource and a rallying point for collaboration and innovation. Together, we can turn knowledge into action, building sustainable health systems that are prepared to withstand the challenges of a changing climate.

About the Africa Research and Impact Network

The Africa Research and Impact Network (ARIN) is a premier research-impact nonprofit comprising over 200 researchers and policymakers with national focal points across 36 African countries. ARIN is at the forefront of promoting evidence-informed decision-making in Africa by fostering research excellence and creating impact pathways. At its core, ARIN seeks to identify and leverage key research talents to flexibly and innovatively contribute to Africa's research transformation, policy analysis, and capacity building. ARIN operates on the principle that robust evidence and collaborative partnerships are essential for crafting effective policies and interventions. To this end, the organization invests in the following key areas:

- **Knowledge Generation and Synthesis -** ARIN develops localized data collection tools and frameworks through initiatives like the Consultative Platform on Climate and Health in Africa (CAPCHA). These efforts generate actionable insights that inform targeted policies and enhance resource allocation, particularly in addressing the complex dynamics of the climate-health nexus.
- **Capacity Building and Community Engagement -** ARIN empowers researchers, practitioners, and policymakers by offering tailored training programs and collaborative platforms. Through the creation of a dynamic Community of Practice (CoP), ARIN unites diverse stakeholders to co-design innovative solutions that tackle critical issues like climate-related health impacts.
- **Data-Driven Policy Advocacy** - By translating complex research findings into practical, actionable recommendations, ARIN advocates for evidence-informed policies that reflect the realities of African communities. This approach ensures that policy frameworks are both relevant and effective.
- **Facilitating Regional Collaboration** - ARIN spearheads regional workshops, forums, and conferences, including the annual ARIN International Conference. These platforms encourage cross-border knowledge exchange, foster collaboration, and highlight best practices for addressing climate and health challenges across the continent.
- **Innovative Tools and Technologies** - Leveraging technology is central to ARIN's mission. The organization develops tools for measuring climate impacts and assessing health risks, equipping policymakers with reliable data to guide decision-making.

Through these initiatives, ARIN continues to champion evidence-based approaches to addressing Africa's intertwined climate and health challenges, ensuring that African voices and expertise are at the forefront of sustainable solutions

01

INTRODUCTION

Chapter 1: Introduction

1.1 Context for the 2024 State of Evidence Report

1.1.1 Climate-Health Nexus in Africa: A Growing Crisis

The intersection of climate change and health in Africa reveals a complex, multifaceted landscape. Climate change presents significant risks to public health across the continent, exacerbating existing vulnerabilities and introducing new challenges. Some of the most notable impacts include droughts, desertification, coastal flooding, and declines in food production and security, each with profound health implications for diverse populations. However, the effects of climate change vary significantly across the continent's subregions.

West Africa is particularly vulnerable to the health impacts of climate change due to the influence of the West African Monsoon (WAM), which affects several countries in the region. The movement of the Inter-Tropical Convergence Zone (ITCZ) and the El Niño Southern Oscillation (ENSO) results in warming of both sea and air temperatures, leading to heavy rainfall and floods. Similarly, East Africa, which is typically characterized by dry conditions, has experienced several severe droughts linked to ITCZ-ENSO movements. While ENSO originates in the Pacific, its effects, such as drought and water scarcity, have profound consequences for Eastern Africa. Conversely, Malawi and Mozambique have recently experienced notable flooding, despite being in a region usually associated with drought.

The literature consistently highlights Africa's heightened vulnerability to the adverse effects of climate change, due to a combination of socioeconomic factors, environmental conditions, and inadequate health infrastructure. Research shows that climate change impacts on health in Africa are both profound and diverse. For example, Chersich and Wright note that although climate change research in South Africa has increased, only a small fraction addresses health-related issues, revealing a significant gap in the literature (Chersich & Wright, 2019). This gap is also reflected in Oladimeji's work, which points out the limited evidence connecting climate change to health impacts, particularly after accounting for confounding variables (Oladimeji, 2023).This lack of comprehensive research hampers effective public health responses and policy formulation.

The health risks linked to climate change in Africa include an increase in vector-borne diseases, respiratory issues from air pollution, and significant mental health challenges. Ryan et al. emphasize that climate change is altering malaria transmission dynamics, necessitating the re-evaluation of intervention strategies to address shifting risk profiles (Ryan et al., 2019). Furthermore, Ezeruigbo and Ezeoha point out that climate change exacerbates existing health burdens, especially in impoverished communities where healthcare systems are already strained (Ezeruigbo & Ezeoha, 2023). The World Meteorological Organization has linked rising temperatures and shifting precipitation patterns to the spread of diseases like dengue and malaria, further underscoring the health risks posed by climate change (Ezeruigbo & Ezeoha, 2023). Moreover, the mental health consequences of climate change are increasingly recognized. Atwoli et al. argue that climate change can lead to significant mental health crises, particularly among vulnerable populations, underscoring the need for focused research and interventions (Atwoli et al., 2022). The connection between climate change and mental health is critical, as the stressors associated with environmental

changes can worsen existing mental health issues and create new challenges for public health systems.

Regarding adaptive capacity, the evidence suggests that Africa's health systems are ill-equipped to cope with the compounded effects of climate change. Chersich et al. advocate for a health-centric approach to climate change, stressing that health professionals must play a central role in identifying and addressing the health impacts of climate change (Chersich et al., 2018). This call for integration is supported by Ramirez, who highlights the significant barrier posed by insufficient knowledge of the impacts of climate change on vector-borne diseases, hindering effective health policy (Ramirez, 2017). Additionally, Africa's socioeconomic context exacerbates the health impacts of climate change. As Ogaya et al. note, the continent's high vulnerability is worsened by poverty, food insecurity, and inadequate governance, all of which undermine resilience to climate-related health threats (Ogaya et al., 2024). Integrating climate change considerations into public health planning is crucial to mitigating these risks and enhancing adaptive capacity (Anugwom, 2021).

Notably, over half (56%) of Africa's public health emergencies between 2001 and 2021 were climate-related, disproportionately affecting vulnerable populations, including children, pregnant women, and the elderly (WHO, 2022; Benevolenza & DeRigne, 2019). The World Economic Forum (2024) projects that by 2050, climate change will lead to approximately 14.5 million deaths and $12.5 trillion in global economic losses, with a particularly disproportionate impact on healthcare systems in low- and middleincome countries like those in Africa. Moreover, the healthcare sector itself is a significant contributor to greenhouse gas emissions, accounting for up to 5% of global emissions, equivalent to the carbon footprint of 514 coal-fired power plants (Smith, 2022)

These challenges call for a more resilient approach to addressing climate-induced health issues in Africa. The current state of evidence on climate change and health in Africa underscores the urgent need for comprehensive research and policy responses tailored to the unique challenges facing the continent. The interplay between climate change, health, and socio-economic factors demands a transdisciplinary approach to develop effective strategies for mitigating health risks and building resilience. Given the transnational nature of climate-related health challenges, such as fluctuating temperatures and vector-borne diseases, a holistic, transdisciplinary approach is essential for an effective response (Wright et al., 2021). Developing transdisciplinary skills and fostering collaborations will be key to achieving these objectives. Therefore, this 2024 Africa State of Evidence Report aims to synthesize existing knowledge and generate new insights into how climate change is impacting public health across Africa, emphasizing the critical role of evidence in shaping effective, scalable responses.

1.1.2 Complexity in Climate and Health Linkages

The linkages between climate hazards and their health impacts are intricate, as illustrated in **Figure 1**. Numerous studies have highlighted the effects of climate change on health outcomes (IPCC, 2022; Benevolenza & DeRigne, 2019).
Understanding these pathways is vital for the development of effective and integrated solutions. Moreover, addressing the climate-health nexus necessitates collaboration across multiple sectors. While climate change impacts health directly, these effects

are shaped by broader socio-economic conditions such as food security, infrastructure, and governance.

This report underscores the need for transdisciplinary research that unites expertise in public health, climate science, agriculture, and economics to tackle the multifaceted challenges posed by climate change. By integrating knowledge from diverse fields, Africa can devise comprehensive strategies to mitigate the immediate health impacts of climate change while building long-term resilience.

Despite promising advancements in climate and health policy, research in this domain—requiring the collaboration of researchers, policymakers, and implementers, remains at an early stage, particularly in Africa where funding for climate action is constrained (Berrang-Ford et al., 2021). Efforts are underway to develop tools and indicators to elucidate these complex relationships and inform strategies (Kenney et al., 2018; Murray et al., 2020; Hambling, 2011; Liu et al., 2021). However, addressing these complexities in practice demands transdisciplinary evidence—knowledge generated through collaborative efforts that span multiple disciplines

While existing research offers insights into the broader health effects of climate change (IPCC, 2023; Benevolenza & DeRigne, 2019), identifying specific pathways remains crucial for crafting effective and integrated solutions.

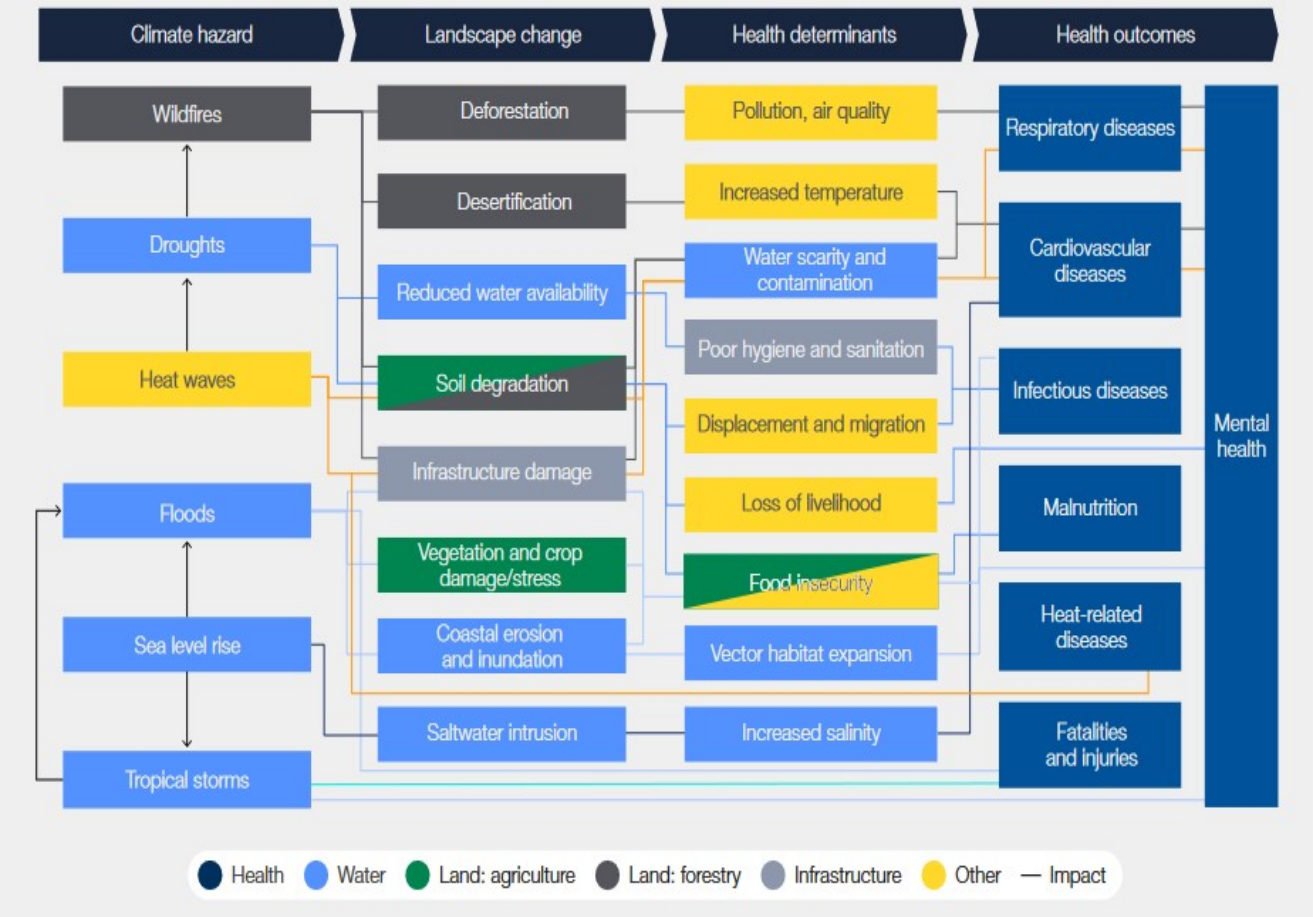


Figure 1: A Schematic of Climate Hazard Impacts on Human Health Outcomes (Source: World Economic Forum, 2024)

1.1.3 The Critical Role of Evidence in Climate-Health Responses in Africa

Evidence generation is pivotal in addressing the nexus of climate change and health. Accurate, localised, and timely data are essential for developing informed strategies to mitigate the impacts of climate change on health. The role of evidence in responding to climate and health challenges in Africa cannot be overstated. It provides the foundation for understanding the complex interactions between climate and health, informs policy and decision-making, enhances early warning systems, and bolsters the resilience of healthcare systems against future climate impacts. For Africa to effectively confront the looming health crises exacerbated by climate change, continued investment in evidence generation and transdisciplinary research is imperative. Through collaborative efforts involving governments, scientists, and global organisations, Africa can build a more climate-resilient future. As climate change continues to pose significant risks to public health across the continent, robust evidence generation will remain the cornerstone of crafting effective and sustainable solutions.

However, Africa faces critical gaps in climate and health data, primarily due to the absence of comprehensive and integrated surveillance systems. These gaps limit the capacity for effective policymaking and disaster preparedness, as many countries lack real-time, localised information on the impacts of climate change on health outcomes. This challenge forces governments and health agencies to rely on incomplete data when addressing climate-induced health risks such as the spread of vector-borne diseases or heat-related illnesses.

In this context, the *State of Evidence in Africa Report 2024* plays a transformative role. This report consolidates existing research and identifies the most pressing gaps in climate and health data across the continent. By synthesising information from diverse studies, the report offers policymakers a clearer understanding of data deficiencies and prioritises areas requiring immediate attention. This consolidation of evidence is crucial not only for national planning but also for securing international funding. The report equips countries with a strong evidence base to justify investments in climate resilient health systems, thereby strengthening their cases for climate adaptation funding.

Furthermore, the report advocates for transdisciplinary approaches to data collection, urging African governments, research institutions, and international bodies to collaborate in establishing robust climate-health surveillance systems. By fostering partnerships among health ministries, meteorological agencies, and academic institutions, the report underscores the importance of cross-sector collaboration to address data gaps and develop comprehensive frameworks for understanding climate-health dynamics

1.2 Purpose and Methodology of the Report

1.2.1 Purpose of the Report

This report is designed to achieve the following objectives:

1 Consolidate the state of evidence on the climate-health nexus in Africa, highlighting the multifaceted impacts of climate change on public health and vulnerabilities across diverse regions and populations.

2 Identify research and data deficiencies, with a focus on localised climate-health dynamics, underrepresented populations, and the influence of socioeconomic and structural factors on health outcomes.

3 Provide actionable recommendations for policymakers, healthcare providers, and international organisations to develop climate-resilient health systems and implement context-specific interventions.

4 Promote transdisciplinary collaboration across climate science, public health, and social policy to create integrated, scalable solutions addressing the interconnected challenges of climate and health in Africa.

5 Mobilise Investment regional and international stakeholders to invest in climate-health research, surveillance infrastructure, and equitable funding mechanisms.

1.2.2 Research Questions

a) **Impact of Climate Change on Health in Africa:**
   - How do climate-related hazards (e.g., droughts, floods, heatwaves) influence the prevalence and distribution of major diseases across the continent?
   - What specific vulnerabilities do African populations face regarding climate-related health risks?

b) **Policy and Governance:**
   - To what extent do existing climate and health policies address the intersection of climate change and public health in Africa?
   - How can evidence-based policymaking be strengthened to integrate health priorities into national and regional climate strategies?

c) **Adaptation and Resilience:**
   - What are the most effective climate adaptation strategies for enhancing the resilience of health systems in Africa?
   - How can community-level interventions mitigate the health impacts of climate change?

d) **Data and Evidence Gaps:**
   - What are the critical gaps in climate-health data, and how can they be addressed to support informed decision-making?
   - How can Africa leverage technology and international partnerships to improve data collection and monitoring systems?

e) **Funding and Collaboration:**
   - What funding mechanisms and partnerships are most effective for scaling climate-health interventions in Africa?
   - How can regional collaboration enhance Africa's capacity to respond to transboundary climate-health challenges?

1.2.3 Methodological Approach

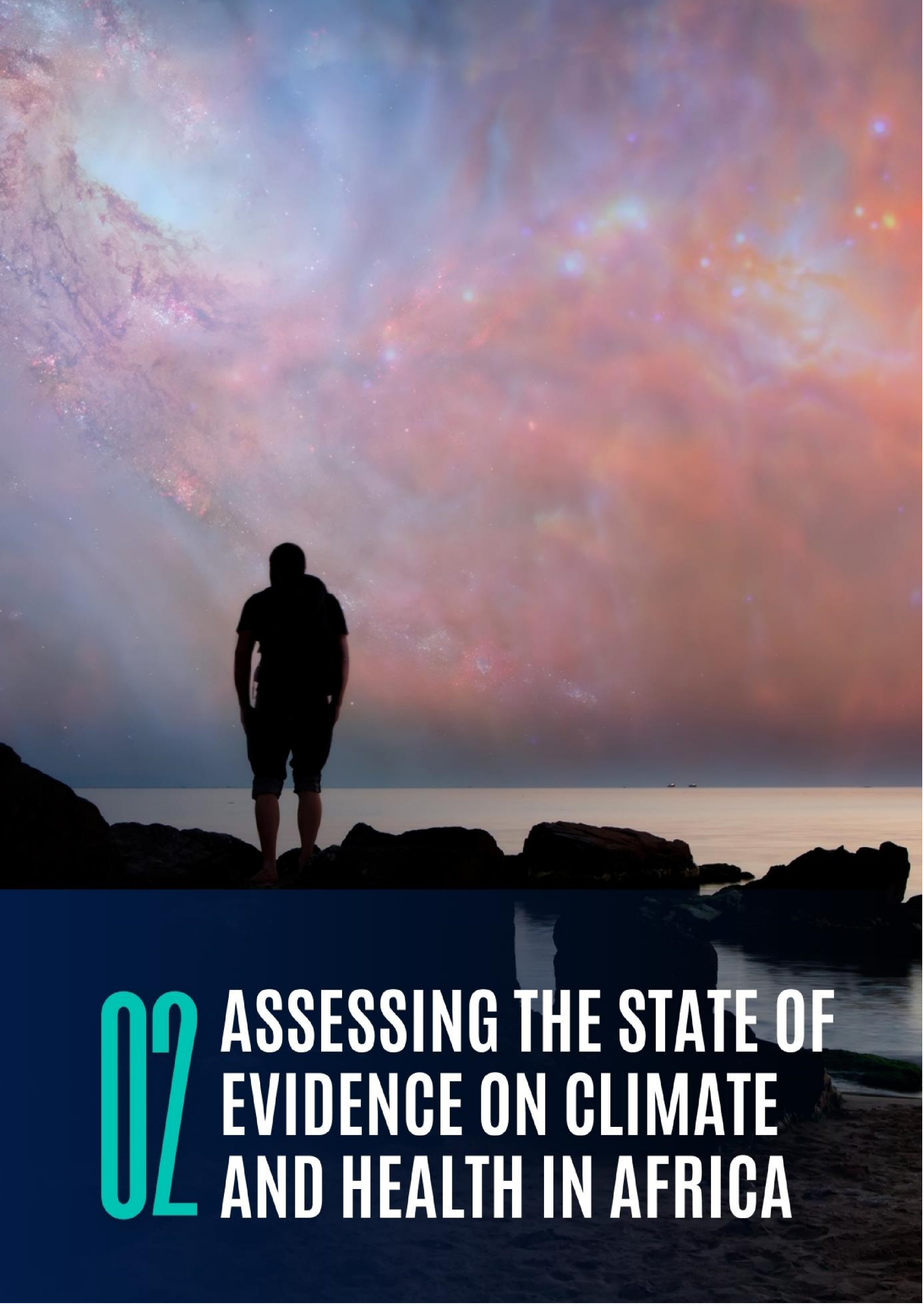
This report employs a multi-pronged approach to synthesize existing data, identify gaps, and provide informed policy recommendations. At its core, the methodology is built on a systematic desk-based literature review of existing research on climate change and health in Africa. This review draws on a broad spectrum of sources, including academic journals, government reports, publications by non-governmental organizations (NGOs), and international bodies such as the World Health Organization (WHO), the Intergovernmental Panel on Climate Change (IPCC), and the World Meteorological Organization (WMO). By consolidating diverse sources of knowledge, the review ensures a robust evidence base for the report. Secondary data from national and regional databases, including climate health profiles, meteorological records, and health surveillance reports, was also integrated. This approach provides a holistic view of the direct effects of climate change (e.g., heatwaves) and its indirect impacts (e.g., vector-borne diseases) on public health.

A key component of the methodology is stakeholder engagement through consultations and interviews. These engagements involved experts from health ministries, climate scientists, representatives of NGOs, and local community leaders. Stakeholders from diverse regions were included to ensure the representation of a wide range of perspectives, particularly those from vulnerable populations most affected by climate change. These consultations were conducted using surveys, semi structured interviews, and focus group discussions. The qualitative insights derived from these engagements provided valuable information on on-the-ground challenges, especially regarding the collection of climate-health data and the implementation of adaptation policies. Such insights also helped identify context-specific solutions often overlooked in generalised reports.

A comprehensive gap analysis was conducted to identify the most significant deficiencies in climate and health data across Africa. This analysis evaluated the availability, quality, and accessibility of data from national meteorological agencies and health ministries. It also assessed the infrastructure and capacity of health systems to integrate climate data into their decision-making processes. Special focus was placed on regions where data is scarce or unreliable, such as remote rural areas and conflict zones. By highlighting these deficiencies, the report contributes to guiding future research priorities and investment decisions. The findings serve as a basis for advocating for capacity-building initiatives and increased funding to strengthen climate-health surveillance systems in Africa.

The methodology highlights the importance of cross-sectoral collaboration, acknowledging that climate change impacts health through its interactions with other sectors such as agriculture, water resources, and infrastructure. To address these interconnections, the report integrates insights and data from a range of disciplines, including environmental science, public health, and economics. Collaborative efforts were undertaken with regional bodies such as Clim-HEALTH Africa and the African Climate Policy Centre (ACPC), as well as institutional initiatives such as CAPCHA. These collaborations ensured that the analysis reflects the interconnected nature of climate-health challenges and promotes transdisciplinary solutions.

The report also includes a detailed policy analysis of existing national adaptation plans, climate policies, and health strategies. This analysis evaluates the extent to which current policies incorporate climate-health risks and identifies areas for improvement. The recommendations, grounded in evidence from the literature review, stakeholder consultations, and gap assessments, provide actionable short-term and long-term strategies for building climate-resilient health systems.



02 ASSESSING THE STATE OF EVIDENCE ON CLIMATE AND HEALTH IN AFRICA

Chapter 2: Assessing the State of Evidence on Climate and Health in Africa

2.1 Climate-Health Context in a Global Perspective

Africa's climate and health situation presents a distinct and pressing challenge compared to other continents, characterized by a complex interplay of environmental vulnerabilities and health disparities. The continent is particularly susceptible to the adverse effects of climate change, which exacerbate existing health issues and create new challenges for public health systems. This section explores the unique features of Africa's climate and health landscape, contrasting them with other regions, while underscoring the urgent need for adaptive strategies

Africa is often described as a climate change hotspot, facing significant threats from rising temperatures, altered precipitation patterns, and extreme weather events. Research highlights that Africa is projected to experience a disproportionate increase in temperatures, potentially exceeding global averages, with dire implications for health and agriculture (Weber et al., 2018). The Intergovernmental Panel on Climate Change (IPCC) estimates a rise of 1.5°C to 2°C by the end of the century, depending on global mitigation efforts (IPCC, 2021). This warming trend is expected to intensify the frequency and severity of droughts, floods, and heatwaves, which have direct health repercussions. The IPCC has identified Africa as particularly vulnerable due to its limited adaptive capacity and high exposure to climate risks (Oguntuase & Adu, 2021). By contrast, regions such as Europe and North America, while also grappling with climate challenges, possess more robust infrastructure and adaptive mechanisms. For instance, European countries have implemented comprehensive climate adaptation strategies, such as early warning systems for extreme weather and investments in resilient infrastructure (European Environment Agency, 2022; Oguntuase & Adu, 2021).

The health impacts of climate change in Africa are profound and multifaceted. Climate change is linked to an upsurge in climate-induced diseases, such as malaria and respiratory infections, which are already prevalent across many African countries (Opoku et al., 2021; Wright, 2024). For example, studies in Ghana report a rising incidence of diseases correlating with changing weather patterns (Opoku et al., 2021). In comparison, developed regions with advanced healthcare systems are better equipped to manage these impacts. For example, North America has seen a decline in vector-borne diseases due to effective public health interventions and robust healthcare resources. These disparities in health outcomes between Africa and other regions emphasize the urgent need for targeted interventions tailored to the continent’s unique context.

The mental health implications of climate change are increasingly being recognised as a significant issue, particularly in vulnerable regions such as Africa, where health systems are underdeveloped and the effects of climate induced stress are often amplified (Atwoli et al., 2022). Frequent exposure to extreme weather events, including droughts, floods, and heatwaves, can lead to chronic stress, anxiety, and depression among affected populations. This is especially pronounced in communities experiencing environmental degradation, which threatens

livelihoods and social stability. People in regions with fragile economies, reliant on natural resources such as agriculture and fishing, face heightened levels of distress when these sectors are disrupted by climate change.

In contrast, regions like Europe and North America generally have more resilient healthcare systems, which are better equipped to manage climate-related health challenges, including mental health issues. In these regions, there is greater access to mental health services, crisis intervention, and social safety nets that can mitigate the psychological impacts of environmental disasters. Public awareness and government initiatives addressing the mental health impacts of climate change are also more advanced. As a result, climate resilience programs in these areas often include mental health support as a core component.

In Africa, however, the lack of mental health infrastructure, combined with social stigmas surrounding mental health, exacerbates the problem. For instance, in Kenya, South Africa, and Nigeria, extreme weather events have been linked to rising cases of post-traumatic stress disorder (PTSD), depression, and anxiety, especially in communities that suffer repeated climate shocks without sufficient psychological or economic support. The psychological impacts of climate migration—where individuals are forced to leave their homes due to drought or flooding—add to the complexity of trauma, as displaced persons lose their homes and livelihoods.

Efforts to address these growing challenges are underway but are often hindered by resource constraints and the limited inclusion of mental health in climate adaptation plans. Greater emphasis on integrating mental health into climate resilience strategies is necessary to provide psychological support to vulnerable populations, which can help build broader resilience against climate-induced stressors.

This contrast between Africa and more developed regions underscores the inequities in global health systems. Regions most affected by climate change often have the least capacity to address the physical and mental health challenges posed by environmental crises.

Africa's reliance on climate-sensitive sectors such as agriculture and water resources amplify its vulnerability to climate variability. Rain-fed agriculture, the backbone of many African economies, is increasingly threatened by changing rainfall patterns and prolonged droughts (Freeman, 2017; Russo et al., 2016). This reliance directly affects food security, leading to malnutrition and increased susceptibility to diseases (Kariuki et al., 2023; Anugwom, 2021). In contrast, regions such as Asia and Latin America have adopted innovative agricultural practices to mitigate the impacts of climate change on food production (World Bank, 2020; Opoku et al., 2021).

Socio-economic factors such as poverty and limited access to healthcare further compound Africa's vulnerabilities. High levels of poverty and inadequate infrastructure hinder the continent’s ability to adapt to climate change and respond to health crises (Oladimeji, 2023; Kariuki et al., 2023). Africa bears a disproportionate burden of communicable diseases, maternal and child health issues, and noncommunicable diseases, all exacerbated by climate change (WHO, 2021). In comparison, high-income countries allocate significant resources to build resilient health systems and address climate-induced health challenges. For instance, the

United States has developed public health strategies that include substantial funding for research and community-based intervention

The COVID-19 pandemic underscored the interconnectedness of health and environmental issues, highlighting Africa's fragile health systems as they grappled with dual threats from infectious diseases and climate change (Ongoma et al., 2023; Samba, 2023). This experience reinforced the need for integrated approaches that merge climate action with health strategies to enhance resilience and adaptive capacity (Ndejjo et al., 2023; Atwoli et al., 2022)

Africa's climate and health landscape is defined by significant challenges that distinguish it from other regions. Addressing these intertwined issues demands urgent, coordinated, and multifaceted actions that integrate climate adaptation into public health planning while emphasizing the development of resilient health systems. Collaborative efforts among governments, international organizations, and local communities will be crucial to providing Africa with the resources and support it needs to enhance adaptive capacity and improve health outcomes in the face of a changing climate.

2.2 Current Evidence on Climate and Health Impacts in Africa

Climate change is recognised as one of the greatest global health challenges of the 21st century. According to the Intergovernmental Panel on Climate Change (IPCC), the world's climate has been undergoing substantial changes over the past few decades, including in Africa. The health consequences of climate change are unevenly distributed, with populations in developing countries—particularly in Africa—experiencing the highest impacts, despite contributing only 4% of global greenhouse gas emissions. People at the extremes of age, those living in poverty, individuals with pre-existing conditions, and communities in geographically vulnerable locations are disproportionately affected. This disparity is attributed to the region's overdependence on climate-sensitive sectors and a lack of institutional, technological, and financial capacity to reduce emissions and build resilience to climate change (Doku et al., 2021a, 2021b; Mekonnen et al., 2021; Phiri & Doku, 2024).

The IPCC's Sixth Assessment Report (AR6) highlights that the impacts of climate change on health are severe, widespread, often underestimated, and worsening over time (IPCC, 2023). The type and magnitude of these health impacts vary significantly across communities and regions. These variations are influenced by factors such as geographic differences in temperature and precipitation, socio-economic conditions, the quality of health infrastructure, communication capacity, and underlying epidemiological factors.

Climate change presents several health hazards. Exposure to climate-related events such as extreme heat exacerbates existing chronic conditions and increases the risk of heat-related illnesses and mortality (Ebi et al., 2021). Wildfires, floods, and droughts contribute to food insecurity, leading to undernutrition. Additionally, climate change enhances the suitability of environmental conditions for infectious disease transmission (Pate et al., 2022). It also directly affects the delivery of health services, with extreme weather events causing damage to clinic and hospital infrastructure or impeding healthcare workers from reaching their places of work due to road damage.

These impacts are often additive, compounding, and cascading, with numerous modifying factors influencing the pathways that link climate change to human health outcomes. Heat and Health Impacts

2.2.1 Heat-Related Health Risks

According to the IPCC, tens of millions of Africans are experiencing the negative health impacts of climate change, including heat stress, extreme weather events, and increased transmission of infectious diseases. However, most studies on heat and human health have focused on high-income countries (HICs), with significantly fewer studies conducted in low- and middle-income countries (LMICs), particularly in tropical Africa (Frimpong et al., 2020; Nunfam, 2021; Kinda et al., 2024). The number of people exposed to extreme heat is growing exponentially due to climate change across all world regions. Between 2000–2004 and 2017–2021, heat-related mortality among individuals over 65 years of age increased by approximately 85% (Lancet, 2023).

High temperatures can lead to an increase in core body temperature and heart rate, resulting in heat stress, heat stroke, and, in severe cases, death (Rahman and Adnan, 2023). Additionally, elevated temperatures can contribute to various health conditions, including heat exhaustion, dehydration, respiratory problems, cardiovascular strain, skin diseases, mental health issues, and electrolyte imbalances (Mora et al., 2017). The effects of heat on human health are further intensified by environmental, socioeconomic, and demographic factors such as poverty, literacy levels, age (infants and the elderly being particularly vulnerable), and physiological and behavioural responses to the surrounding environment (Oluwafemi et al., 2023; Nyadanu et al., 2023).

Urban environments, characterised by high population densities, limited green spaces, and extensive artificial impervious surfaces (AIS), often experience elevated temperatures compared to surrounding rural areas, a phenomenon known as the urban heat island effect (Chen et al., 2022a; Rajagopal et al., 2023; Kunda et al., 2024). In Botswana, for example, minimum temperatures have been associated with increased occurrences of diarrhoea (Alexander et al., 2013).

A study by Rayco-Solon et al. (2004) identified seasonality in death rates, with higher mortality observed during the "hungry" season (July to November), a period marked by intense agricultural work, depletion of food supplies, and a rise in infectious diseases. Heat stress has also significantly affected farmers in Bawku East, Northern Ghana, where malaria and heat cramps are among the prevalent health issues (Frimpong et al., 2023).

In some regions, such as West Africa, studies suggest that climate change-induced increases in temperature and reductions in precipitation have led to a decline in malaria transmission (Ermert et al., 2012). Conversely, other studies, including those by McGregor et al. (1961), Lawoyin (2001), Reyburn et al. (2011), and Ifatimehin and Ujoh (2014), have reported increased morbidity and mortality during rainy and hot seasons. Daniel (2015) further noted a significant relationship between extreme temperatures, rainfall, and the prevalence of heat rash.

2.2.2 Vector-Borne Diseases

Warmer temperatures and changes in rainfall patterns continue to influence the incidence and distribution of malaria in Africa. Currently, approximately one-third of the continent is considered optimally suitable for malaria transmission throughout the year (Trisos et al., 2023). Projections for malaria transmission under the RCP 4.5 and RCP 8.5 climate change scenarios suggest the emergence of new endemic malaria vector hotspots, alongside increases in prevalence and spatial extent. RCP 4.5 is characterised as a moderate scenario, in which emissions peak around 2040 before declining (Meinshausen et al., 2011). Temperature increases projected for Africa under both RCP 4.5 and RCP 8.5 indicate that countries most at risk of increased malaria transmission in 2030 include northern Angola, southern DRC, western Tanzania, and central Uganda (Trisos et al., 2023). Warmer conditions influence malaria transmission by accelerating the development and survival rates of malaria parasites and their vectors.

In other parts of the continent, changing climatic conditions and decreased environmental suitability will render certain regions unsuitable for the malaria vector and parasite. For instance, countries such as Burkina Faso, Cameroon, Ivory Coast, Ghana, Niger, Nigeria, Sierra Leone, Zambia, and Zimbabwe will experience rising temperatures that exceed optimal thresholds, causing a significant decline in the adult mosquito population, particularly under the RCP 8.5 scenario (Trisos et al., 2023).

Dengue, Zika, and Rift Valley Fever have been observed at higher altitudes than in previous years due to rising temperatures. These diseases also occur during dry periods when open water storage and stagnant water serve as breeding sites, as well as during flooding, which spreads viruses through human settlements (Caminade et al., 2019). Epidemics of dengue, chikungunya, and yellow fever are projected to increase in the future, along with shifts in mosquito species. However, if temperatures rise too high, the transmission of some infectious diseases may be inhibited. Yellow fever is estimated to cause 78,000 deaths annually in Africa, and it is projected with high confidence that annual deaths will increase by 2050 (Gaythorpe et al., 2020).

2.2.3 Water and Foodborne Diseases and Sanitation

Water and foodborne diseases, including salmonellosis, cryptosporidiosis, norovirus, and cholera, often result in diarrheal symptoms in affected individuals. Diarrheal diseases are among the leading causes of death in children under 5 years of age in Africa (WMO, 2021).

Changes in temperature and precipitation can increase the transmission of bacterial and protozoal diarrheal disease agents through the contamination of water and food. Cholera incidence has been shown to increase with rising temperatures. In the summer of 2021, a cholera outbreak occurred in Niger and Nigeria, exacerbated by flooding, inadequate waste management, poor sanitation practices, a lack of drainage systems, and human consumption of contaminated water (WMO, 2021). Notably, the outbreak disproportionately affected children aged 5 to 14 years, with over 3,000 deaths, despite efforts to control cholera in these countries and the absence of observed cholera cases since 2018.

Access to adequate, clean water and the means to practice good hygiene, such as those promoted through Water, Sanitation, and Hygiene (WASH) programs, are crucial for curbing the spread of infectious diseases, especially in the face of potential disruptions to water availability and sanitation due to infrastructure failures or breakdowns caused by extreme weather events (Trisos et al., 2023; Kapwata et al., 2022). Impacts on other infectious diseases, such as schistosomiasis and salmonella, will also significantly affect human health in Africa.

2.2.4 Air Quality and Respiratory Health

Ambient air pollution, which is on the rise in Africa, was estimated to be responsible for nearly 400,000 deaths across the continent in 2019 (Fishe et al., 2021). Air pollution is a major contributor to cardiovascular diseases (Bont et al., 2022; Boundrel et al., 2022) and respiratory conditions, which can lead to premature mortality.
In a changing climate, air pollutants and their concentrations are expected to fluctuate. For instance, warm temperatures and sunny conditions can increase ground-level ozone concentrations. Personal exposure to ozone can lead to adverse health outcomes, including chest pain, coughing, throat irritation, and the exacerbation of bronchitis, emphysema, and asthma (USEPA, 2023). Another pollutant that may see increased concentrations in a changing climate is particulate matter, which poses health risks throughout the life course. The presence of such pollutants not only affects public health but also has significant implications for the formation of human capital and the productivity of the workforce.

In 2019, the loss of economic output due to air pollution-related morbidity and mortality was estimated at $3.2 billion in Ethiopia (EthFuller et al., 2023), $1.63 billion in Ghana, and $349 million in Rwanda (Fishe et al., 2021). These figures highlight the urgent need for deliberate and effective interventions to build economic resilience in Africa against the dual threats of climate change and air pollution.

A report titled *"Integrated Assessment of Air Pollution and Climate Change for Sustainable Development in Africa"* (UNEP C&CAC & AU, 2022) highlights the immense **potential for Africa to save approximately 880,000 lives annually by 2063 through strategic actions targeting air pollution and climate change. The report emphasizes addressing five critical sectors**: **transport, residential, energy, agriculture, and waste**.

Implementing the recommended measures would not only reduce emissions of carbon dioxide, methane, and nitrous oxide but also yield substantial co-benefits, including improved food security. For example, actions to curb desertification could increase crop yields for staples such as rice, maize, soy, and wheat.

However, in the absence of deliberate interventions, the twin threats of air pollution and climate change are projected to escalate morbidity and mortality rates, hinder the formation of human capital, and undermine sustainable development efforts across the continent (Fishe et al., 2021).

Addressing air pollution in Africa offers multiple co-benefits, including improved public health. A “baseline scenario” of high material consumption, population growth, and warming was compared to projected scenarios of low warming and high warming (Shindell et al., 2022). Under a low warming scenario, it was projected that annual premature deaths due to fine particulate matter (PM2.5) would be reduced by approximately 515,000 by 2050, compared to the high warming scenario. Region-specific reductions include 100,000 in Northern Africa, 175,000 in West Africa, 55,000 in Central Africa, 140,000 in East Africa, and 45,000 in Southern Africa (Shindell et al., 2022).

Another co-benefit of reducing air pollution is increased agricultural productivity, which can enhance food security and improve livelihoods. Many sources of air pollution, such as the burning of fossil fuels and biomass, also contribute to climate change. Therefore, tackling air pollution can simultaneously mitigate the effects of climate change. Transitioning from “dirty fuels” to clean and renewable energy sources not only reduces air pollution but also improves energy security, decreasing dependence on fossil fuels. Additionally, air pollution negatively impacts economic productivity by reducing worker efficiency and increasing healthcare costs. By significantly curbing air pollution, national economies stand to benefit substantially.

Critical knowledge gaps in climate change and health in Africa hinder the development of effective strategies to protect health systems and populations. A comprehensive understanding of the full extent of health impacts, including long-term effects and the life course implications of climate change, remains limited. Additionally, there is insufficient research on how rising sea levels and subsequent displacement affect mental health, particularly among vulnerable communities. Another critical area is understanding the distribution of health impacts across different populations, both within and across countries, to enable the planning and implementation of targeted and effective response measures. Furthermore, there is a pressing need to assess the effectiveness of various adaptation and mitigation measures, which would enhance efforts to adapt health systems and reduce the adverse health consequences of climate change. Research on the cost-effectiveness of these measures is also crucial to identify the most economically viable strategies for adapting health systems and mitigating impacts. Addressing these knowledge gaps through robust and informed research will contribute to equitable, effective, and efficient strategies to safeguard health systems and populations from the ongoing and future impacts of climate change.

2.3 Vulnerability to Climate and Health Impacts

2.3.1Vulnerability Assessment to the Impacts of Climate and Health in Africa

Africa's vulnerability to climate change is closely linked to socioeconomic disparities, environmental degradation, and limited adaptive capacity (Guillaumont & Simonet, 2011). The continent's geographical position and dependence on climate-sensitive sectors, such as rain-fed agriculture, water resources, herding, and fishing, exacerbate its exposure. Despite contributing the least to global warming and having the lowest greenhouse gas emissions globally, Africa faces disproportionate collateral damage. These systemic risks threaten economies, infrastructure investments, water and food systems, public health, agriculture, and

livelihoods, undermining modest development gains and pushing the region toward higher levels of extreme poverty (World Meteorological Organization, 2020). It is estimated that, as of 2020, Africa loses between $7 billion and $15 billion annually due to the impacts of climate change. This figure is projected to rise to $50 billion per year by 2030 if adaptive measures are not implemented (African Development Bank Group, 2022).

According to the Climate Vulnerability Index in 2021, nine of the top 10 most vulnerable and least resilient countries are in Sub-Saharan Africa. These include Chad, the Central African Republic, Eritrea, Guinea-Bissau, the Democratic Republic of Congo, Sudan, Niger, Liberia, and Somalia (Arrieta & Mbungu, 2023). African populations are particularly susceptible to climate-related health impacts due to a combination of environmental and socio-economic factors. Key contributors to vulnerability include poverty levels, gender dynamics in agricultural activities, access to WASH (Water, Sanitation, and Hygiene) infrastructure, proximity to health facilities, climate-resilient housing, literacy rates, annual income, weak agricultural supply chains, non-farm business ownership, health status, and communication systems (Rakotoarison et al., 2018).

Climate change vulnerability can be understood through three main components: **sensitivity**, **exposure**, and **adaptive capacity**. Groups with heightened sensitivity include women, children, the elderly, and individuals with chronic illnesses or disabilities. Those at greater exposure include outdoor workers, residents of areas affected by urban heat islands, droughts, famines, conflicts, floods, and coastal communities. Socio-economically disadvantaged populations often experience both higher exposure and lower adaptive capacity (Akerlof et al., 2015). Sub-Saharan Africa, already grappling with climate-sensitive diseases, has low levels of preparedness, adaptation, and response capacity. This exacerbates the vulnerability of populations most at risk to the health impacts of climate change (Nilsson et al., 2021).

Differences in vulnerability across geographical regions are influenced by national, regional, and local capacities to manage and prepare for the effects of climate change. These capacities are shaped by economic conditions, social stability, and the availability and prioritisation of resources for health systems (Nilsson et al., 2021). Vulnerable populations have been disproportionately affected by the adverse effects of climate change, exacerbated by significant socio-economic disparities, unequal power dynamics, poor governance, and increased risks coupled with inadequate and ineffective adaptation and mitigation strategies (Ngcamu, 2023). The risks faced by specific populations due to climate impacts are mediated by a complex interplay of social, economic, and political factors. Social factors include poverty, gender inequality, and access to education and healthcare. Economic factors involve resource availability, employment opportunities, and income distribution, while political factors encompass governance, policy implementation, and institutional effectiveness. Together, these dimensions contribute to the varying degrees of vulnerability and resilience among populations.

People living in poverty, displaced individuals, women, children, migrants, and the elderly are among the most vulnerable to climate impacts due to their limited access to knowledge, technology, and financial resources (Jjemba, 2021). Health

impacts are already being felt across Africa, affecting both rural and urban populations. Rural communities, often lacking access to health services, clean water, and sanitation and relying predominantly on rain-fed agriculture for their livelihoods, are particularly at risk. Urban centres, especially informal settlements, also face significant threats from heatwaves, air pollution, and water-borne diseases, exacerbated by inadequate infrastructure and the challenges of rapid urbanisation (Ramsay et al., 2021).

Africa's diverse geography, ranging from arid and semi-arid regions to tropical zones, results in varying levels of exposure to climate change. For instance, the Sahel region is grappling with increased desertification and declining agricultural productivity, while coastal areas in West Africa face heightened risks from sea-level rise and extreme weather events (Aly Mbaye & Gueye, 2024; Dada et al., 2024). Similarly, East, Central, and Southern Africa experience significant climate variability, including cyclones and floods. These events disrupt public health services, increase disease exposure (Eriksen et al., 2008), and create favourable conditions for the proliferation of vector-borne pathogens such as mosquitoes. This raises concerns about the future burden of vector-borne diseases, including those caused by the Zika virus, in these regions (Obame-Nkoghe et al., 2024).

Climate change is also impacting water quality and availability across Africa, leading to increased health vulnerabilities due to a rise in water-related diseases such as cholera and diarrhoeal illnesses, particularly among residents of informal settlements, displaced persons, and migrants (Charnley et al., 2021). Inadequate water management and infrastructure in many parts of the continent exacerbate these health risks. Droughts and floods, which are becoming more frequent as a result of climate change, disrupt access to clean water and sanitation. Coupled with human-induced factors such as poverty, poor sanitation, inadequate drainage, compromised water quality, insufficient healthcare, malnutrition, and unhealthy eating and handwashing practices, these conditions can significantly influence the transmission dynamics of waterborne diseases like cholera, thereby increasing the risks of contamination and transmission (Charnley et al., 2021).

Climate-health vulnerabilities may also be exacerbated by underfunded public health infrastructure, a shortage of healthcare professionals, and inadequate disease surveillance systems (Oleribe et al., 2019). This undermines Africa’s ability to respond effectively to emerging climate-related health challenges, such as extreme heat events and vector-borne diseases like malaria, dengue, and Rift Valley fever. Rising temperatures altered precipitation patterns, and changes in humidity are expanding the geographic range of disease vectors such as mosquitoes. Higher temperatures are shortening the incubation period of pathogens within vectors, thereby increasing transmission efficiency (Caminade et al., 2018). In East Africa, malaria transmission is projected to increase in highland areas, exposing populations to greater disease vulnerability in regions where the disease was previously rare due to cooler temperatures (Ermert et al., 2011; Obame-Nkoghe et al., 2024). Addressing these vulnerabilities requires strengthening healthcare infrastructure, improving disease surveillance systems, and implementing targeted interventions to mitigate the impacts of climate-induced health threats.

Moreover, climate change significantly threatens food security in Africa by affecting agricultural productivity, with 95% of the continent’s population

dependent on rain-fed agriculture. Changes in rainfall patterns, extreme weather events, and shifts in growing seasons are reducing crop yields, leading to increased food prices and limiting access to nutritious food (Food and Agriculture Organization of the United Nations, 2017). This has profound implications for malnutrition, particularly among vulnerable groups such as the elderly, children under the age of 5, and pregnant women (Niang et al., 2014). Chronic food insecurity and undernutrition are expected to worsen in the coming decades, particularly in regions like the Horn of Africa, where recurrent droughts have already strained food systems (World Health Organization, 2024).

Extreme heat events, both globally and especially in Africa, are becoming more frequent and intense, posing a direct threat to human health. Heatwaves increase the risk of heat stress, heat strokes, dehydration, and premature death, particularly among the elderly and those with pre-existing health conditions such as cardiovascular diseases, diabetes, mental health issues, and asthma (World Health Organization, 2024a). Outdoor workers, especially older individuals (International Labour Organization, 2019), urban populations, young children, and low-income groups due to poor-quality housing are particularly vulnerable to heatwaves. This is compounded by the urban heat island effect, where cities experience higher temperatures than surrounding rural areas (Yadav et al., 2023). This phenomenon is exacerbated in cities with limited access to cooling systems and green spaces, leading to higher heat-related morbidity and mortality (United States Environmental Protection Agency, 2024).

2.3.2 Vulnerability Assessments Across Demographic Groups

Vulnerability assessments, using data from national surveys, community input, climate models, and health records, help pinpoint demographic groups disproportionately affected by climate-related hazards and guide the design of effective interventions (Gan et al., 2021). These assessments identify vulnerable groups based on factors such as socioeconomic status, access to health services, and existing health conditions.

A. Social Economic Status

Socioeconomic status (SES) analysis, through tools like poverty indices from national surveys, participatory research, and the Social Vulnerability Index developed by the CDC (Agency for Toxic Substances and Disease Registry, 2024), reveals the following insights:

Low-Income Groups

Individuals in low-income groups often live in areas prone to climate-related hazards such as flooding, pollution, and extreme heat. These populations are more likely to reside in urban or rural areas with poorly maintained or aging infrastructure, including buildings, utilities, transportation systems, and healthcare facilities, which may be ill-equipped to handle climate-related events. Limited financial resources further restrict their ability to access health services, safe nutrition, and social support, leaving them vulnerable during and after extreme weather events (United States Environmental Protection Agency, 2024).

Climate Literacy

Populations with lower climate literacy have reduced awareness of climate-health hazards, making it challenging to adopt adaptive measures or access critical information. Conversely, individuals with higher climate literacy tend to support climate-oriented policies, demonstrate higher adaptive capacities, and experience lower risks from climate impacts (United Nations Educational Scientific and Cultural Organization (UNESCO), 2024).

Climate-Sensitive Occupations

Workers in sectors like agriculture, fishing, and outdoor labour are at increased risk of climate-health hazards due to changing weather patterns, droughts, floods, and extreme temperatures. Vulnerable groups, including women, migrant workers, and persons with disabilities, are disproportionately affected. Climate change has led to a reduction in labour productivity and increased morbidity and mortality linked to environmental factors such as heat stress, particularly in workplaces with minimal adaptive measures (International Labour Organization, 2018).

Gender Inequalities

Climate change exacerbates existing gender inequalities, making women and girls more vulnerable to its health impacts. Limited access to resources, education, and decision-making power restricts their ability to cope with climate shocks. Women are often responsible for household tasks such as water and food collection, which increases their susceptibility to the effects of droughts, floods, and other climate related disruptions (UN Women, 2022). Financial dependence and limited income generating opportunities further reduce their resilience, increasing risks such as food insecurity, malnutrition, waterborne diseases, and sexual and gender-based violence.

During extreme weather events, healthcare facilities may be overwhelmed or damaged, compromising essential services, particularly sexual and reproductive health services. This heightens risks of maternal health complications and neonatal mortality (World Health Organization, 2014).

Female-Headed Households

Women-headed households are particularly vulnerable due to their socioeconomic disadvantages, including lower wages, fewer assets, and limited access to productive resources like financial capital, technology, and land. These factors lead to reduced agricultural productivity and heightened food insecurity during climate events such as droughts or floods. Furthermore, female-headed households often bear a high dependency burden and face restricted decision-making power, which complicates their ability to adapt to or recover from climate impacts. Financial constraints also limit access to healthcare, essential supplies, and nutrition, exacerbating health risks like malnutrition and maternal health issues (Flatø et al., 2017).

Women represent a significant proportion of communities dependent on natural resources for livelihoods, making them particularly susceptible to the adverse effects of climate change (United Nations, 2009). Addressing these vulnerabilities requires tailored interventions that consider the specific challenges faced by low-income groups, climate-sensitive workers, and women, particularly those heading households
Livelihood Vulnerabilities and Resilience

Coastal populations, particularly fisherfolk and aquatic communities in low-lying areas, are vulnerable to rising sea levels, which exert pressure on coastal zones and disrupt their functions, including recreation, storm protection, and supporting diverse marine life, such as vital fisheries. Rising seas also lead to saltwater intrusion into underground freshwater sources, essential for towns, farms, and natural ecosystems. This jeopardizes homes, water sources, and livelihoods, as fish stocks and edible marine life may decline due to ocean acidification and temperature increases, exacerbating food insecurity and related health challenges (Das & Swain, 2024).

Pastoralists, especially in arid and semi-arid regions of the Sahel, East Africa, the Horn of Africa, and nomadic populations in southern Africa, are heavily reliant on livestock for their livelihoods. Pastoral systems have long been undermined by decades of neglect, receiving as little as 1% of government budget allocation, alongside challenges such as violence, displacement, insecure land rights, deteriorating natural resources, and a growing risk of animal and zoonotic diseases. Climate change, through altered rainfall patterns, droughts, and desertification, further diminishes pasturelands and water sources, leading to food insecurity and income loss. These challenges heighten health risks, including malnutrition and zoonotic diseases, as pastoralists maintain close interactions with animals (Food and Agriculture Organization of the United Nations, 2018).

Health Risks Among Communities of Colour

Communities of colour often face disproportionate health risks linked to cumulative exposures to environmental hazards such as air pollution and water and food insecurities. These risks are compounded by racialized health and socioeconomic disparities unrelated to climate change, such as systemic disinvestment in access to quality housing, education, and food. Racialized segregation interacts with broader socio-economic status factors, amplifying spatial concentrations of poverty among racial and ethnic minority populations (Berberian et al., 2022; Sonderlund et al., 2022).

B. Access to Healthcare

Access to healthcare analysis, through tools such as geospatial mapping (Moturi et al., 2022), health system capacity assessments (Oleribe et al., 2019), and community surveys (Ravaghi et al., 2023), reveals the following insights:

Vulnerable Communities in Climate-Prone Areas

In developing countries, national health systems are often overwhelmed during extreme weather events such as flooding and heat waves. Rural areas and underserved regions may lack specialized medical facilities and expertise, worsening the health impacts of climate-related events. Smaller facilities like community health centers, which provide affordable services to vulnerable communities, may lose electricity during storms and flooding, impairing their ability to offer essential services such as first aid and obstetric care (Allarané et al., 2023).

Access

Lack of health insurance and the financial burden of out-of-pocket medical costs increase vulnerability, limiting access to essential services. Vulnerable groups, including migrant workers, often face additional barriers such as transportation challenges and disrespectful treatment in healthcare settings, further exacerbating healthcare access issues. Undocumented migrants are particularly at risk, as their lack of formal status leads to underdiagnosis, poor disease control, and underreporting, especially of malaria symptoms, which contributes to the rise of drug resistance during the climate-health crisis (Parry et al., 2019).

Speed and Efficiency of Emergency Medical Response

The speed and efficiency of emergency medical responses are critical in helping vulnerable populations cope with climate-induced health crises, particularly in regions prone to hurricanes, wildfires, and other extreme weather events. In the absence of functioning medical facilities, particularly in areas prone to climate hazards, vulnerable populations, including people with disabilities, may face inadequate care, leading to increased mortality rates (Khirekar et al., 2023).

Food Insecurity and Climate Crisis

Regions experiencing conflict, insect plagues, droughts, and other climate crises are particularly impacted by food insecurity. East Africa, the Sahel, and the Horn of Africa are facing some of the world's most severe hunger crises, affecting children under the age of 5 who are more susceptible to climate-sensitive diseases such as malaria and diarrhoea. Additionally, children in poverty or rural areas may suffer from malnutrition, compounded by disrupted healthcare services due to extreme weather events (International Rescue Committee, 2022; Fanzo et al., 2024).

Extreme weather events, such as increasing temperatures, can compromise the health of pregnant women, particularly during labour. These conditions can lead to dehydration, endocrine dysfunction, and placental issues, heightening the risk of maternal mortality, hypertensive disorders, and pre-term births (Chersich et al., 2022). Furthermore, air pollution from extreme weather events can increase the risk of lowbirth-weight neonates, neonatal mortality, and pre-term births. Disruptions to

healthcare services, especially maternal and neonatal care, can lead to increased maternal and child mortality (Roos et al., 2021).

Indigenous Communities and Healthcare Access

Indigenous communities, often residing in ecologically sensitive areas such as coastlines, mountains, and forests, are particularly vulnerable to climate change impacts, including rising sea levels, melting glaciers, and extreme weather events. These populations rely heavily on traditional practices for food and livelihood, making them especially vulnerable to climate-induced disruptions. Limited access to healthcare and formal infrastructure exacerbates their vulnerabilities, especially when traditional food sources and water supplies are compromised (International Labour Office, 2017). Climate-induced displacement and the erosion of traditional governance also contribute to mental health struggles, including anxiety and depression (Roos et al., 2021).

Displaced Populations and Health Access

As climate change intensifies, displaced populations face increased health risks, including exposure to climate hazards like floods, droughts, and storms. Refugees and internally displaced persons (IDPs) often live in overcrowded camps or informal settlements where access to healthcare is limited. These populations are vulnerable to waterborne diseases, malnutrition, and mental health issues, with healthcare access further strained during extreme weather events. The climate crisis also heightens tensions over resources like water, fuel, and arable land, creating conditions that exacerbate the risks faced by displaced communities (The UN Refugee Agency, 2023).

Small Island States and Healthcare Vulnerabilities

Small island states face existential threats from rising sea levels, saltwater intrusion, and extreme weather events such as tropical cyclones and hurricanes. These events threaten their freshwater resources, agriculture, and infrastructure, leading to displacement, food and water insecurity, and heightened health risks. Access to healthcare is often limited, which exacerbates the impacts of climate-related disasters. Additionally, these populations face disproportionate health risks associated with extreme weather events, including injuries, infectious diseases, and deaths (Commission of Small Island States on Climate Change and International Law, 2023).

Sexual and Gender Minorities' Healthcare Challenges

Sexual and gender minorities, particularly in marginalized socio-economic groups, face compounded vulnerability to the health impacts of climate change. Discrimination and limited access to healthcare result in higher rates of poverty, unemployment, and housing insecurity, leaving them more exposed to climate-related risks such as displacement, food insecurity, and inadequate housing. In healthcare settings, stigma and discriminatory practices further limit their access to essential services, heightening their risk to climate-related health issues like heat stress, malnutrition, mental health challenges, and infectious diseases (Ross & Setchell, 2019; Physiopedia, 2024).

C. Existing Health Conditions

Analysis of existing health conditions, through the review of epidemiological data (National Research Council (US) Committee on Environmental Sciences and National Research Council (US) Commission on Life, 1997), health impact models (Ammann et al., 2021), and health risk assessments (Pradyumna & Sankam, 2022), reveals the following insights:

Chronic Conditions and Climate Stressors

Existing chronic conditions such as asthma, cardiovascular diseases, diabetes, and weakened immune systems are often exacerbated by climatic stressors, including extreme heat, air pollution, and the spread of infectious diseases. Individuals with preexisting conditions, including the elderly, are at a heightened risk of health morbidities and mortalities due to climate change. These groups are more prone to heat stress, dehydration, infections, and exacerbation of heart and lung diseases. Vulnerabilities are further compounded by environmental conditions, where healthcare access may be compromised during extreme weather events, reducing the capacity to manage these chronic health issues (Better Health Channel, 2021).

Vulnerability of Children and Pregnant Women

Vulnerability to climate impacts extends to children and pregnant women. Children's immune systems are still developing, making them particularly susceptible to climatic stressors such as heat stress, dehydration, and air pollution, all of which increase their risk of infections. Their dependency on adults for safety during climate-related emergencies and recovery further exacerbates their exposure to climate risks. Pregnant women, who face additional physiological demands, are particularly at risk of heightened heat stress during heatwaves. Exposure to air pollutants and wildfires can have severe consequences for both the mother and the unborn child (Better Health Channel, 2021).

Disability and Mobility Constraints

Persons with disabilities face additional vulnerability due to mobility challenges during evacuation procedures. This increased vulnerability is particularly evident in the context of extreme weather events, where timely evacuation can be hindered by limited access to transportation or assistance. In situations like floods or heatwaves, the compounded challenges of navigating inaccessible environments, coupled with the difficulty in receiving necessary healthcare, further intensify the risks faced by individuals with disabilities (Pradyumna & Sankam, 2022).

Gender-Specific Vulnerabilities

Climate impacts particularly affect women, who often bear the responsibility for food production, management, and distribution within families and communities. Recurrent extreme weather events, such as floods and cyclones, devastate agricultural production, leading to losses in food supplies. In response, families may reduce food consumption or consume lower-quality food, contributing to the triple burden of malnutrition: undernutrition, overnutrition, and micronutrient deficiencies. This malnutrition weakens the population's resilience to disease outbreaks. In regions already struggling with food security, climate-induced food shortages exacerbate

vulnerability, further affecting the health and well-being of women and their families (Mukerji, 2

2.3.3 Policy Landscape for Climate and Health in Africa

The climate and health policy landscape is constantly evolving, marked by pivotal moments that rejuvenate collective action at all levels (Atela et al., 2024b). Building on previous global and regional declarations aimed at fostering public health resilience and overall environmental health, a renewed emphasis on integrated approaches emerged, centred around the 2015 Paris Agreement (PA). Existing climate change policies under the United Nations Framework Convention on Climate Change (UNFCCC) provide a solid foundation for these efforts.

Current climate policies, along with health-determining sectoral policies such as those in energy and agriculture, can enhance health outcomes. These include National Climate Change Action Plans (NCCAPs), Nationally Determined Contributions (NDCs), National Adaptation Plans (NAPs), Renewable Energy Strategies, Agricultural Development Strategies, and Air Quality Strategies. By identifying the most urgent and immediate needs for adapting to climate change across sectors, these policies create a strong platform for integrating health considerations into climate action.

The establishment of the Alliance for Transformative Action on Climate and Health (ATACH) by the World Health Organization during the 26th Conference of Parties (COP26) marked a pivotal moment, characterised by intensified advocacy for placing health at the core of climate change discussions. With over **83** countries globally and **30** from Africa committing to ATACH, the development of Health National Adaptation Plans (HNAPs) represents a crucial step in integrating health into climate policies through robust vulnerability assessments. Advocacy efforts are steadily increasing the number of African countries developing HNAPs.

By early 2024, 17 countries had engaged in national consultations for HNAPs. These processes facilitate collaboration among health-determining sectors, stimulating demand for and the uptake of transdisciplinary research and evidence. The inclusion of health as a key focus area in the Global Goal on Adaptation Framework provides a foundation for setting targets and monitoring policy progress. Notably, Paragraph 9 of the Global Goal on Adaptation Framework, established at COP28, identified health as a target sector for developing adaptation targets and reporting.

Pan-African declarations and strategies, such as the African Union Climate Change and Resilient Development Strategy and Action Plan (2022-2032), further promote these objectives through the One Health Agenda (African Union, 2022). At the national level, a multi-sectoral approach to developing health adaptation plans is gaining momentum, although a lack of transdisciplinary evidence remains a challenge (Atela et al., 2024a). These renewed efforts build upon existing policies that have not fully addressed the increasingly complex interplay between climate and health. While the reasons for limited success in previous endeavours are unclear, the renewed focus on health signals a paradigm shift in addressing climate impacts on health outcomes.

Key Insights

a) Shifting Climate and Health Policy Landscape:

The climate and health policy landscape is undergoing a significant transformation, shifting from multilateral agreements towards frameworks that prioritise integrated approaches, placing health at the forefront of climate policy. This renewed focus on climate and health action is driving a paradigm shift, fostering collaboration between climate and health experts, which contrasts with previous siloed efforts. The unprecedented participation of over 60 health ministers at COP28 underscores the growing political commitment to this integration. The Global Goal on Adaptation, established at COP28, specifically targets health outcomes, *emphasising resilience building, climate-resilient health services, and reduced climate-related morbidity and mortality, particularly in vulnerable communities.* While global momentum is building, translating these efforts into concrete actions at national and local levels remains crucial.

At the national level, global and continental policies are being domesticated through Nationally Determined Contributions (NDCs), which underpin countries' commitments to the Paris Agreement. Several African nations have integrated health sector actions into their NDCs, earning recognition as "Healthy NDCs" from the World Health Organization. Burundi and Côte d'Ivoire exemplify leadership in this area (GCHA, 2023). Additionally, countries like Egypt, Rwanda, and Zambia have developed specific health sector response plans to address heat-related illnesses.

The latest National Communications submitted by African countries to the UNFCCC[1] indicate that the majority are already implementing health adaptation measures (Table 1). These measures primarily focus on policy development and controlling climate linked infectious diseases. While progress in early warning systems has been made, many stakeholders identify this area as a critical priority for further investment. Notably, action on public health infrastructure and technology remains limited. This could be attributed to a lack of robust evidence on the systemic connections between climate and health, which could inform comprehensive interventions across the entire healthcare system.

[1] https://unfccc.int/non-annex-I-NCs

Table 1: Health Adaptation Measures Identified in the NDCs of Various African Countries (Source: latest National Communication to the UNFCCC)

Country	Early Warning Systems	Public Education and Awareness	Surveillance, Research, &Monitoring	Infectious Disease Control	Policies Development	Public Health Infrastructure and Technology
Botswana		√	√√	√√	√	
Egypt	√√		√√	√√	√√	√√
Eritrea	√	√	√√	√√	√	√
Gambia	√√	√√	√	√√	√√	
Ghana		√	√√		√√	
Guinea Bissau				√		
Lesotho	√√	√√	√		√√	
Malawi				√		
Mauritius		√	√		√	
Namibia				√√		
Nigeria	√√	√√	√		√	
Rwanda	√√	√√		√√		
Seychelles		√			+	
Sierra Leone	√	√	√	√√	√	√
South Africa	√√		√√	√√	√√	√√
Uganda	√			√√	√√	
Zambia	√		+			
Zimbabwe				√		

Note: √√ denotes being implemented, √ denotes in consideration.

b) Integration of Climate-Health Actions in National Policies:
Beyond Health National Adaptation Plans (HNAPs), several African countries possess climate policies that have the potential to enhance health outcomes. For example, Uganda's National Climate Change Policy prioritises health initiatives. One of the policy's objectives is to strengthen adaptive mechanisms, improve early warning systems, and ensure adequate preparedness for climate change-related diseases.

Tanzania's National Climate Change Strategy aims to enhance stakeholder capacity for implementing climate and health action plans. The policy outlines opportunities for mitigating climate impacts through sustainable programmes. However, limitations in capacity building, resource mobilisation, and stakeholder awareness of climate and health policies hinder progress. There is a need to invest in alternative, non-policycentric approaches to resilience.

South Africa's 2007 Air Quality Act seeks to reduce greenhouse gas and air pollutant emissions. The Act mandates the development of air quality control plans at various government levels (Nhamo & Muchuru, 2019).

Ghana, Lesotho, and **Namibia** have developed National Adaptation Programmes of Action (NAPAs) to address the health impacts of climate change (Nhamo & Muchuru, 2019). These programmes focus on water, sanitation, and hygiene (WASH), vector control, and disease management. NAPAs also outline disaster preparedness and response strategies, informed by the WHO's Integrated Disease Surveillance and Response Strategy, which is championed by Ministries of Health.

c) Gaps in Climate-Health Risk Integration:
While progress is being made, there are significant gaps in integrating climate risks into health policies. Many African countries cannot conduct comprehensive climatehealth risk assessments, which hinders the ability to develop effective, context-specific health interventions. Furthermore, the lack of reliable data and weak surveillance systems make it difficult to monitor the long-term health impacts of climate change. This gap is especially pronounced in rural and marginalised areas, where health infrastructure is underdeveloped.

d)Importance of Early Warning Systems:
Early warning systems are crucial in mitigating the health impacts of extreme weather events**.** African health policies are increasingly recognising the importance of climate services, which provide critical data on weather and environmental conditions to anticipate health risks. For example, Clim-HEALTH Africa is collaborating with various African governments to integrate climate information into national health systems, improving preparedness for disease outbreaks triggered by climate events such as floods and droughts. Despite these efforts, the uptake and use of climate data remain limited, and more robust infrastructure is needed to ensure that early warning systems can be effectively deployed across the continent.

e) Role of Regional and International Partnerships:
Regional initiatives and international partnerships are essential for advancing climate and health policies in Africa**.** The African Union and organisations like the World Health Organization (WHO) and the World Meteorological Organization (WMO) play critical

roles in supporting African nations with policy guidance, technical assistance, and capacity-building. Moreover, climate finance mechanisms such as the Green Climate Fund and the Africa Climate Change Fund are increasingly being used to support health-related adaptation efforts, although many countries struggle to access sufficient funding for these initiatives.

f) Contribution of Civil Society Organisations (CSOs):

Civil society organisations (CSOs) also play a pivotal role in supporting the adoption and implementation of climate adaptation policies. They act as intermediaries, fostering connections across sectors and governance levels. For instance, YADNET Uganda convened national multi-stakeholder dialogues, contributing to the development of the Health Vulnerability Assessment and National Adaptation Plan. This led to the inclusion of health initiatives and broader stakeholder representation within Uganda's National Climate Change Policy. Similar efforts by CSOs in Tanzania and other African countries focus on implementing Water, Sanitation, and Hygiene (WASH) initiatives to address climate and health challenges at the community level while linking with government efforts.

g) Challenges in Operationalising Global Frameworks:

Operationalising global climate and health frameworks at national and regional levels presents significant challenges. Policymakers struggle to adapt global data platforms to inform national vulnerability assessments and HNAPs. Regional focus groups and consultations with policymakers have identified key obstacles, including sectoral tensions between climate and health domains, a lack of domestic expertise to interpret climate-health linkages, and a shortage of contextual data. While countries like Uganda and Tanzania have integrated health into climate plans, concrete implementation steps, such as defined tasks, timelines, and accountability, remain elusive.

Recommendations

- A comprehensive assessment of country-specific contexts is essential to identify optimal opportunities for developing integrated climate and health policies that yield desired health outcomes.
- Invest in the expansion of climate services infrastructure to ensure timely, reliable data for health-related early warning systems across Africa.
- Strengthen surveillance systems and enhance the capacity for climate-health risk assessments, particularly in rural and underserved areas.
- Increase regional collaboration and access to international funding to support climate-health adaptation efforts and capacity-building initiatives.
- Strengthening the capacity of civil society organisations (CSOs) to understand climate and health linkages at the local level is crucial. Equipping CSOs to mediate between local communities and national HNAP processes can significantly enhance policy implementation.

2.3.4 Climate and Health Funding Landscape

Funding remains a primary challenge for transdisciplinary climate and health research and action (Figure 3). While Africa faces significant climate-related health challenges, the financial resources required to address these issues are still insufficient. The continent's health systems are under-resourced, and the additional burden of climate induced health crises only exacerbates this situation. African nations are increasingly seeking international and regional funding to strengthen their climate-health resilience, yet access to, and the effective allocation of, such funding remains problematic.

Despite growing global funding for climate and health initiatives, it remains inadequate (Beyeler & Schaferhoff, 2023; Ijjasz-Vasquez et al., 2024). The majority of funding comes from the Global North, which disadvantages African researchers due to funds being channelled through institutions in high-income countries. Despite the increasing emphasis on transdisciplinary research and policy development, international climate finance often overlooks critical local-level health initiatives, leaving funding for these essential interventions critically low.

Health was a significant focus at the 29th UN Climate Change Conference (COP29), held in Baku, Azerbaijan, which concluded with notable developments concerning Africa's climate change and health landscape. A key outcome was the agreement to triple climate finance for developing nations to enhance their resilience against climate-induced disasters and facilitate participation in the growing clean energy sector. A global consensus was reached to set an annual climate finance target of $300 billion by 2035. However, many developing countries, particularly in Africa, consider this amount insufficient to address the mounting challenges posed by climate change (Daigle & Wong, 2024).

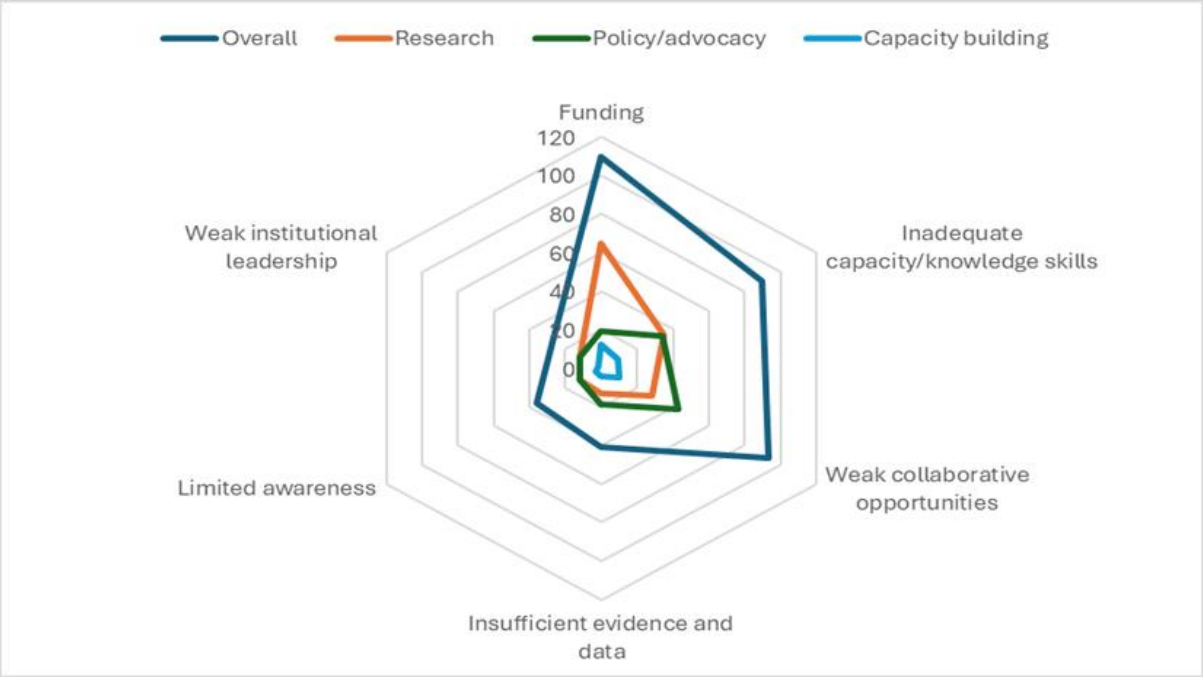


Figure 2: Priority Needs/Barriers to Transdisciplinary Climate and Health Research and Action.

Key Insights

a) *Growing Investment in Climate and Health Research and Action*:

While current funding for climate and health (C&H) research remains inadequate, there is a positive trend towards increased investment. Key funders, such as Wellcome, the National Institute for Health, Novo Nordisk Foundation, Gates Foundation, International Development Research Centre (IDRC), Medical Research Foundation (MRF), and Rockefeller Foundation are establishing dedicated programs to support integrated climate and health research, capacity building, and policy support. These initiatives are helping to catalyze greater focus and funding for the intersection of climate and health in Africa.

b) *Fragmentation and Inefficiencies in Funding Landscape*
Overlapping funding from international donors has led to fragmentation and inefficiencies in the climate and health landscape. Stakeholders have expressed concerns about redundant funding for similar activities, which hinders collaboration. In response, international funders are increasingly collaborating to pool resources. A notable example is the joint commitment of the Novo Nordisk Foundation, Wellcome, and the Gates Foundation, which have pledged US$300 million over three years to address the health impacts of climate change and promote global health equity.

c) Limited Domestic Funding and Institutional Barriers:
Domestic funding for climate and health remains limited and underdeveloped. While most African governments allocate budgets for climate change initiatives, these funds are often not strategically aligned with integrated climate and health approaches. The early stage of National Health Adaptation Plans (NHAPs) has hindered adequate budgetary allocation for climate and health integration. Furthermore, institutional barriers within government ministries impede the integration of research into government programs, limiting access to funding opportunities for researchers. This calls for streamlining research processes within government bodies to enhance access to resources and create a conducive research environment.

d) Disparity in Resource Allocation for African Researchers:
Funding from the Global North, typically channelled through institutions in these regions, disadvantages African researchers. Despite growing global commitments to climate change research and skill development, a concerning disparity persists in resource allocation. Overland et al. (2021) reported that approximately 78% of funding for African climate research is directed to European and American institutions, leaving only 14.5% for African counterparts. This imbalance results in non-African researchers having significant control over projects, further exacerbating the marginalisation of African research teams. Furthermore, available C&H funding primarily targets vector borne diseases like malaria, overlooking region-specific challenges.

e) Growing Role of the Private Sector in Climate Adaptation:

The private sector is beginning to play a more active role in climate adaptation, though its involvement in the health sector remains limited. Private investment in renewable

energy projects, such as solar-powered health clinics, and public-private partnerships for climate-resilient infrastructure are on the rise, though these remain small relative to the overall need. Innovative financing mechanisms, such as climate bonds and insurance schemes, are being explored as alternative ways to fund climate-health resilience. For example, the African Risk Capacity (ARC), an agency of the African Union, provides insurance against climate-related disasters, helping countries recover from events like droughts and floods.

f) Gap in Funding for Health-Related Transdisciplinary Research:

While there is growing interest in funding transdisciplinary research and policy development, international climate finance for health activities remains limited. A recent study by Alcayna et al. (2023) found that only 0.5% of multilateral climate adaptation funds are allocated to the health sector, highlighting a significant funding gap. Despite efforts to integrate health into climate decision-making, health expert involvement in program development remains low. To address this, leveraging international climate finance mechanisms, such as the Green Climate Fund (GCF), private sector funding, and multilateral development banks, is crucial. The GCF, for example, offers opportunities to support climate-resilient health systems and climateinformed advisory services (GCF, 2022).

Recommendations

- **Increase Funding and Build Capacity**: Significantly increase funding for climate and health (C&H) research in Africa, equipping researchers and stakeholders to define priorities and establish locally driven frameworks. This will ensure that funding is directed towards pressing issues, fostering a more equitable research landscape.

- **Enhance Funding Coordination**: Establish effective coordination mechanisms, such as funders' consortia, to optimise resource allocation and achieve sustainable, impactful outcomes that extend beyond individual projects.

- **Prioritise Equity and Ethics**: Reinforce affirmative action and equity in the disbursement and management of climate and health funds. Allocate dedicated funding to African researchers to build capacity and strengthen South-South collaborations.

- **Explore Innovative Funding Mechanisms**: Investigate innovative funding instruments, such as Public-Private Partnerships, to enable action-oriented organisations to access government funding and implement impactful projects.

2.4 Interventions for Climate Adaptation and Mitigation in Health

The increasing strain on Africa’s health infrastructure, exacerbated by the impacts of climate change, has contributed to higher mortality rates from extreme weather events and heightened exposure to disease outbreaks, particularly among vulnerable

communities. According to the 2024[2], fact sheet of the Integrated African Health Observatory, Africa experienced 64 natural disasters in 2023, resulting in approximately 20,800 deaths, while 12.7 million people were either directly or indirectly affected. Leal Filho et al. (2023) highlight a correlation between temperature fluctuations and the incidence of malaria across Africa between 2000 and 2018. African communities are particularly susceptible to malaria when average temperatures and humidity rise, creating conducive conditions for vector breeding and the proliferation of Anopheles mosquitoes. Similarly, Aedes mosquitoes, responsible for dengue fever, thrive in comparable climatic conditions. Chersich et al. (2022) further underscore the risks posed by ambient temperatures, particularly to women and newborns, who face challenges in thermoregulation.

In response to these challenges, Moyo et al. (2023) emphasise the urgent need for effective and sustainable strategies for climate change adaptation and mitigation in health. These strategies should focus on enhancing socio-economic structures and physical systems that safeguard the psychological well-being of local communities. Such interventions necessitate a multisectoral approach, which includes improving surveillance of climate risks, designing robust information dissemination strategies, establishing climate-resilient health systems, and investing in research and development.

One effective mitigation strategy that has been adopted across Africa's health systems is the establishment of early warning infrastructures. Extreme weather events and seasonal forecasting systems have been implemented in countries like Lesotho, Rwanda, South Africa, Uganda, Zambia, and Eritrea (Nhamo & Muchuru, 2019; Chersich & Wright, 2019; Kalantary, 2010). These systems include risk maps to identify areas vulnerable to severe weather and health alert networks and heat-health warning systems (Nhamo & Muchuru, 2019; Chersich & Wright, 2019). A notable example is the development of an early warning system for cholera outbreaks in Ethiopia, which integrates meteorological, water quality, and environmental data to predict and prevent outbreaks (EPHI, 2022). By monitoring climate-sensitive parameters such as rainfall and flooding, this system enables communities to anticipate outbreaks linked to climate events, thereby facilitating timely interventions.

South Africa has made significant strides in addressing heat-related health risks by introducing its National Heat Health Action Guidelines. These guidelines, developed to mitigate the impact of extreme heat on vulnerable populations, particularly in rural areas with limited access to cooling infrastructure, include the Healthy Environment Assessment Tool (HEAT). HEAT evaluates indoor heat risks in healthcare facilities, revealing that indoor temperatures in some facilities often exceed outdoor heat levels, creating unsafe conditions for both patients and staff. These findings have led to the development of heat-health action protocols, which focus on low-cost, practical interventions such as improving ventilation, using shaded or cooling spaces, and enhancing green infrastructure to reduce urban heat islands. The

[2] https://files.aho.afro.who.int/afahobckpcontainer/production/files/iAHO_Climate_change_in_health_Fact_Shee t-April_2024.pdf

guidelines also establish a heat-health warning system to alert communities and healthcare providers to dangerous heat events, enabling timely responses. Vulnerable groups, including children, the elderly, outdoor workers, and residents of informal settlements, are prioritised in these measures. South Africa's approach highlights the intersection of public health and climate resilience, emphasising the need for proactive governance and community-centred approaches to climate adaptation.

Additionally, public health education and awareness campaigns about preventive measures are being implemented in countries such as Malawi, Rwanda, Botswana, Mauritius, and Eritrea (Nhamo & Muchuru, 2019; Otieno et al., 2022; Scheelbeek et al., 2021). These efforts focus on raising awareness about climate risks and promoting appropriate behaviours, such as using cooling fans during hot weather, improving ventilation, and wearing light, loose-fitting clothing, as in Malawi (Nhamo & Muchuru, 2019; Scheelbeek et al., 2021), and increasing awareness of vector-borne diseases (Otieno et al., 2022).

Strengthening health systems for infectious disease control has also been reported in countries like Rwanda, South Africa, Uganda, Eritrea, and Botswana (Nhamo & Muchuru, 2019; Otieno et al., 2022; Chersich & Wright, 2019; Scheelbeek et al., 2021). Adaptation efforts include the surveillance of infectious diseases in South Africa, Mozambique, and Eswatini, as well as research and development activities focused on vector control, case detection, and treatment in Uganda (Scheelbeek et al., 2021; Nhamo & Muchuru, 2019). Investments in research and development have also improved vaccination programs in Botswana, South Africa, and Rwanda, ensuring vulnerable communities have access to safe water and sanitation.

In Eastern and Southern Africa, climate resilience in public health infrastructure is being enhanced by modifying architectural designs to accommodate weather changes. New building designs are being promoted to reduce energy use, enable natural cooling, and strengthen roofs to withstand heavy storms and strong winds (Nhamo & Muchuru, 2019; Chersich & Wright, 2019; Scheelbeek et al., 2021). Rwanda's government has made notable efforts to integrate climate resilience into health planning (Muvinyi et al., 2024). These efforts have identified gaps in resource mobilization, capacity building, and dissemination strategies, which are essential for enhancing the climate resilience of public health systems. Through the Urban Low-Emission Development Strategies (Urban-LEDS II), health facilities like Gahanga and Gitarama in Rwanda have been equipped with water harvesting infrastructures, such as tanks and solarized water pumps, ensuring water security even during extreme weather events like droughts and floods. Green energy infrastructures have also been installed to reduce energy operational costs and provide reliable power for quality services. To ensure sustainability, technicians at these facilities have been trained to operate and maintain the installed infrastructures[3]. The scaling up of such initiatives across Africa is crucial for establishing climateresilient health infrastructures in both urban and remote areas.

[3] https://urban-leds.org/wp-content/uploads/2021/11/Rwanda_ICLEI-Urban-LEDS-Case-Study.pdf

Restoration of degraded lands in the Sahel region through the Great Green Wall (GGW) initiative (Turner et al., 2021) has been leveraged to mitigate the dust storms. Dust storms are often associated with respiratory illnesses such as asthma, especially among children and the elderly. It is to this end that the GGW has since restored 40 million hectares of degraded lands in Senegal, Ethiopia, Burkina Faso, Nigeria and Niger by 2024[4]. This Afforestation initiative seeks to enhance the continent's carbon sinks and establish a vibrant biodiversity in the Sahel region while providing sustainable livelihoods to the local communities including water and food security (Sacande et al., 2021).

The promotion of climate-smart agriculture (CSA) has emerged as a critical intervention for enhancing food security in vulnerable African communities. CSA adapts agricultural practices to climate change by promoting drought-resistant crops and improving yields in the face of extreme weather events. The Food and Agriculture Organization (FAO) has endorsed CSA as a key approach for better nutrition, as outlined in its strategic framework for 2022-2031. In Kenya, the Climate Smart Villages (CSVs) in Nyando are leveraging CSA to combat malnutrition by introducing drought-resistant high-yield crops (Yang, 2024). Additionally, solar powered boreholes have proven effective in providing sustainable water supplies to communities in Arid and Semi-Arid Lands (ASAL) regions, as seen in Kenya's Climate Change Adaptation Programme (KCCAP).

2.5 Mapping Stakeholders and Networks in Climate and Health

The interconnected challenges posed by climate change and health risks in Africa demand coordinated efforts from a diverse range of stakeholders, including governments, international organizations, non-governmental organizations (NGOs), research institutions, and the private sector. These stakeholders are increasingly forming regional and international networks to share knowledge, pool resources, and collaboratively address the health impacts of climate change. The evolving landscape of climate and health stakeholders in Africa reflects the growing recognition that comprehensive, transdisciplinary collaboration is crucial for building resilience against climate-induced health crises

Given the continent's complex vulnerabilities, addressing the intersection of climate change and health requires a coordinated, multisectoral approach. This involves bringing together diverse actors such as governments, international organizations, civil society, and the private sector to implement solutions that address Africa's unique climate-health challenges collectively.

2.5.1 Key Stakeholders

The climate and health landscape in Africa is increasingly complex, comprising stakeholders from research, policy, advocacy, capacity building, and funding domains. Driven by global advocacy to address the health impacts of climate change, this field is rapidly growing. Policy-focused stakeholders, particularly, are expanding, supported by global alliances such as the Alliance for Transformative Action on Climate and Health (ATACH), which pressures governments for policy action. Regional alliances

[4] https://thegreatgreenwall.org/results

and advocacy groups are also emerging as intermediaries, translating global policies into national contexts. However, operationalising these global aspirations often encounters challenges due to insufficient contextual evidence, expertise, and data, as dedicated transdisciplinary research (TDR) teams are still under development.
While emerging pan-African networks offer promising platforms for transdisciplinary research and action, their full potential remains untapped due to gaps in coordination, partnerships, and funding. The evolving donor landscape suggests a growing interest in transdisciplinary investments that transcend traditional cause-effect analyses. Despite a well-developed climate and health advocacy landscape in Africa, with numerous alliances and networks, there is an urgent need for robust TDR evidence to convert advocacy efforts into actionable plans

Stakeholders identified in this context include organisations, institutions, and agencies engaged in climate change and health initiatives that encompass research, policy, advocacy, or practice. These stakeholders can be classified based on their geographical scope as global, regional, or national stakeholders. Global stakeholders operate across African and non-African countries. Regional stakeholders function within multiple African nations, sharing information, conducting research, or implementing policy, capacity building, or advocacy activities at local levels. National stakeholders operate exclusively within a single African country, either nationally or locally.

Key Insights

a.) Geographical Imbalances and Stakeholder Distribution

A significant imbalance exists in the geographical distribution of stakeholders working on climate change and health across Africa, influenced by factors such as funding, vulnerability, and geopolitics. Among the 188 stakeholders mapped, 52 focus solely on climate change, 57 on health, and 79 on the climate-health nexus. Stakeholder concentration is highest in East, West, and Southern Africa, with underrepresentation in Central and Northern Africa (Atela1 et al., 2024a). This regional disparity is partly attributed to funding allocations that predominantly target sub-Saharan Africa, perceived as facing the most acute climate and health challenges (Opoku et al., 2021). Methodological biases, such as the use of English and French, may have limited engagement with non-English-speaking regions.

While some stakeholders interpret these geographical imbalances as indicative of greater capacity in East, West, and Southern Africa, others see these regions as hubs for innovative approaches with broader applicability. However, persistent imbalances risk exacerbating vulnerabilities in under-resourced areas, potentially undermining health system resilience.

b.) Thematic Engagement and Synergies

Many stakeholders engage in multiple thematic areas, including research, policy, and capacity building, creating potential synergies for transdisciplinary collaboration. As illustrated in **Figure 5,** research organizations primarily focus on research while incorporating policy elements, but capacity-building efforts are limited, leaving gaps in translating research into actionable solutions. Conversely, civil society organisations prioritise policy advocacy with less emphasis on research, underscoring the need to

bridge the gap between advocacy and evidence-based action. Government organisations mainly address policy issues with limited research and capacity building, hindering the development of actionable programs based on established policies.

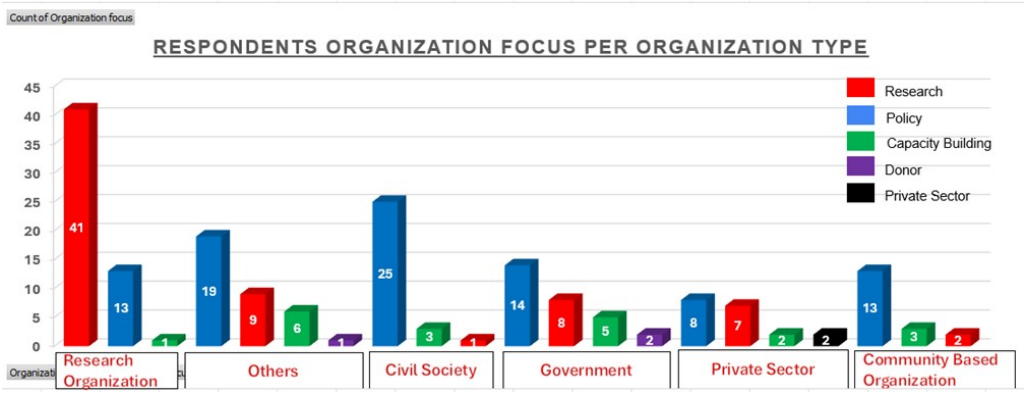


Figure 3: Thematic Focus of Different Types of Organizations (n=198) Mapped in the Online Survey

c.) Regional and Continental Organisations

Regional organisations such as the African Union (AU) and African Ministers of Health and Environment facilitate cross-border collaboration and knowledge sharing. The African Risk Capacity (ARC), a specialised AU agency, provides insurance solutions to help governments finance responses to climate disasters, including health emergencies triggered by extreme weather events. The AU's involvement ensures that climate and health resilience strategies align with broader development goals across the continent.

d.) Role of NGOs

Non-governmental organizations (NGOs) such as Amref Health Africa and Doctors Without Borders are critical players in implementing health interventions in underserved areas affected by climate events. Their efforts include healthcare delivery during crises, health education, and advocacy for integrating health considerations into climate action plans. NGOs also act as intermediaries between local communities and governments, ensuring grassroots concerns inform national climate-health policies.

d.) Government-Led Adaptation Planning

Government ministries of health and environment are pivotal in leading national vulnerability assessments and health adaptation planning. Locally led resilience health plans, often developed by civil society organizations and local authorities, bridge the gap between national policy and local action. Guided by frameworks such as ATACH and the AU Declaration on Environmental Health, ministries are spearheading the development of Health National Adaptation Plans. Civil society organizations and local authorities collaborate with communities to address interconnected challenges, such

as those led by the Southern African Faith Communities Environment Institute, which supports residents in adapting to climate change while safeguarding their health.

e.) Knowledge Brokering by Regional Networks

Regional organisations and networks play a crucial role in translating global policy goals into national actions. These entities advocate for evidence-based planning and mobilize resources to support interventions. For instance, WHO-Afro has mobilized African Member States to join the ATACH Alliance and guided the development of health vulnerability assessment plans. Advocacy groups like the CHANCE network and the Africa Climate and Health Alliance have amplified calls for action. However, pan-African research organizations focusing on health and climate impacts still need to integrate their findings more effectively into broader climate change policies to ensure their knowledge drives impactful interventions.

2.5.2 Key Networks

Networks comprised of diverse organizations, initiatives, or individuals, are pivotal in advancing transdisciplinary research and action in the climate and health (C&H) field. A mapping of existing C&H networks in Africa highlights a predominance of projectbased consortia. While these consortia have facilitated research and action within their project timelines, their impact is often constrained once projects conclude, limiting opportunities for knowledge sharing and the sustainability of lessons learned.

Key Insights

a) ***Typologies of Climate and Health Networks***

The climate and health field features various network typologies, each with unique operational approaches and strengths.

- **Project-Based Collaborations**: These are partnerships formed by researchers or organizations to secure and implement specific C&H projects. Such collaborations draw on diverse expertise to advance integrated research and action. However, their temporary nature often limits knowledge transfer and the continuity of partnerships beyond the project lifecycle.
- **Organizational Networks**: These involve multiple entities uniting under a shared agenda, offering a flexible structure for pursuing a wide range of climate and health objectives. Anchored by a lead institution, these networks facilitate joint initiatives, discussions, advocacy, and fundraising. Examples include global alliances like ATACH, hosted by the WHO, and regional networks such as the Africa Climate and Health Alliance, which brings together civil society and research organizations to advance climate and health priorities. Organizational networks have the potential for long-term collaboration, given their integration into institutional mandates. However, key informant interviews reveal that these networks often suffer from a lack of clear focus and encounter funding challenges. Funders tend to prioritize short-term projects over

long-term institutional strengthening. By investing in specialized niches and building on organizational strengths, these networks can achieve more significant and enduring impacts.

- **Individual Expert Networks**: These involve collaborations among professionals from diverse fields within professional bodies or networks. Examples at the regional level include the Pan-African Climate Justice Alliance and the Africa Research and Impact Network, which break institutional silos and foster transdisciplinary research and innovation. While these networks offer benefits such as knowledge sharing and institutionalizing outcomes, members often struggle to balance network commitments with their organizational roles.

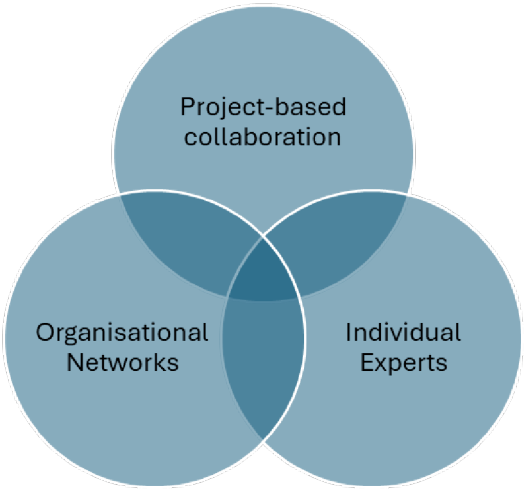


Figure 4: Collaborative Models for Research, Policy/Advocacy, and Action in Climate and Health. (Source: Authors)

b) Opportunities for Transdisciplinary Research and Action

Networks vary in focus, with some addressing specific climate or health disciplines while others adopt a broader climate-health nexus approach. These networks create opportunities to foster transdisciplinary research and action in Africa. However, existing networks face challenges, including funding constraints, disciplinary silos, unclear objectives, capacity gaps, and weak connectivity. To overcome these challenges, stakeholders must carefully select and optimize collaborative models by considering factors such as network focus (research, policy, or action), member expertise, governance structure, communication strategies, and sustainability. This approach can maximize the effectiveness of transdisciplinary climate and health research and action.

c)Strengthening Regional Networks and Cross-Sector Collaboration

Regional networks like Clim-HEALTH Africa hold significant potential to facilitate cross-border collaboration and address transboundary climate and health challenges, such as disease outbreaks and extreme weather events. By pooling resources and sharing best practices, regional stakeholders can strengthen their capacity to address these challenges. Additionally, enhanced cross-sector collaboration between fields such as health, environment, agriculture, and disaster risk management can lead to more integrated responses to climate risks. For instance, combining agricultural and health

data can help predict food insecurity crises and mitigate malnutrition and related health issues.

Recommendations

Conduct a comprehensive review of regional network functionalities

A thorough evaluation of the operations and capacities of regional networks is essential to enhance their knowledge brokerage capabilities. Aligning existing research outputs with the emerging integrated climate and health (C&H) agenda will ensure that transdisciplinary research is effectively informed and regional networks are empowered to mobilise research evidence into actionable outcomes.

Improve coordination among governments, NGOs, and international organisations

Efforts should focus on reducing fragmentation in climate and health initiatives by fostering collaboration across sectors. Establishing robust knowledge sharing platforms and promoting joint action will strengthen coordination and create synergies among stakeholders, enhancing the effectiveness of climate and health responses.

Address regional disparities in stakeholder presence

Targeted efforts are needed to encourage climate-health initiatives in underrepresented regions, particularly Central and Northern Africa. This can be achieved by allocating funding specifically for these under-resourced areas and supporting the emergence of local research and advocacy networks to ensure equitable progress across the continent.

03 INTEGRATING EVIDENCE INTO CLIMATE AND HEALTH POLICYMAKING

Chapter 3: Integrating Evidence into Climate and Health Policymaking

The relationship between climate change and health represents one of the most critical challenges for Africa. However, policies addressing this nexus often lack grounding in local evidence, undermining their effectiveness. For instance, while global models may project disease spread due to rising temperatures, they frequently overlook Africa specific factors such as cultural practices, population density, and the varying resilience of health systems.

Evidence-informed policymaking (EIPM) offers a vital bridge, grounding decisions in robust data, context-specific insights, and the expertise of diverse stakeholders. This approach enhances policy relevance and strengthens the capacity to mitigate health risks associated with climate change.

While African countries have made notable strides in addressing the health-related impacts of climate change, there are gaps in the integration of scientific evidence into policy frameworks. This chapter provides an analysis of the status, challenges, and opportunities in integrating evidence into climate and health policymaking in Africa.

3.1 Advances in Evidence-Based Policymaking

3.1.1 National Frameworks for Climate and Health

Several African countries have developed policies and frameworks explicitly addressing the nexus of climate change and health. These frameworks are increasingly informed by scientific evidence and are tailored to address specific climate vulnerabilities.

South Africa's **National Heat Health Action Guidelines**, launched in 2022, represent a significant milestone. These guidelines leverage data from tools such as the **Healthy Environment Assessment Tool (HEAT)**, which evaluates indoor heat risks in healthcare facilities. Based on this evidence, targeted interventions have been implemented, including enhanced ventilation systems and localized heat-health warning mechanisms to safeguard public health.

Similarly, Ethiopia's **Climate Resilient Green Economy Strategy** exemplifies the integration of evidence-based approaches to address climate-induced health impacts. For instance, the strategy includes measures to combat the increasing prevalence of vector-borne diseases driven by shifting rainfall patterns. These approaches highlight the potential of localized evidence to inform and strengthen policy frameworks in mitigating health risks associated with climate change.

3.1.1 Disease Surveillance and Early Warning Systems

Several African countries have embraced advanced technologies and methodologies to forecast and manage climate-sensitive health risks, showcasing the effective integration of evidence into practical interventions.

In **Kenya**, the **malaria early warning system** exemplifies this progress. By integrating climate variables such as temperature and rainfall with epidemiological data, the system forecasts outbreaks in high-risk regions. This evidence-based approach has

significantly enhanced resource allocation and the timing of interventions, reducing the disease burden in vulnerable communities.

Similarly, **Senegal** has adopted predictive models for **Rift Valley fever outbreaks** that utilize satellite imagery and climate data. This proactive strategy has successfully anticipated outbreaks, enabling timely public health responses and minimizing impacts. These examples underscore the critical role of environmental and epidemiological data integration in bolstering health system resilience against climate induced health threats.

3.1.2 Regional and Continental Collaboration

Regional and continental initiatives are vital for building capacity, fostering knowledge exchange, and promoting collaboration among African nations in addressing climate and health challenges.

The **Africa Centres for Disease Control and Prevention (Africa CDC)** exemplifies this approach by adopting a **One Health framework**. This transdisciplinary initiative emphasizes the interconnected health of humans, animals, plants, and their shared environment. Through programs such as the **Kofi Annan Fellowship**, the **Institute of Workforce Development's online courses**, and various regional training opportunities, Africa CDC is enhancing the skills of health professionals in tackling One Health issues. Furthermore, its support for regional One Health networks strengthens training and collaboration, enabling countries to develop **climate-resilient health systems** through technical support and capacity building.

In parallel, **WHO-supported *Early Warning and Response Systems (EWARS)*** have significantly enhanced the ability of African countries to predict and respond to climate sensitive health challenges. By facilitating cooperation between national health systems and meteorological agencies, EWARS fosters more robust responses to emerging threats.

On an institutional level, the **Africa Research and Impact Network (ARIN)** has developed the Consultative Platform on Climate and Health in Africa (CAPCHA). This initiative addresses Africa's pressing climate and health challenges by promoting collaboration across diverse disciplines through a transdisciplinary approach. CAPCHA serves as a knowledge-sharing and coordination hub, connecting researchers, policymakers, and practitioners to enhance the integration of evidence into climate and health interventions across the continent.

3.1.3 Climate Models and Health Risk Assessments

African countries are making significant strides in employing climate models and health risk assessments to guide health policies and interventions. These tools provide valuable insights into current and future health vulnerabilities, enabling evidence-based planning and resource allocation.

For example, Uganda and Ghana have incorporated health considerations into their National Adaptation Plans (NAPs). These NAPs rely on projections from climate models to anticipate changes in disease patterns, such as the shifting geographical range of malaria due to rising temperatures. This evidence-based approach ensures that health policies are aligned with emerging climate challenges.

In South Africa, the *South African Risk and Vulnerability Atlas* (SARVA) serves as a central repository for climate and health data. Policymakers use SARVA to identify populations and regions most at risk from climate-related health impacts, enabling targeted interventions and resource prioritization.

Such initiatives underscore the critical role of integrating climate data and risk assessments into health policy frameworks to improve resilience and reduce climate sensitive health risks across Africa.

3.1.4 Locally Tailored and Community-Based Interventions

Integrating **local knowledge** with **scientific evidence** has proven effective in addressing community-specific climate-health challenges across Africa. This approach ensures that interventions are not only scientifically sound but also contextually relevant to local populations.

In **Mozambique**, **cyclone preparedness plans** incorporate both **local community insights** and **meteorological forecasts**. This collaboration enhances the effectiveness of interventions aimed at reducing the health impacts of flooding, particularly the outbreak of **waterborne diseases** such as **cholera**. By combining local knowledge of flood-prone areas and community practices with weather data, Mozambique has enhanced its capacity to predict and mitigate health risks during cyclones.

In **Rwanda**, **community health workers** are trained to monitor and respond to **climate-sensitive diseases**, such as **respiratory illnesses** linked to changes in air quality. These workers play a vital role in bridging the gap between local populations and national health systems, ensuring that vulnerable communities have timely access to health information and care. Their involvement strengthens community resilience and enhances the overall health response to climate-induced health challenges.

These locally tailored, community-based interventions are vital in ensuring that **climate-health policies** are effective at the grassroots level, promoting health resilience and improving adaptation efforts.

3.1.5 Global Partnerships in Climate and Health Research

International collaborations have played a crucial role in strengthening the integration of evidence-based research into climate and health policymaking by providing essential resources, expertise, and advanced tools. These partnerships ensure that countries have the necessary support to address climate-related health challenges effectively.

A key example of such collaboration is the WHO UNFCCC Health and Climate Change Country Profile Project. This initiative serves as the cornerstone of the World Health Organization's efforts to monitor both national and global progress on health and climate change. By working closely with national health authorities and other stakeholders, the project aims to increase awareness of the health impacts of climate change, helping to build a broader understanding among policymakers, healthcare professionals, and the public. It also supports evidence-based decision-making,

enhancing the resilience of health systems to climate-induced stressors such as disease outbreaks, malnutrition, and extreme weather events.

Moreover, the project facilitates health involvement in national and international climate processes, such as the UNFCCC, ensuring that health considerations are embedded within global climate negotiations and frameworks. Through this collaboration, the project also promotes actions that improve health while simultaneously reducing greenhouse gas emissions, fostering synergies between climate change mitigation and public health goals. These efforts are making significant strides in improving the capacity of countries to integrate health and climate considerations into both policy development and global climate action.

3.1.6 Interdisciplinary Approaches in Policy Design

Countries across Africa are increasingly adopting integrated governance structures that promote the sharing of evidence across various sectors. South Africa's *Let's Respond Toolkit* is a prime example of how municipal-level climate data can be effectively integrated with public health planning. This toolkit helps create targeted interventions, such as urban heat management projects and upgrades to health facilities, aimed at addressing climate-related health risks at the local level. Similarly, Nigeria's cross-sectoral task forces bring together ministries of health, agriculture, and the environment to ensure that climate-health evidence is incorporated into policies addressing issues such as food security and vector control.

These examples underscore the progress being made in integrating evidence into climate and health policymaking across the continent. National frameworks, early warning systems, and regional collaborations are contributing to the advancement of this integration. However, challenges remain, such as data gaps, resource constraints, and institutional silos that continue to hinder full-scale implementation. Despite these challenges, the ongoing initiatives and partnerships indicate a strong commitment from African nations to leverage scientific evidence and bolster their resilience to the dual threats of climate change and health vulnerabilities

3.2 Challenges in Translating Evidence into Policy

Despite the significant strides being made in integrating climate and health considerations into policymaking, several challenges persist in translating evidence into effective policies. These obstacles not only hinder the development of robust, evidence-based strategies but also prevent the successful implementation of initiatives that can mitigate the health risks posed by climate change. This section examines the key challenges faced by policymakers and health professionals in leveraging scientific evidence for climate-health decision-making.

Data and Research Gaps

One of the primary obstacles to evidence-based policymaking in the climate and health sector is the lack of comprehensive data. Many African countries face challenges such as inadequate monitoring systems, limited access to region-specific climate models, and a shortage of epidemiological studies tailored to local needs. Often, health data fails to capture the indirect impacts of climate change, such as malnutrition caused by droughts or floods. This absence of robust and relevant data undermines the ability to create policies that effectively address climate-induced health risks.

Institutional Silos

A significant challenge to integrating climate and health policies is the existence of institutional silos. Climate and health agencies typically operate independently, which results in fragmented and often disconnected approaches to policymaking. This lack of coordination hinders the creation of integrated responses to climate-sensitive health issues. The siloed approach impedes the flow of information and limits the collective ability of various sectors to work towards unified solutions, which are essential for addressing the complex, interconnected issues at the climate-health nexus.

Resource Constraints

The financial limitations faced by many African countries further complicate the integration of climate and health policies. Funding for climate-health initiatives remains insufficient, with governments often prioritising immediate healthcare needs over long term investments in climate adaptation. As a result, many crucial programs are left underfunded, which hampers their effectiveness and sustainability. Furthermore, the reliance on external donors for funding can lead to misaligned priorities, as donors may focus on short-term objectives that do not align with the long-term needs of the country.

Awareness and Training

Another key challenge is the limited awareness among policymakers and health professionals regarding the links between climate change and health. This lack of knowledge reduces the uptake of scientific evidence in the decision-making process. Moreover, limited access to training opportunities exacerbates the issue, leaving policymakers and professionals without the necessary skills to apply climate-health evidence effectively in their work. This gap in awareness and training further perpetuates the disconnect between evidence and policy.

Inequitable Impact of Climate Change

Vulnerable populations, such as those living in informal settlements or rural areas, are disproportionately affected by the health impacts of climate change. However, policies often fail to prioritise these groups, leaving them more exposed to the adverse effects of climate-related health risks. This inequity highlights the need for policies that integrate a focus on equity and inclusivity, ensuring that the most vulnerable communities are not left behind in the face of climate change. The lack of equity focused evidence integration further undermines the effectiveness and fairness of climate-health policies.

3.3 Opportunities for Strengthening Evidence Integration

While significant progress has been made in integrating climate and health considerations into policy frameworks across Africa, there remains considerable room for improvement. By capitalising on various opportunities, African countries can strengthen the integration of evidence into climate-health policymaking, ensuring more effective responses to the growing threats posed by climate change. The following strategies offer practical solutions to the challenges faced in translating evidence into policy, fostering an environment where scientific knowledge can be leveraged for better health outcomes in the face of climate change.

One of the key opportunities lies in **strengthening local research capacity**. The development of context-specific evidence is essential to address the unique challenges faced by African countries. Programmes like the *Pan-African Programme for Public Health Adaptation to Climate Change* and the Africa Research and Impact Network's Consultative Platform on Climate and Health in Africa (CAPCHA) are pivotal in enhancing the research capacity of African stakeholders, including researchers, policymakers, and donors. These initiatives help build the necessary expertise to generate data that is not only regionally relevant but also tailored to specific climate health challenges. A greater emphasis on local research will ensure that the evidence guiding policy decisions is grounded in the realities of the populations most affected.

Enhancing cross-sectoral collaboration is another crucial avenue for progress. Governments need to create interdisciplinary platforms that bridge the gaps between climate, health, agriculture, and other sectors. The integration of climate and health data in several African countries has demonstrated the effectiveness of such collaboration. By breaking down institutional silos, these platforms can foster more coordinated responses to climate-sensitive health issues, ensuring that policies address the full spectrum of interconnected factors influencing health outcomes.

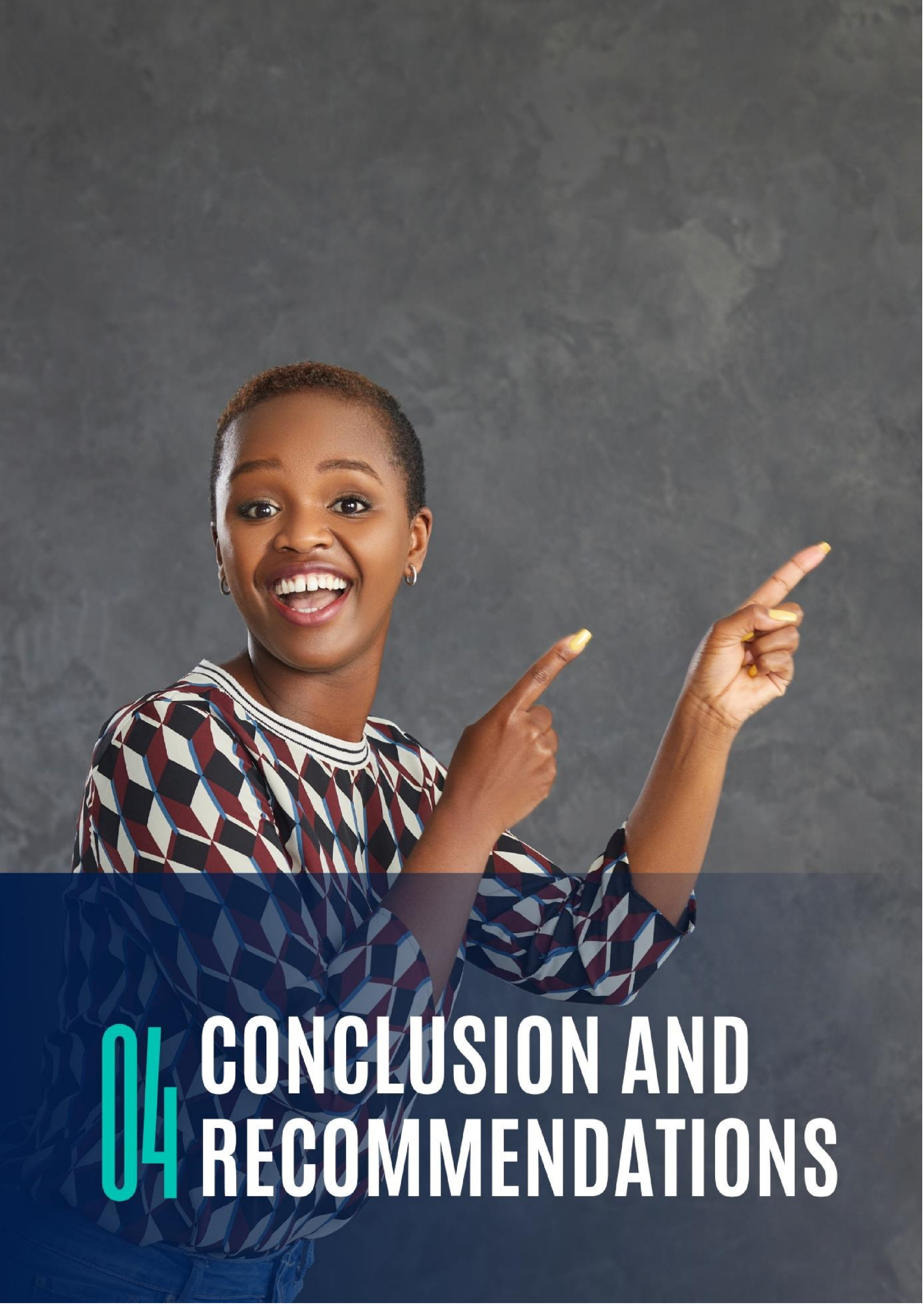
Leveraging **technology** presents an exciting opportunity to strengthen evidence integration. Tools such as Geographic Information Systems (GIS), remote sensing, and artificial intelligence have transformative potential in improving disease surveillance and enabling real-time responses to emerging health threats. By incorporating these technologies into climate-health policies, governments can enhance their ability to predict and manage climate-related health risks, such as vector-borne diseases, heat-related illnesses, and waterborne diseases.

To address the **financial constraints** that often impede the implementation of evidence-based policies, there is a need to **increase funding and policy alignment**. Governments should align national budgets with climate-health priorities and actively seek international funding opportunities. For example, the Green Climate Fund can be a vital source of financial support for initiatives that integrate climate change adaptation and health improvement. Moreover, multi-stakeholder engagement is critical to ensure that funding is directed towards evidence-based interventions that deliver tangible outcomes.

Finally, **promoting community involvement** is essential for ensuring the relevance and acceptance of climate-health policies. Local knowledge can complement scientific frameworks and provide valuable insights into the needs and priorities of affected

communities. Community-based adaptation projects, such as village-level heat-health action plans, can be an effective way to address local vulnerabilities while complementing broader national strategies. These projects not only empower communities but also enhance their resilience to climate-related health risks.

While progress has been made, the integration of evidence into climate and health policymaking across Africa remains uneven. However, through strengthening local research capacity, fostering cross-sectoral collaboration, leveraging advanced technologies, increasing funding, and promoting community involvement, African countries can build more resilient health systems. As the impacts of climate change continue to intensify, the need for robust, evidence-informed policies becomes even more critical to protect vulnerable populations and achieve sustainable development goals. These strategies offer a pathway towards more integrated, effective, and equitable climate-health policies.



04 CONCLUSION AND RECOMMENDATIONS

Chapter 4: Conclusion and Recommendations

In addressing the critical need for integrating climate and health (C&H) considerations into policymaking, it is imperative that governments, policymakers, and development partners adopt a multi-faceted approach. The following recommendations outline key strategies that will strengthen the evidence integration process, enhance the policy landscape, and secure the necessary funding and coordination for effective climate-health actions in Africa.

4.1 Integrate Evidence into Climate and Health Policymaking in Africa

A foundational step towards improving evidence integration is **expanding data infrastructure**. Governments must invest in robust climate-health surveillance systems to ensure the collection of reliable, real-time data. Expanding tools like the Healthy Environment Assessment Tool (HEAT) across more regions will significantly enhance evidence collection, especially in underserved areas. Additionally, **fostering regional collaboration** through platforms such as Clim-HEALTH Africa and ARIN's Consultative Platform on Climate and Health in Africa (CAPCHA) should be scaled up. These platforms promote knowledge-sharing and cross-border policy alignment, which are vital in addressing transboundary health risks exacerbated by climate change. Furthermore, **public-private partnerships (PPPs)** can offer funding and technological solutions for enhancing data systems and health infrastructure, addressing the resource constraints that many governments face.

It is also essential to **build local capacity**. Policymakers and healthcare professionals need the skills to interpret and apply climate-health data effectively. Prioritising capacity-building initiatives, such as training health workers in climate-sensitive disease surveillance, will help to integrate evidence into policymaking. In parallel, the **enhancement of monitoring and evaluation (M&E)** frameworks will ensure accountability and provide a mechanism for assessing the impact of policies. Standardised frameworks will help identify what works, refine strategies, and maintain momentum towards long-term objectives.

4.2 Strengthen the Climate and Health Policy Landscape

To strengthen the policy landscape, it is important to **assess country-specific contexts** and develop integrated climate-health policies that are contextually relevant. Each nation faces unique climate and health challenges, and these must be reflected in policy frameworks. Strengthening the role of civil society organisations in understanding climate-health linkages will also be crucial, as these groups can mediate between local communities and national health adaptation plans (HNAPs). In addition, **reviewing existing research** and commissioning new transdisciplinary studies will help fill gaps in evidence and support informed policy decisions. By reinforcing national-level multi-sectoral working groups, expanding their scope to include sectors that determine health outcomes, and integrating transdisciplinary expertise, governments can ensure that climate and health policies are comprehensive and holistic. Finally, **aligning local and national health strategies with global and regional frameworks** like the ATACH and the AU Declaration on Environmental Health will provide a broader context and ensure that policies are aligned with international commitments.

4.3 Enhance Coordinated, Adequate, and Sustainable Funding for Climate and Health Research and Action

Funding is essential for translating evidence into action, and **significantly increasing funding for climate and health research** is a priority. This will allow researchers to define their own priorities and establish locally driven frameworks. By ensuring that funds are directed towards pressing climate-health issues, the research landscape will become more equitable and impactful. Moreover, **promoting effective coordination among funders** will optimise resource allocation, ensuring that resources are used efficiently and that long-term, impactful outcomes are achieved.

Equity and ethics in the disbursement and management of climate-health funds must be central to this approach. There should be **affirmative action** to ensure that African researchers receive more dedicated resources to build capacity, strengthen South South collaborations, and drive transdisciplinary research. Furthermore, **innovative funding instruments**, such as Public-Private Partnerships, should be explored, as these can facilitate greater access to funding for action-oriented organisations that require government channels to implement their initiatives.

4.4 Strengthen Climate and Health Transdisciplinary Research and Impact

The development of **transdisciplinary research teams** is essential for generating evidence that can inform policy. These teams, comprising experts from health, environment, policy, and climate science, should be prioritised for funding, with a focus on long-term projects that build local research capacity. Research should also focus on **assessing socio-economic determinants of health** in the context of climate change, identifying vulnerabilities within specific community groups. This will enable the development of integrated solutions that address the root causes of health disparities exacerbated by climate change. Moreover, **participatory and localized data collection tools**, such as citizen science and storytelling, should be promoted to capture the nuances of climate-health interactions at the local level.

It is crucial to **invest in applied research** that explores the intersection between climate change and socio-economic factors, with a focus on the impact of climate change on vulnerable populations. Dedicated canters for **climate and health evidence uptake** should be established, where evidence synthesis, knowledge translation, and co-creation activities can take place. These centers can help strengthen existing data systems, deploying interactive tools that enhance data-driven decision-making at the national and regional levels.

4.5 Strengthen Climate and Health Skills Among Diverse Actors

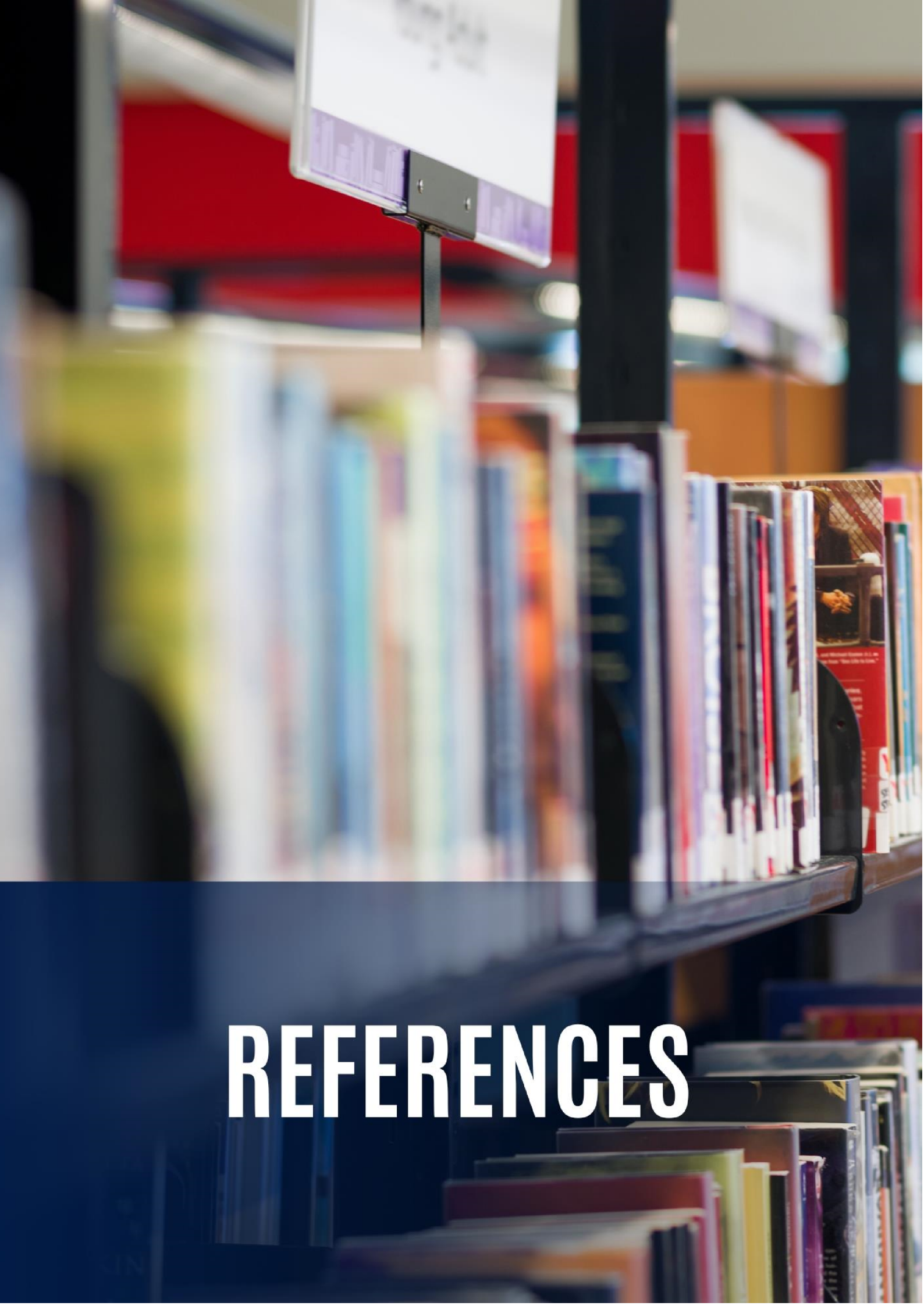
The success of evidence-based climate-health interventions depends on the **skills** of the actors involved. **Interactive platforms** like CAPCHA, which disseminate climate-health research and action across Africa, will play a pivotal role in raising awareness and strengthening the capacity of stakeholders. **Short-term courses** should be utilised to assess skill gaps and develop effective approaches for delivery, while **climate-health capacity building** should be integrated into the curricula of universities and research networks.

Investing in **dedicated scholarships and fellowships** for early-career researchers will also build a pool of skilled local scholars, ensuring long-term sustainability. Furthermore, **specialised training** is needed to help create bankable health projects and access blended finance from international climate funds, such as the Green Climate Fund and the Adaptation Fund

4.6 Strengthen Climate and Health Networks as Opportunities for a Transdisciplinary Community of Practice

Lastly, to foster a **transdisciplinary climate and health community of practice**, coordination among governments, NGOs, and international organisations must be improved. This can be achieved by creating centralised platforms for knowledge sharing and joint action, enabling collaboration across sectors and reducing fragmentation in climate-health initiatives. Strengthening **multi-stakeholder platforms** will further enhance collaboration and ensure that efforts are not duplicated or fragmented, thereby improving communication, coordination, and resource allocation.

Existing networks at the intersection of climate and health should be reinforced, with a focus on improving coordination mechanisms and communication channels. Equitable and inclusive participation within these networks is essential for the **cocreation and ownership** of research, policy, and practice outcomes. **Efficient data sharing mechanisms** must also be established between climate services and health ministries, enabling real-time meteorological data to inform public health systems. Platforms integrating this data will enhance early warning systems and health adaptation plans, crucial for responding to extreme weather events and their health impacts.



REFERENCES

References

African Development Bank Group. (2022). *Focus Africa | The Africa Development Bank at COP 27*. https://www.afdb.org/en/cop27/focus-africa

Agency for Toxic Substances and Disease Registry. (2024, June 14). CDC/ATSDR Social Vulnerability Index (CDC/ATSDR SVI). https://www.atsdr.cdc.gov/placeandhealth/svi/index.html

Akerlof, K. L., Delamater, P. L., Boules, C. R., Upperman, C. R., & Mitchell, C. S. (2015). Vulnerable Populations Perceive Their Health as at Risk from Climate Change. International Journal of Environmental Research and Public Health 2015, Vol. 12, Pages 15419-15433, 12(12), 15419–15433. https://doi.org/10.3390/IJERPH121214994

Allarané, N., Atchadé, A. J., Azagoun, V. V. A., Houngnigbe, A. I., Gouataine Seingue, R., N'Dilbé, T. R., & Hetcheli, F. (2023). Assessment of Climate Risks, Vulnerability of Urban Health Systems, and Individual Adaptation Strategies in the City of N'Djaména (Chad). Climate 2024, Vol. 12, Page 5, 12(1), 5. https://doi.org/10.3390/CLI12010005

Aly Mbaye, A., & Gueye, F. (2024, August 28). *Climate change and food security in the Sahel*. https://www.brookings.edu/articles/climate-change-and-food-security-inthe-sahel/

Ammann, P., Dietler, D., & Winkler, M. S. (2021). Health impact assessment and climate change: A scoping review. The Journal of Climate Change and Health, 3, 100045. https://doi.org/10.1016/J.JOCLIM.2021.100045

Arrieta, M. I., & Mbungu, G. (2023, June 23). *Climate Change Impacts in Africa: The Effects on Key Sectors in the Nine Most Vulnerable Countries - Africa Policy Research Institute (APRI)*. https://afripoli.org/climate-change-impacts-in-africa-the-effects-onkey-sectors-in-the-nine-most-vulnerable-countries

Atwoli L, Muhia J, Merali Z. Mental health and climate change in Africa. *BJPsych International*. 2022;19(4):86-89. https://www.cambridge.org/core/journals/bjpsychinternational/article/mental-health-and-climate-change-inafrica/65A414598BA1D620F4208A9177EED94B

Atela[1], J., Muhindi[2], K., Gitau[2], H., Thiam[2], S., Bolo[1], E., Onyango[1], F., Irungu[1], A., Gogo[1], E., & Atela, J. (2024a). Building effective communities of practice for transdisciplinary research and action in climate change and health in africa. https://www.capcha-arin-africa.org/2024/08/28/technical-report-buildingeffective-communities-of-practice-for-transdisciplinary-research-and-action-inclimate-change-and-health-in-africa/

Atela[1], J., Muhindi[2], K., Gitau[2], H., Thiam[2], S., Bolo[1], E., Onyango[1], F., Irungu[1], A., Gogo[1], E., & Atela, J. (2024b). Opportunities for enhancing transdisciplinary research and action in climate change and health in africa. https://www.capchaarin-africa.org/2024/08/28/policy-brief-opportunities-for-enhancingtransdisciplinary-research-and-action-in-climate-change-and-health-in-africa/

Bălă GP, Râjnoveanu RM, Tudorache E, Moti an R, Oancea C. Air pollution exposure—the (in)visible risk factor for respiratory diseases. Environmental Science and Pollution Research. 2021 Apr 4; 28(16): 19615–28. DOI:https://doi.org/10.1007/s11356-021-13208-x

Berberian, A. G., Gonzalez, D. J. X., & Cushing, L. J. (2022). Racial Disparities in Climate Change-Related Health Effects in the United States. *Current Environmental Health Reports*, *9*(3), 451. https://doi.org/10.1007/S40572-022-00360-W

Better Health Channel. (2021, November). Climate change and health - Better Health Channel. https://www.betterhealth.vic.gov.au/health/healthyliving/climate-changeand-health#who-is-most-at-risk-of-health-effects-due-to-climate-change

Bont J, Jaganathan S, Dahlquist M, Persson Å, Stafoggia M, Ljungman P. Ambient air pollution and cardiovascular diseases: an umbrella review of systematic reviews and meta-analyses. J Intern Med 2022 Jun 8; 291(6): 779–800. DOI:https://doi.org/10.1111/joim.13467

Bryson JM, Patterson K, Berrang-Ford L, Lwasa S, Namanya DB, Twesigomwe S, et al. Seasonality, climate change, and food security during pregnancy among Indigenous and non-indigenous women in rural Uganda: implications for maternal-infant health. PLoS One. 2021 Mar 24; 16(3): e0247198. DOI: https://doi.org/10.1371/journal.pone.0247198

Caminade C, McIntyre KM, Jones AE. Impact of recent and future climate change on vector-borne diseases. Ann N Y Acad Sci. 2019 Jan; 1436(1): 157–73. DOI:https://doi.org/10.1111/nyas.13950

Caminade, C., McIntyre, K. M., & Jones, A. E. (2018). Impact of recent and future climate change on vector-borne diseases. *Annals of the New York Academy of Sciences*, *1436*(1), 157. https://doi.org/10.1111/NYAS.13950

Charnley, G. E. C., Kelman, I., & Murray, K. A. (2021). Drought-related cholera outbreaks in Africa and the implications for climate change: a narrative review. *Pathogens and Global Health*, *116*(1), 3. https://doi.org/10.1080/20477724.2021.1981716

Chersich, M. F., Scorgie, F., Filippi, V., Luchters, S., Huggett, A., Sibanda, E., Parker, C., Lakhoo, D., Maimela, G., Rees, H., Solarin, I., Harden, L., Hetem, R., & Mavhu, W. (2022). Increasing global temperatures threaten gains in maternal and newborn health in Africa: A review of impacts and an adaptation framework. *International Journal of Gynaecology and Obstetrics*, *160*(2), 421. https://doi.org/10.1002/IJGO.14381

Commission of Small Island States on Climate change and International law. (2023). *Inter-American Court of Human Rights Climate Emergency and Human Rights (Request For Advisory Opinion Submitted by the Republic of Chile and the Republic Of Colombia) Written Opinion of the Commission of Small Island States on Climate Change and International Law 18 December 2023*.

Dada, O. A., Almar, R., & Morand, P. (2024). Coastal vulnerability assessment of the West African coast to flooding and erosion. *Scientific Reports 2023 14:1*, *14*(1), 1–15. https://doi.org/10.1038/s41598-023-48612-5

Daigle, K., & Wong, J. (2024). Takeaways from the COP29 climate summit in Azerbaijan | Reuters. https://www.reuters.com/sustainability/cop/takeawayscop29-climate-summit-azerbaijan-2024-11-24/

Das, A., & Swain, P. K. (2024). Navigating the sea level rise: Exploring the interplay of climate change, sea level rise, and coastal communities in India. *Environmental Monitoring and Assessment*, *196*(11), 1010. https://doi.org/10.1007/S10661-02413191-Z/TABLES/1

DeBenedetti, S. (OSP). (n.d.). Strategic Framework 2022-31. Health effects of climate change in Africa: A call for an improved implementation of prevention measures—ScienceDirect. (n.d.). Retrieved October 29, 2024, from https://www.sciencedirect.com/science/article/pii/S2772985023000200

Demissie GD, Yeshaw Y, Aleminew W, Akalu Y. Diarrhea and associated factors among under-five children in sub-Saharan Africa: evidence from demographic and health surveys of 34 sub-Saharan countries. PLoS One. 2021 Sep 20; 16(9): e0257522. DOI:https://doi.org/10.1371/journal.pone.0257522

Ebi KL, Vanos J, Baldwin JW, Bell JE, Hondula DM, Errett NA, et al. Extreme weather and climate change: population health and health system implications. Annu Rev Public Health. 2021 Apr 1; 42(1):293–315. DOI:https://doi.org/10.1146/annurevpublhealth-012420-105026

Epidemiology National Research Council (US) Committee on Environmental Sciences and National Research Council (US) Commission on Life. (1997). Environmental-Epidemiology Studies: Their Design and Conduct. https://www.ncbi.nlm.nih.gov/books/NBK233644/

Eriksen, S., O'brien, K., & Rosentrater, L. (2008). *Climate Change in Eastern and Southern Africa Impacts, Vulnerability and Adaptation*. www.gechs.org/publications/reports/

Ermert, V., Fink, A. H., Morse, A. P., & Paeth, H. (2011). The Impact of Regional Climate Change on Malaria Risk due to Greenhouse Forcing and Land-Use Changes in Tropical Africa. *Environmental Health Perspectives*, *120*(1), 77. https://doi.org/10.1289/EHP.1103681

Ethiopian Public Health Institute (EPHI). (2022). *National Guideline for Cholera Surveillance and Outbreak Response*. 3rd Edition 2022 G.C. Retrieved from https://ephi.gov.et/wp-content/uploads/2022/11/Guideline_for_Cholera_Surveillance_and_Outbreak_Response_Final_V2.pdf

European Environment Agency. (2022). Climate Change Adaptation in Europe.

Eze Anugwom, E. (2021). Reflections on Climate Change and Public Health in Africa in an Era of Global Pandemic. IntechOpen. https://www.intechopen.com/chapters/76312

Fanzo, J., Schneider, K. R., & Wood, S. (2024). Food Insecurity and Malnutrition.

Climate Change and Public Health, 153–179. https://doi.org/10.1093/OSO/9780197683293.003.0008

Fisher S, Bellinger DC, Cropper ML, Kumar P, Binagwaho A, Koudenoukpo JB, et al. Air pollution and development in Africa: impacts on health, the economy, and human capital. Lancet Planet Health. 2021 Oct; 5(10): e681–8. DOI:https://doi.org/10.1016/S2542-5196(21)00201-1

Flatø, M., Muttarak, R., & Pelser, A. (2017). Women, Weather, and Woes: The Triangular Dynamics of Female-Headed Households, Economic Vulnerability, and Climate Variability in South Africa. *World Development*, *90*, 41–62. https://doi.org/10.1016/J.WORLDDEV.2016.08.015

Food and Agriculture Organization of the United Nations. (2017). *The future of food and agriculture and challenges*.

Food and Agriculture Organization of the United Organization. (2018). *Pastoralism in Africa's drylands Reducing risks, addressing vulnerability and enhancing resilience*.

Freeman, L. (2017). Environmental Change, Migration, and Conflict in Africa: A Critical Examination of the Interconnections. *The Journal of Environment & Development*, *26*(4), 351-374, https://journals.sagepub.com/doi/10.1177/1070496517727325

Fuller G, Friedman S, Mudway I. Impacts of air pollution across the life course—evidence highlight note. London; 2023.

Gan, C. C. R., Oktari, R. S., Nguyen, H. X., Yuan, L., Yu, X., KC, A., Hanh, T. T. T., Phung, D. T., Dwirahmadi, F., Liu, T., Musumari, P. M., Kayano, R., & Chu, C. (2021). A scoping review of climate-related disasters in China, Indonesia and Vietnam: Disasters, health impacts, vulnerable populations and adaptation measures. International Journal of Disaster Risk Reduction, 66. https://doi.org/10.1016/J.IJDRR.2021.102608

Gaythorpe KA, Hamlet A, Cibrelus L, Garske T, Ferguson NM. The effect of climate change on yellow fever disease burden in Africa. Elife. 2020 Jul 28; 9. DOI:https://doi.org/10.7554/eLife.55619

Grzywa-Celińska A, Krusiński A, Milanowski J.'Smoging kills'—effects of air pollution on the human respiratory system. Annals of Agricultural and Environmental Medicine. 2020 Mar 17; 27(1): 1–5. DOI: https://doi.org/10.26444/aaem/110477

Guan WJ, Zheng XY, Chung KF, Zhong NS. Impact of air pollution on the burden of chronic respiratory diseases in China: time for urgent action. The Lancet. 2016 Oct; 388(10054): 1939–51. DOI: https://doi.org/10.1016/S0140-6736(16)31597-5

Guillaumont, P., & Simonet, C. (2011). *To What Extent Are African Countries Vulnerable to Climate Change? Lessons from a New Indicator of Physical Vulnerability to Climate Change*.

Increasing global temperatures threaten gains in maternal and newborn health in

Africa: A review of impacts and an adaptation framework—Chersich—2023—International Journal of Gynecology & Obstetrics—Wiley Online Library. (n.d.).

Retrieved October 29, 2024, from https://obgyn.onlinelibrary.wiley.com/doi/full/10.1002/ijgo.14381

International Labour office. (2017). *Indigenous peoples and climate change: from victims to change agents through decent work*. ILO.

International Labour Organization. (2018). The employment impact of climate change adaptation – Input Document for the G20 Climate Sustainability Working Group. www.ilo.org/publns.

International Labour Organization. (2019). *Working on a warmer planet: The impact of heat stress on labour productivity and decent work*.

International Rescue Committee. (2022, October 6). *Why are children so vulnerable to famine and other hunger crises? | International Rescue Committee (IRC)*. https://www.rescue.org/article/why-are-children-so-vulnerable-famine-and-otherhunger-crises

IPCC. (2021). Climate Change 2021: The Physical Science Basis. Cambridge University Press.

Jjemba, E. (2021). *Climate Change Impacts On Health: Kenya Assessment April 2021 2 Climate Change Impacts On Health And Livelihoods: Kenya Assessment*.

Kapwata T, Kunene Z, Wernecke B, Lange S, Howard G, Nijhawan A, et al. Applying a WASH Risk Assessment Tool in a Rural South African Setting to Identify Risks and Opportunities for Climate Resilient Communities. Int J Environ Res Public Health . 2022 Feb 25; 19(5): 2664. DOI:https://doi.org/10.3390/ijerph19052664

Kariuki T, Omumbo J, Ciugu K and Marincola E. The interconnected global emergencies of climate change, food security and health: a call to action by the Science for Africa Foundation [version 1; peer review: 2 approved, 1 approved with reservations]. Open Res Africa 2023, **6**:1 https://doi.org/10.12688/openresafrica.13566.1

Khirekar, J., Badge, A., Bandre, G. R., & Shahu, S. (2023). Disaster Preparedness in Hospitals. Cureus, 15(12). https://doi.org/10.7759/CUREUS.50073

Kunda, J. J., Gosling, S. N., & Foody, G. M. (2024). The effects of extreme heat on human health in tropical Africa. *International Journal of Biometeorology*, *68*(6), 10151033

Lancet Countdown: Heat-related Mortality. 2023. https://lancetcountdown.org/exploreour-data/

Leal Filho, W., May, J., May, M., & Nagy, G. J. (2023). Climate change and malaria: Some recent trends of malaria incidence rates and average annual temperature in selected sub-Saharan African countries from 2000 to 2018. Malaria Journal, 22(1), Article 1. https://doi.org/10.1186/s12936-023-04682-4

Meinshausen M, Smith SJ, Calvin K, Daniel JS, Kainuma MLT, Lamarque JF, et al. The RCP greenhouse gas concentrations and their extensions from 1765 to 2300.

Clim Change. 2011 Nov 9; 109(1–2): 213–41. DOI:https://doi.org/10.1007/s10584011-0156-z

Moturi, A. K., Suiyanka, L., Mumo, E., Snow, R. W., Okiro, E. A., & Macharia, P. M. (2022). Geographic accessibility to public and private health facilities in Kenya in 2021: An updated geocoded inventory and spatial analysis. Frontiers in Public Health, 10. https://doi.org/10.3389/FPUBH.2022.1002975/FULL

Mukerji, R. (2019, October). Climate Change and Hunger - Issues in Focus. Global Hunger Index. https://www.globalhungerindex.org/issues-in-focus/2019.html

Ndejjo, R., Musinguzi, G., Musoke, D., & Wanyenze, R. K. (2023). Unlocking the power of communities to achieve Universal Health Coverage in Africa. *South Eastern European Journal of Public Health*. https://www.seejph.com/index.php/seejph/article/view/220

Ngcamu, B. S. (2023). Climate change effects on vulnerable populations in the Global South: a systematic review. Natural Hazards, 118(2), 977–991. https://doi.org/10.1007/S11069-023-06070-2/FIGURES/2

Niang, I., Ruppel, O. C., Abdrabo, M. A., Dube, P., Leary, N., Schulte-Uebbing, L., Field, C., Dokken, D., Mach, K., Bilir, T., Chatterjee, M., Ebi, K., Estrada, Y., Genova, R., Girma, B., Kissel, E., & Levy, A. (2014). Africa. In *Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* (pp. 1199–1265). Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

Nilsson, M., Sie, A., Muindi, K., Bunker, A., Ingole, V., & Ebi, K. L. (2021). Weather, climate, and climate change research to protect human health in sub-Saharan Africa and South Asia. Global Health Action, 14(sup1), 1. https://doi.org/10.1080/16549716.2021.1984014

Nunfam VF (2021) Mixed methods study into social impacts of work-related heat stress on Ghanaian mining workers: A pragmatic research approach. Heliyon 7(5):06918. https://doi.org/10.1016/j.heliyon.2021.e06918.

Obame-Nkoghe, J., Agossou, A. E., Mboowa, G., Kamgang, B., Caminade, C., Duke, D. C., Githeko, A. K., Ogega, O. M., Engone Elloué, N., Sarr, F. B., Nkoghe, D., Kengne, P., Ndam, N. T., Paupy, C., Bockarie, M., & Voua Otomo, P. (2024). Climateinfluenced vector-borne diseases in Africa: a call to empower the next generation of African researchers for sustainable solutions. *Infectious Diseases of Poverty*, *13*(1), 1–10. https://doi.org/10.1186/S40249-024-01193-5/FIGURES/2

Oguntuase, O.J., Adu, O.B. (2021). Bioeconomy as Climate Action: How Ready Are African Countries?. In: Oguge, N., Ayal, D., Adeleke, L., da Silva, I. (eds) African Handbook of Climate Change Adaptation. Springer, Cham. https://doi.org/10.1007/978-3-030-45106-6_82

Oladimeji, K. E., Zungu, L., Chocko, R., Hyera, F. L., Nyatela, A., Gumede, S., Dwarka, D., & Lalla-Edward, S. T. (2023). A Rapid Review of Impact Assessment of Climate Change on Health and Mental Well-Being in Africa. *New Voices in Psychology*, *13*, 23 pages. https://doi.org/10.25159/2958-3918/15604

Oleribe, O. O., Momoh, J., Uzochukwu, B. S. C., Mbofana, F., Adebiyi, A., Barbera, T., Williams, R., & Taylor-Robinson, S. D. (2019). Identifying Key Challenges Facing Healthcare Systems In Africa And Potential Solutions. International Journal of General Medicine, 12, 395. https://doi.org/10.2147/IJGM.S223882

Oleribe, O. O., Momoh, J., Uzochukwu, B. S. C., Mbofana, F., Adebiyi, A., Barbera, T., Williams, R., & Taylor-Robinson, S. D. (2019). Identifying Key Challenges Facing Healthcare Systems In Africa And Potential Solutions. *International Journal of General Medicine*, *12*, 395. https://doi.org/10.2147/IJGM.S223882

Ongoma, V., Epule, T., Brouziyne, Y. *et al.* COVID-19 response in Africa: impacts and lessons for environmental management and climate change adaptation. *Environ Dev Sustain* **26**, 5537–5559 (2024), https://link.springer.com/article/10.1007/s10668-02302956-0

Opoku, Samuel Kwasi, Walter Leal Filho, Fudjumdjum Hubert, and Oluwabunmi Adejumo. 2021. "Climate Change and Health Preparedness in Africa: Analysing Trends in Six African Countries" *International Journal of Environmental Research and Public Health* 18, no. 9: 4672. https://doi.org/10.3390/ijerph18094672

Parry, L., Radel, C., Adamo, S. B., Clark, N., Counterman, M., Flores-Yeffal, N., Pons, D., Romero-Lankao, P., & Vargo, J. (2019). The (in)visible health risks of climate change. Social Science & Medicine, 241, 112448. https://doi.org/10.1016/J.SOCSCIMED.2019.112448

Pate MA, Seck AMC, Lo S, Horton R. A new Lancet Commission on the future of health and economic resiliency in Africa. The Lancet. 2022 Aug; 400(10353): 641–3. DOI:https://doi.org/10.1016/S0140-6736(22)01435-0

Physiopedia. (2024). *Introduction to Affirming Care for Gender and Sexual Minorities - Physiopedia*. https://www.physiopedia.com/Introduction_to_Affirming_Care_for_Gender_and_Sexual_Minorities

Pradyumna, A., & Sankam, J. (2022). Tools and methods for assessing health vulnerability and adaptation to climate change: A scoping review. The Journal of Climate Change and Health, 8, 100153. https://doi.org/10.1016/J.JOCLIM.2022.100153

Rakotoarison, N., Raholijao, N., Razafindramavo, L. M., Rakotomavo, Z. A. P. H., Rakotoarisoa, A., Guillemot, J. S., Randriamialisoa, Z. J., Mafilaza, V., Ramiandrisoa, V. A. M. P., Rajaonarivony, R., Andrianjafinirina, S., Tata, V., Vololoniaina, M. C.,

Rakotomanana, F., & Raminosoa, V. M. (2018). Assessment of Risk, Vulnerability and Adaptation to Climate Change by the Health Sector in Madagascar. International Journal of Environmental Research and Public Health 2018, Vol. 15, Page 2643, 15(12), 2643. https://doi.org/10.3390/IJERPH15122643

Ramsay, E. E., Fleming, G. M., Faber, P. A., Barker, S. F., Sweeney, R., Taruc, R. R., Chown, S. L., & Duffy, G. A. (2021). Chronic heat stress in tropical urban informal settlements. *IScience*, *24*(11), 103248. https://doi.org/10.1016/J.ISCI.2021.103248
Ravaghi, H., Guisset, A. L., Elfeky, S., Nasir, N., Khani, S., Ahmadnezhad, E., & Abdi, Z. (2023). A scoping review of community health needs and assets assessment: concepts, rationale, tools and uses. BMC Health Services Research 2023 23:1, 23(1), 1–20. https://doi.org/10.1186/S12913-022-08983-3

Roos, N., Kovats, S., Hajat, S., Filippi, | Veronique, & Stephansson, O. (2021). *Maternal and newborn health risks of climate change: A call for awareness and global action*. *8*, 9. https://doi.org/10.1111/aogs.14124

Ross, M. H., & Setchell, J. (2019). People who identify as LGBTIQ+ can experience assumptions, discomfort, some discrimination, and a lack of knowledge while attending physiotherapy: a survey. *Journal of Physiotherapy*, *65*(2), 99–105. https://doi.org/10.1016/j.jphys.2019.02.002

Samba Vera Larfi, Mezgebu Esubalew, Habtes Habtamu, Oti Naomi Ohene, Mangongolo Bilonda Michou, Bafumba Ritah, Burns Kathryn, Olarte Sierra Maria Fernanda, Challinor Julia, de Villiers Martjie (2023) Climate change and oncology nursing: the African perspective *ecancer* 17 1621.
https://ecancer.org/en/journal/article/1621-climate-change-and-oncology-nursing-theafrican-perspective

Shindell D, Faluvegi G, Parsons L, Nagamoto E, Chang J. Premature deaths in Africa due to particulate matter under high and low warming scenarios. Geohealth . 022 May 7; 6(5). DOI:https://doi.org/10.1029/2022GH000601

Simone Russo *et al* (2016). When will unusual heat waves become normal in a warming Africa?. *Environ. Res. Lett.* 11 054016,
https://iopscience.iop.org/article/10.1088/1748-9326/11/5/054016

Sonderlund, A. L., Charifson, M., Schoenthaler, A., Carson, T., & Williams, N. J. (2022). Racialized economic segregation and health outcomes: A systematic review of studies that use the Index of Concentration at the Extremes for race, income, and their interaction. *PLOS ONE*, *17*(1), e0262962.
https://doi.org/10.1371/JOURNAL.PONE.0262962

Trisos CH, Adelekan IO, Totin E, Ayanlade A, Efitre J, Gemeda A, et al. Africa. In: Climate Change 2022: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change. In: Pörtner HO, Roberts DC, Tignor M, Poloczanska ES, Mintenbeck K, Alegría A, et al., (eds.), Climate Change 2022—Impacts, Adaptation and Vulnerability Cambridge University Press; 2023. p. 1285–456. DOI:https://doi.org/10.1017/9781009325844.011

Turner, M. D., Carney, T., Lawler, L., Reynolds, J., Kelly, L., Teague, M. S., & Brottem, L. (2021). Environmental rehabilitation and the vulnerability of the poor: The case of the Great Green Wall. Land Use Policy, 111, 105750. https://doi.org/10.1016/j.landusepol.2021.105750
U.S. Department of Health and Human Services. (2022). Climate Change and Health.

UN Refugee Agency. (2023). *Climate change and displacement | UNHCR*. https://www.unhcr.org/what-we-do/build-better-futures/climate-change-anddisplacement
United Nations Educational Scientific and Cultural Organization (UNESCO). (2024). Education and climate change Learning to act for people and planet.

United Nations Environment Programme C& CAC& AU. Integrated assessment of air pollution and climate change for sustainable development in Africa—summary for decision makers. https://wedocs.unep.org/20.500.11822/41223 . 2022.

United Nations. (2009). *Women...In The Shadow of Climate Change | United Nations*. https://www.un.org/en/chronicle/article/womenin-shadow-climate-change

United States Environmental Protection Agency. (2024, August 20). *Heat Island Impacts*. https://www.epa.gov/heatislands/heat-island-impacts

United States Environmental Protection Agency. (2024, July 22). Climate Change and the Health of Socially Vulnerable People | US EPA. https://www.epa.gov/climateimpacts/climate-change-and-health-socially-vulnerablepeople

United States Environmental Protection Agency. Health effects of ozone pollution. https://www.epa. gov/ground-level-ozone-pollution/health-effects-ozone-pollution 2023.

Weber, T. (2018). *Analyzing Regional Climate Change in Africa in a 1.5, 2, and 3°C Global Warming World,* Earth's Future, https://agupubs.onlinelibrary.wiley.com/doi/10.1002/2017EF000714

WHO. (2021). Climate Change and Health in Africa.

World Bank. (2020). Climate-Smart Agriculture in Africa.

World Health Organization. (2024a, May 28). *Heat and health*. https://www.who.int/news-room/fact-sheets/detail/climate-change-heat-and-health

World Health Organization. (2024b, June 30). *Drought and food insecurity in the greater Horn of Africa*. https://www.who.int/emergencies/situations/drought-foodinsecurity-greater-horn-of-africa

World Meteorological Organization. (2020). *State of the Climate in Africa 2019*.

Wright, C.Y., Kapwata, T., Naidoo, N., Asante, K.P., Arku, R.E., Cissé, G., Simane, B., Atuyambe, L. and Berhane, K. (2024) 'Climate Change and Human Health in Africa in Relation to Opportunities to Strengthen Mitigating Potential and Adaptive Capacity: Strategies to Inform an African "Brains Trust"', *Annals of Global Health*, 90(1), p. 7. Available at: https://doi.org/10.5334/aogh.4260.

Yadav, N., Rajendra, K., Awasthi, A., & Singh, C. (2023). Systematic exploration of heat wave impact on mortality and urban heat island: A review from 2000 to 2022. *Urban Climate*, *51*, 101622. https://doi.org/10.1016/J.UCLIM.2023.101622

Yang, G. J. (n.d.). Understanding the Design of Rural Agricultural Development Projects: The Case of Climate-Smart Villages in Kenya.

AFRICA RESEARCH & IMPACT NETWORK

Contact Us

www.arin-africa.org

+254746130873

info@arin-africa.org

arin_africa

Africa Research and Impact Network. (ARIN)
The Consultative Platform on Climate and Health in Africa

The Africa Research and Impact Network

ACK Gardens House, 1st Floor, 1St Ngong Ave, Upperhill,
Nairobi.