

**Climate Change and Health Systems
in East and Southern Africa:
A Rapid Review**

Godfrey Musuka, Tafadzwa Dzinamarira

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Contents

Executive Summary.....	2
1. Introduction.....	4
2. Methods	6
2.1 Study design and inclusion	6
2.2 Literature sources, search strategy and data extraction	6
2.3 Search results and characteristics of included studies	6
2.4 Limitations	8
3. Results	8
3.1 Climate change impact on populations and health systems	8
3.2 Health systems adaptations and mitigation to climate change	11
3.3 Health system advocacy and policy issues raised by ESA countries	12
4. Discussion	13
5. Conclusion	15
6. References.....	16

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Executive summary

Climate change is perceived to be one of the biggest global threats to health in the 21st century. African countries are more vulnerable to the impacts of global climate change, with their populations more susceptible to illness and injury from the natural emergencies and extreme weather events and to increased infectious diseases as a result of vector spread. Extreme weather events may compromise access to clean water and sanitation, food production, transport and energy infrastructures and other factors that affect health.

This desk review was commissioned by the Regional Network for Equity in Health in Southern Africa (EQUINET), through Training and Research Support Centre, with support from the Open Society Policy Centre (OSPC), to explore: how climate change is affecting health systems in east and southern Africa (ESA); how the region's health systems are adapting to climate change; and to identify the health system advocacy and policy issues raised in climate change negotiations by ESA countries, including in relation to issues of equity.

The Preferred Reporting Items for Systematic Reviews and Meta-Analysis Protocols (PRISMA-P) method was used to guide the rapid review, applying a problem-interest-context (PICO) framework to determine the criteria for inclusion of papers. For this, the problem was defined as the impact of climate change, the interest as health systems and the context as ESA. Articles published in English from 2009 to 2023 were searched on Google Scholar, ScienceDirect, MEDLINE, Africa Journals Online (AJOL), SCOPUS and PubMed databases, as well as from the websites of the United Nations organisations, governments in ESA, civil society organisations and media outlets in ESA. A data extraction form developed by the authors captured information on the name of the first author, publication year, type of article, the country or region being discussed, the study design, if applicable and key findings.

Climate change was found to be associated with various impacts on ESA health systems, including both increased demand for health care services and reduced access to them, due to negative impacts on health care service provision and on people's ability to afford/pay for them.

An **increased demand for health services** was found to arise from malnutrition caused by drought-related food shortages, an increase in food and water-borne infectious diseases because of drought and floods, especially in low-income settings, as well as heat exhaustion and heat strokes due to heat waves, particularly among people living in informal settlements. Increased demand for health services also arose from increased incidence of climate-related diseases such as malaria, Rift Valley fever and dengue fever. In addition, extreme heat was found to be associated with an increase in stress and mental illness and in cardiovascular and renal diseases, further boosting the demand for health services.

At the same time, **in terms of health equity, access to and provision of health services was found to be reduced** by extreme weather events, with flooding disrupting transport and communication networks, affecting laboratory services, staff and patient travel, supplies of medication and ambulance availability, especially in rural areas. Health service provision was further affected by electric power outages due to extreme weather events such as flooding and storms. For households, barriers to access arose from reduced household income, especially among households relying on subsistence farming, as well as from damage to health and transport infrastructures.

As described in the paper, these climate change impacts did not affect all population groups equally. The review revealed that the effects of malnutrition are greater on children and older people. Children under the age of five and those with non-communicable diseases (NCDs) were found to be more vulnerable to higher temperatures than the rest of the population due to their decreased ability to thermoregulate.

Women also suffer the effects of climate change more than men because of economic marginalisation, political exclusion and their labour responsibilities, such as food and water collection. Poor households, whose income and nutrition depend on agriculture, are reported to be more vulnerable to climate-related malnutrition and to cost barriers to health care uptake.

Health systems in ESA were found to have applied various mitigation and adaptation responses to climate change. Adaptation measures aim to reduce health systems' vulnerability to the impact of climate change, while mitigation measures seek to reduce greenhouse gas emissions and slow the progression of climate change. Measures taken include the establishment of early warning systems on extreme weather events and seasonal forecasting; public health education to create awareness on preventive options and the strengthening of infectious disease controls. Health systems are improving the resilience of technology and public health infrastructure to climate impacts by modifying architectural designs to suit weather changes, promoting new building infrastructure that reduces energy use and enables natural cooling, and strengthening roofs to better resist heavy storms and strong winds. Health systems are also investing in capacity building communities to improve environmental health in rural areas.

ESA countries have raised a range of advocacy and policy issues related to climate change and health systems in negotiations at the African Ministerial Conference on Environment and the UN Climate Change Conference of Parties (COP). These largely raise issues of financing for adaptation measures and for loss and damage to health and related facilities. Given that the largely low- and middle-income countries (LMICs) in the ESA have made limited contributions to global warming, LMICs consider that these financial resources should be availed by high-income countries to address the direct and indirect impacts of climate change on poverty and its economic consequences and on poverty.

There are still many knowledge gaps around the threats climate change poses to human health and health systems. These gaps call for funded **research on impacts and on measures to protect health systems**. These include the full extent of its health impacts, their distribution across countries and populations and of the effectiveness and cost-effectiveness of adaptation and mitigation measures.

Climate change is impacting on ESA health systems and the review identified several adaptation and mitigation measures that are underway. However, ESA countries face financial constraints in scaling up these measures. With low-income households and vulnerable groups directly and indirectly affected and facing cost barriers to service access despite rising demand, the resource gap to implement responses appears to have greater impact on already disadvantaged groups. Climate change thus seems to be exacerbating existing inequities in health and health systems are key in confronting this inequity.

1. Introduction

Climate change is perceived to be one of the biggest global threats to health in the 21st century. According to the International Panel on Climate Change (IPCC), the world's climate has changed significantly over the past few decades, particularly in Africa. Global warming surpassed pre-industrial levels by about 1°C in 2017 and rainfall patterns have altered as a result (Allen, et al., 2018). The activities of humans have an impact on climate change: carbon dioxide, a greenhouse gas, is released during the burning of fossil fuels and contributes to global warming; in addition, methane, also a greenhouse gas, is produced by chemical processes, nuclear fusion, fission, mining and quarrying, and also contributes to climate change (Kakaki, 2013).

Greenhouse gases cause global warming by creating a layer in the upper atmosphere that reflects energy back to the Earth, raising surface temperatures (Manabe, 2019). Furthermore, the ozone layer, which protects the Earth by reflecting a significant percentage of the sun's ultraviolet rays, is destroyed by chlorofluorocarbons – manmade chemicals commonly emitted by air conditioners and refrigerators. As the ozone layer thins, more ultraviolet rays penetrate the atmosphere, increasing the temperature of the Earth's surface (Fleming, et al., 2020). As a result of the increased temperatures, droughts and heat waves may become more frequent, severe and prolonged (Clarke, et al., 2022). In addition, due to changes in air and water circulation brought on by climate change, wet areas are getting wetter and dry areas are getting drier.

East and southern African (ESA) countries are highly vulnerable to the impacts of climate change. Their populations are susceptible to illness and injury due to extreme weather events, and to increased infectious diseases due vector spread as a result of climate change. Natural disasters and extreme weather events related to climate change are likely to compromise access to clean water and sanitation systems. The impacts of changing weather patterns on farming may also lead to malnutrition. Storms and flooding will further impact on the continent's ability to grow sufficient food and provide suitable housing, further affecting population health. There may also be indirect effects on health due to the economic, social and natural resource consequences of climate change as well as its direct effects on infrastructures and services.

Agriculture, the primary source of income for many in Africa, is also affected by climate change. Clearing forests for agriculture, burning agricultural residues, flooding rice plantations, raising vast herds of cattle and other mammals and using nitrogen-rich fertilisers, all contribute to the emission of greenhouse gases. In 2016, land use change and forestry contributed 36% of Africa's greenhouse gas emissions, followed by the energy sector (35%), agriculture (21%), industrial activities (4%) and waste (4%) (AFDB, 2020). Drought has affected Africa more than any other continent: between 2000 and 2019, African countries experienced 134 drought events, 70 of which were in East Africa (CRED/UNDRR, 2020).

Famine and drought were, for example, reported in 2022 to have affected eight million people in Ethiopia and to have led to 2 500 people dying in Uganda (Dunne, 2022). Although Asia experienced the highest number of extreme weather events between 2000 and 2019, six of the top ten countries affected by severe weather were in Africa, in Somalia, Zimbabwe, Lesotho, Eswatini, Niger and Mauritania (CRED/UNDRR, 2020). Since the beginning of 2022, cyclones, floods, heatwaves, wildfires, droughts and famine have affected about 19 million people and killed at least 4 000 in Africa (Dunne, 2022). Around 75% of flooding incidents that occurred in Africa between 2000 and 2019, were in Kenya, South Africa and Mozambique (CRED/UNDRR, 2020). In April 2022, landslides and floods in the South African provinces of KwaZulu Natal and the Eastern Cape resulted in 459 deaths and the displacement of an additional 40 000 people (Dunne, 2022).

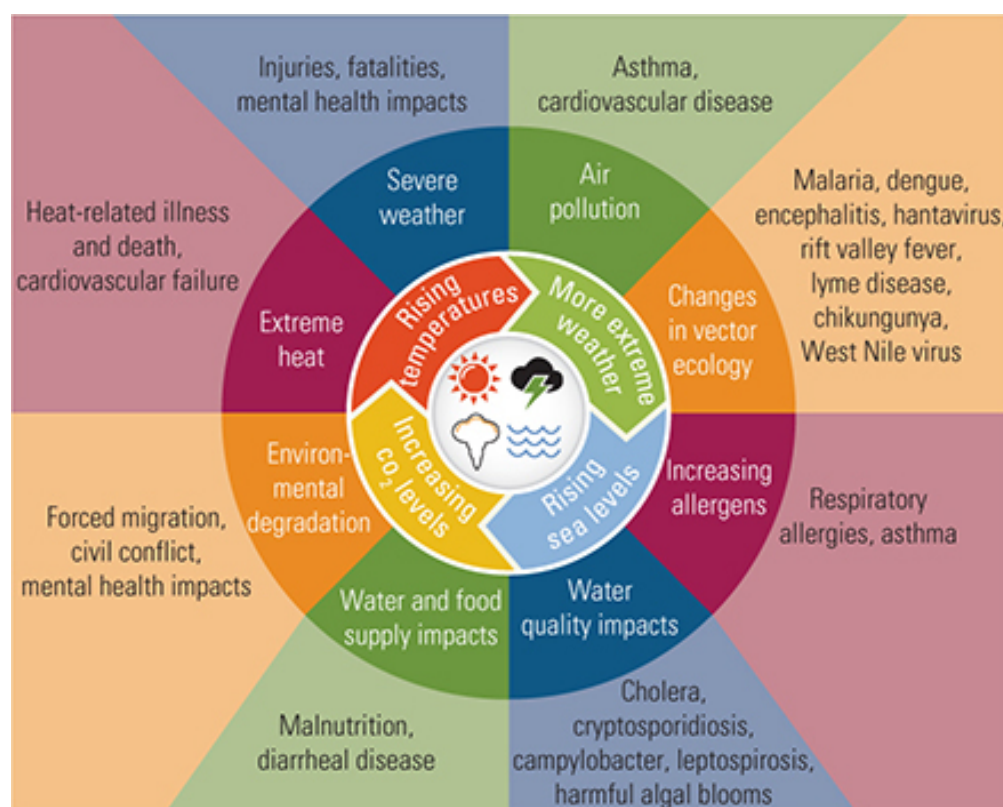
Poor settlement planning and inadequate drainage systems lead to flooding in urban areas (Ramaramanana & Teller, 2021), while in rural areas, this is attributed to deforestation (Acreman, et al., 2021). At least 890 people were killed by six severe storms that struck countries in southern Africa, including Madagascar and Mozambique. In August and October 2022 (Dunne,

2022). Africa's western coast and its north-western, southern and equatorial regions all had hotspots for heatwaves in 2019 (Li, et al., 2022).

Figure 1 shows the ways in which these climate-related trends in the ESA region are likely to impact on health, thus raising the demand on health systems.

Communities are more susceptible to a variety of illnesses as a result of natural catastrophes and extreme weather events brought on by climate change, including raising barriers to access to clean water, sanitation and health care facilities (Curtis, et al., 2017) These factors increase levels of infectious, respiratory and cardiovascular diseases, heat-related morbidity and mortality, malnutrition due to food insecurity and mental health disorders (Rocque, et al., 2021).

Figure 1: Climate change impacts on human health



Source: Ebi KL, Hess JJ, Watkiss P, 2017

Climate risks are likely to disproportionately affect the poorest people and countries, which are more exposed and more vulnerable to the impacts of climate change, because they depend directly on activities that are most affected by it, such as agriculture, forestry and fishing. Consequently, climate change is suggested to worsen existing economic inequalities, poverty and pre-existing disparities in access to clean water and affordable food, further increasing health inequalities (Guivarch, et al., 2021). Climate change could impact on each of the six pillars of ESA countries' health systems, viz: the health workforce, health care financing, service delivery, information and research, medical products and technologies and leadership or governance (WHO, 2020).

To explore this issue further, the Regional Network for Equity in Health in Southern Africa (EQUINET), through Training and Research Support Centre (TARSC) and with support from the Open Society Policy Centre commissioned this rapid desk review to explore how climate change is affecting health systems in ESA, how the region's health systems are adapting to climate change, and the health system advocacy and policy issues that ESA countries have raised in climate change negotiations, including in relation to equity issues.

2. Methods

2.1 Study design and inclusion

The Preferred Reporting Items for Systematic Reviews and Meta-Analysis Protocols (PRISMA-P) statement was a broad guide for this rapid review. To determine the eligibility criteria for the review question, the problem-interest-context (PICO) framework was used; the problem was defined as the impact of climate change, interest as health systems and context as ESA. Articles were eligible for inclusion if they were published in English and reported on the impact of climate change in ESA, how health systems are adapting to climate change in ESA, health systems advocacy and policy issues being raised by ESA in climate change negotiations, as well as how equity issues are being addressed. Articles, systematic reviews, meta-synthesis, editorials, letters to the editor and grey literature were also included.

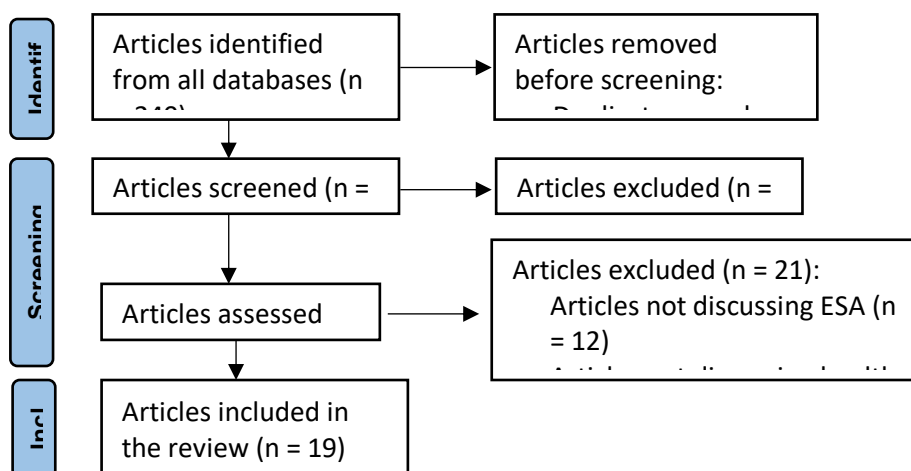
2.2 Literature sources, search strategy and data extraction

Articles published in English from 2009 to 2023 on Google Scholar, ScienceDirect, MEDLINE, Africa Journals Online (AJOL), SCOPUS and PubMed databases, as well as from the websites of the United Nations organisations, civil society organisations and media outlets in ESA were searched for. The keywords used for the literature search were 'climate change', 'health systems', 'financing', 'healthcare workforce', 'service delivery', 'leadership', 'governance', 'information', 'research', 'medical products', 'medical technologies', 'East and Southern Africa', 'advocacy', 'policy', 'negotiations' and 'equity'. Boolean operators 'AND' and 'OR' were used to retrieve articles with both or either term. The full-text versions of all studies that could meet the inclusion criteria were retrieved and assessed. Reference lists of all the retrieved articles were also searched for additional pertinent papers not found through database searches. Two reviewers evaluated the titles and abstracts of all the identified papers and then compared their findings. Where differences arose, these were settled through discussion, or on the decision of a third reviewer. The data extraction form developed by the authors captured information on the name of the first author, publication year, type of article, the country or region being discussed, study design (if applicable) and critical findings. Following extraction, a narrative summary of the key findings from the included articles was drafted.

2.3 Search results and characteristics of included studies

From all the databases searched, 240 articles were retrieved and 150 duplicate records were removed before the screening. Of the 90 articles screened, 50 were excluded because they discussed the impact of climate change in general but not specifically health. Finally, only 40 articles were assessed for eligibility: at this stage, a further 21 articles were excluded and 19 articles remained for this rapid review, as outlined in *Figure 2*.

Figure 2: PRISMA flowchart



The 19 articles included in this rapid review can be seen in *Table 1*. Below is a summary of these articles by focus area.

- a. Nine of the included articles reported on the impact of climate change on health systems: Rocque et al., 2021; Lokotola et al., 2023; Theron et al., 2022; Khine & Langkulsen, 2023; Hellden et al., 2021; Borg et al., 2021; Atela & Otieno, 2022; Mboera et al., 2011; Ezeruigbo & Ezeoha, 2023.
- b. Five papers reported on health systems' adaptations to climate change: Nhamo & Muchuru, 2019; Otieno et al., 2022; Chersich & Wright, 2019; Kalantary, 2010; Scheelbeek et al., 2021.
- c. Five papers reported on health system advocacy and policy issues raised by ESA countries in climate change negotiations: WHO Regional Office for Africa, 2012; Pichon, 2022; United Nations, 2022; Skah, 2020; Madziwa & Betzold, 2014.
- d. Among the nineteen articles were thirteen journal articles: Rocque et al., 2021; Lokotola et al., 2023; Theron et al., 2022; Khine & Langkulsen, 2023; Hellden et al., 2021; Borg et al., 2021; Mboera et al., 2011; Ezeruigbo & Ezeoha, 2023; Nhamo & Muchuru, 2019; Otieno et al., 2022; Chersich & Wright, 2019; Kalantary, 2010; Scheelbeek et al., 2021; one blog: Atela & Otieno, 2022; one WHO report: WHO Regional Office for Africa, 2012; one United Nations news article: United Nations, 2022; one European Union parliamentary briefing article: Pichon, 2022; one policy paper: Skah, 2020; and one handbook: Madziwa & Betzold, 2014.
- e. Of the articles included, ten reported on Africa: Lokotola et al., 2023; Atela & Otieno, 2022; Ezeruigbo & Ezeoha, 2023; Nhamo & Muchuru, 2019; WHO Regional Office for Africa, 2012; Pichon, 2022; United Nations, 2022; Skah, 2020; Madziwa & Betzold, 2014; Mantlana & Jegede, 2022; three were global, including African countries: Rocque et al., 2021, Hellden et al., 2021; Borg et al., 2021; two were on South Africa: Khine & Langkulsen, 2023; Chersich & Wright, 2019; and one each on Zambia: Kalantary, 2010; Tanzania, Mboera et al., 2011; East Africa, Otieno et al., 2022; and multiple African countries covering Uganda, Ghana, Tanzania and Nigeria: Theron et al., 2022.

Table 1 Features of included studies ordered alphabetically and by issue discussed

First author, year	Reference	Article type	Study location	Design
Issue discussed: Climate change impact on health systems				
Atela J, 2022	(Atela & Otieno, 2022)	Blog	Africa	Opinion
Borg FH 2021	(Borg, et al., 2021)	Journal article	Global, including African countries such as Kenya and Ethiopia	Scoping review
Ezeruigbo,CF, 2023	(Ezeruigbo & Ezeoha, 2023)	Journal article	Africa	Review
Hellden D, 2021	(Hellden, et al., 2021)	Journal article	Global, including African countries	Scoping review
Khine MM, 2023	(Khine & Langkulsen, 2023)	Journal article	South Africa	Systematic review
Lokotola CL, 2023	(Lokotola, et al., 2023)	Journal article	Africa	Scoping review
Mboera LE, 2011	(Mboera, et al., 2011)	Journal article	Tanzania	Review
Rocque RJ, 2021	(Rocque, et al., 2021)	Journal article	Global, including African countries such as Ethiopia and Ghana	Systematic synthesis of systematic reviews

Theron E, 2022	(Theron, et al., 2022)	Journal article	Uganda, Ghana, Tanzania and Nigeria	Scoping review
Issue discussion: Health systems adaptations to climate change				
Chersich MF, 2019	(Chersich & Wright, 2019)	Journal article	South Africa	Review
Kalantary C, 2010	(Kalantary, 2010)	Journal article	Zambia	Review
Nhamo G, 2019	(Nhamo & Muchuru, 2019)	Journal article	21 English-speaking African countries, mainly in East and Southern Africa	Review
Otieno MA, 2022	(Otieno, et al., 2022)	Journal article	East Africa	Commentary
Scheelbeek PF, 2021	(Scheelbeek, et al., 2021)	Journal article	Low-to-middle-income countries, including those in East and Southern Africa	Review
Issue discussed: Health system advocacy and policy issues raised by ESA countries in climate change negotiations.				
Madziwa F, 2014	(Madziwa & Betzold, 2014)	Handbook	Africa	N/A
Mantlana,B, 2022	(Mantlana & Jegede, 2022)	Journal article	Africa	Opinion
Pichon E, 2022	(Pichon, 2022)	EU Parliament Briefing	Africa	N/A
Skah M, 2020	(Skah, 2020)	Policy Paper	Africa	N/A
WHO 2012	(WHO Regional Office for Africa, 2012)	WHO Report	Africa	N/A
UN 2022	(United Nations, 2022)	UN News	Africa	N/A

2.4 Limitations

The search strategy had several limitations, one of which is that only a few databases were used, making it possible that some relevant articles were missed. Another limitation is that only articles published in English were considered, which might have introduced a language bias. Additionally, the articles used in this review were from only a few countries in the ESA region, making it difficult to generalise the results to the rest of the region. Following the PRISMA-P guidelines made it easy, however, for the results to be reproducible, while another strength is that two reviewers independently extracted and synthesised the data and then compared their results, confirming the conclusions.

3. Results

The results of this rapid review are outlined below, while *Tables 2 and 3* contain more details of the findings by area of focus.

3.1 Climate change impact on populations and health systems

The impact of climate change on populations is not uniform. One scoping review study (Lokotola, et al., 2023) revealed that malnutrition affects children and older people more, while another only revealed children to be more affected (Hellden, et al., 2021). Children under the age of five years and people with non-communicable diseases (NCDs) were found to be more vulnerable to higher

temperatures compared to the rest of the population, due to their decreased ability to thermoregulate because of age or the effect of the NCDs. For example, people with diabetes may have impaired temperature regulation (Borg, et al., 2021). Women in South Africa were reported to suffer from the effects of climate change more than men because of economic marginalisation, political exclusion and distinct labour responsibilities. The study reported that reduced agricultural production has led to the migration of women to urban areas. This is associated with increased gender-based violence, engagement in sex work and human trafficking, all of which have resulted in greater health risks to women, including mental health disorders (Khine & Langkulsen, 2023). Others report a wide variety of groups to be vulnerable to the health effects of climate change: those at home, those living in low-lying areas or heat islands, patients and health care workers, young adults, children below the age of five years, the elderly, the illiterate, those not proficient in major local languages and women (Theron, et al., 2022). Climate change was also said to cause poor households, whose income and nutrition depend on agriculture, to be more vulnerable to malnutrition and unable to afford health care (Atela & Otieno, 2022).

Among the eight articles that reported on the impact of climate change on health systems, articles on Ethiopia, Ghana and Tanzania reported increased demand for primary health care services due to climate change (Lokotola et al., 2023; Rocque et al., 2021; Hellden et al., 2021; Atela & Otieno, 2022; Mboera et al., 2011). The increase in demand for health care services was reported to arise from malnutrition caused by food shortages due to drought, the increase in food and water-borne infectious diseases because of drought and floods, especially in low-income settings; and from heat exhaustion and heat strokes due to heat waves, especially among people living in informal settlements.

The demand for health care services also emanates from an increase in climate-sensitive diseases such as malaria, Rift Valley fever, dengue fever, trypanosomiasis, schistosomiasis, leptospirosis, plague and water-borne diseases like cholera and typhoid. Temperature and precipitation changes resulting from climate change can alter vector development rates, shifts in geographical distribution and alter transmission dynamics, leading to increased incidence of these diseases. An increase in mental illness and cardiovascular and renal diseases due to extreme heat has also been reported to contribute to an increase in the demand for health care services. An opinion article on Africa reported reduced access to health care services due to extreme weather events such as flooding, disrupting transport and communication networks (Atela & Otieno, 2022).

During severe weather events such as cyclones and storms, transport and communication network impacts have been reported to disrupt laboratory services, staff and patient travel, supplies of medication and ambulance availability, especially in rural areas. An article on Tanzania reported an inability to provide health care services due to electric power outages because of extreme weather events like flooding and storms (Mboera, et al., 2011). Some reported the inability to afford primary health care services due to reduced household income, especially among populations that rely on subsistence farming (Atela & Otieno, 2022; Ezeruigbo & Ezeoha, 2023).

An association is reported between temperature change – extreme heat, aridity and cold temperatures – and an increase in the use of health care services, such as emergency department visits, hospital admissions and the use of ambulances. Extreme weather events and flooding are associated with an increase in hospitalisations. In contrast, wildfire smoke exposure is associated with an increase in hospital emergency department visits in countries like Ghana and Ethiopia (Rocque et al., 2021). Heatwaves have also been reported to increase children's emergency hospital visits in cities in the ESA region due to paediatric kidney stones (Hellden et al., 2021).

The capacity of health systems is reported to be overstretched due to climatically driven malnutrition and starvation, increasing the demand for primary health care services. Some report extra pressure on health care services through increased demand due to weather-related natural disasters such as floods and landslides (Atela & Otieno, 2022; Mboera, et al., 2011).

Climate change-related extreme weather events are reported to cause an increased demand for mental health services due to the disruption of social networks in emergencies, and the stress brought about by the loss of loved ones, of income and productivity and, sometimes, relocation to new places (Mboera et al., 2011). Electric power outages caused by climate change are also associated with an inability to perform operations during emergencies and a compromised quality of care (Rocque et al., 2021; Mboera et al., 2011). Countries where government health expenditure is average or slightly above average, and which experience a higher climate change risk, record an increase in out-of-pocket health expenditure (Ezeruigbo & Ezeoha, 2023).

Table 2: Findings from studies on climate change impact on health systems

First author, year	Findings/opinions
Atela J, 2022	<ul style="list-style-type: none"> - The capacity of health systems in Africa is overstretched due to climatically driven malnutrition, starvation and disasters such as floods - Climate change is likely to affect affordability of and access to health services, especially for the poor, who are the worst hit by the impact - Impacts of climate change on agricultural productivity cause poor households, whose incomes and nutrition depend on agriculture, to become more vulnerable and malnourished and thus unable to afford health care.
Borg FH, 2021	<ul style="list-style-type: none"> - Children under the age of five years and people with NCDs were found to be more vulnerable to higher temperatures compared to the rest of the population.
Ezeruigbo CF, 2023	<ul style="list-style-type: none"> - Countries with average/just above average government health expenditure and facing a higher climate change risk may record increased out-of-pocket health expenditure.
Hellden D, 2021	<ul style="list-style-type: none"> - Emergency hospital visits by children increased in cities during heatwaves - Increased hospital admissions due to childhood malnutrition caused by drought.
Khine MM, 2023	<ul style="list-style-type: none"> - Women in South Africa suffer more from climate change effects than men because of economic marginalisation, political exclusion and distinct labour responsibilities - Loss of agricultural production has led to the movement of women to urban areas, which has been associated with gender-based violence, sex work and human trafficking and has resulted in a greater health risk to women, including mental health disorders.
Lokotola CL, 2023	<ul style="list-style-type: none"> - Drought leads to malnutrition, especially among children and older people - Flooding leads to food and water-borne diseases such as cholera, typhoid, malaria and schistosomiasis - Extreme heat increases mortality, mental health, cardiovascular and renal problems - Extreme weather events lead may to physical injuries.
Mboera LE, 2011	<ul style="list-style-type: none"> - Increased demands due to weather-related natural disasters such as floods and landslides, place extra pressure on health care services - Increased demand for mental health services due to disruption of social networks - Electric power outages leading to inability to perform operations during emergencies - Damage to sanitation infrastructure leading to the spread of water-borne diseases.
Rocque RJ, 2021	<ul style="list-style-type: none"> - Climate change strains on public health resources through population health issues - There is an association between temperature change – extreme heat, aridity and cold temperatures – and increased use of health care services such as emergency department visits, hospital admissions and ambulances - Extreme weather events and flooding are associated with increased use of health care services such as hospitalisations, and compromised quality of care as extreme weather events may lead to power outages. - There is an association between wildfire smoke exposure and increased health care services such as emergency department visits.
Theron E, 2022	<ul style="list-style-type: none"> - Vulnerable groups identified were: those at home; those living in low-lying areas or heat islands; patients and health care workers; young adults, children below the age of five years and the elderly; people with low illiteracy levels; those not proficient in major local languages; and women.

3.2 Health systems adaptations and mitigation of climate change

Health systems are reported to be responding to climate change through early warning systems for extreme weather events and seasonal forecasting, noted in Lesotho, Rwanda, South Africa, Uganda, Zambia and Eritrea (Nhamo & Muchuru, 2019; Chersich & Wright, 2019; Kalantary, 2010). Early warning systems include the development of risk maps that allow mapping of the areas most exposed to severe weather and the introduction of health alert networks (Nhamo & Muchuru, 2019) and heat-health warning systems (Chersich & Wright, 2019).

Health systems are carrying out public health education and creating awareness about preventive options in Malawi, Rwanda, Botswana, Mauritius and Eritrea (Nhamo & Muchuru, 2019; Otieno et al., 2022; Scheelbeek et al., 2021). The public education and awareness adaptations include raising awareness of risks, and appropriate behaviours such as: the promotion of use of cooling fans during sweltering days, opening windows to improve ventilation and putting on loose-fitting and light clothes, in Malawi (Nhamo & Muchuru, 2019; Scheelbeek et al., 2021), and increasing awareness of vector-borne diseases (Otieno et al., 2022).

In Rwanda, South Africa, Uganda, Eritrea and Botswana, health systems are strengthening infectious disease control (Nhamo & Muchuru, 2019; Otieno et al., 2022; Chersich & Wright, 2019; Scheelbeek et al., 2021). Adaptations include surveillance of infectious diseases in South Africa, Mozambique and Eswatini, research in Botswana; vector control, case detection and treatment in Uganda (Scheelbeek et al., 2021, Nhamo and Muchuru, 2019; Otieno et al., 2022), improved vaccination programmes in Botswana and Rwanda; and improvements in access to safe water and sanitation in Rwanda and South Africa (Nhamo and Muchuru, 2019; Chersich & Wright, 2019).

Health systems in ESA are improving climate resilience of public health infrastructure and technology by modifying architectural designs to accommodate weather changes, encouraging new building infrastructure that will reduce energy use and enable natural cooling, and strengthening roofs to better resist heavy storms and strong winds in South Africa and Eritrea (Nhamo and Muchuru, 2019; Chersich & Wright, 2019; Scheelbeek et al., 2021). The capacity of communities for improved environmental health is being built in rural areas in Zambia (Kalantary, 2010). In South Africa, the climate resilience of public health infrastructure and technology is being enhanced through improved housing insulation to reduce extreme indoor temperatures, while urban house planning that avoids building on floodplains and swamps is ongoing, as is the provision of natural ventilation in hospitals to reduce the transmission of multi-drug resistant tuberculosis (Nhamo and Muchuru, 2019; Chersich & Wright, 2019).

Table 3: Findings from studies on health systems adaptations to climate change

First author, year	- Findings/opinions
Chersich MF, 2019	<ul style="list-style-type: none"> - Infectious diseases early warning system - Heat-health warning system - Use of natural ventilation in hospitals Insulation of hospital buildings.
Kalantary C, 2010	<ul style="list-style-type: none"> - Strengthening of early warning systems - Capacity building for improved environmental health in rural areas.
Madziwa F, 2014	<ul style="list-style-type: none"> - Need for climate finance, adaptation and acceptance of the historic responsibility of industrialised countries.
Mantlana B, 2022	<p>Climate change mitigation and adaptation must be designed to directly contribute to the pressing issues of poverty alleviation and economic development on the African continent.</p> <ul style="list-style-type: none"> - Finance for loss and damage - Advancing global stocktake process - Provision of sufficient funding for adaptation.
Nhamo G, 2019	<p>Early warning systems</p> <ul style="list-style-type: none"> - The development of weather and seasonal forecasting and early warning systems - Enhancement of early warning on weather changes Strengthening hydro-agro meteorological information warning systems

	<ul style="list-style-type: none"> - Development of risk maps that allow mapping of areas most exposed to bad weather - Introduction of health alert networks. <p>Public education and awareness</p> <ul style="list-style-type: none"> - Provision of public education about the risks and appropriate protective behaviours - Improvement of waste collection and disposal. <p>Infectious disease control</p> <ul style="list-style-type: none"> - Vector control, case detection and treatment, surveillance and research - Promoting access to good quality health services - Improving vaccination programmes - Improving access to safe water and sanitation. <p>Public health infrastructure and technology</p> <ul style="list-style-type: none"> - Provision of improved insulation of houses, including subsidies for low-income families - Promotion of engineering interventions like clean water technologies and bio latrines - Improving geographical accessibility to health services - Encouraging housing planning in urban areas that avoids floodplain areas and swamps.
Otieno MA, 2022	<ul style="list-style-type: none"> - Awareness and educational programmes on vector-borne diseases - Initiation of natural mosquito and tsetse fly control mechanisms - Income diversification and resilient food production techniques.
Pichon E, 2022	<ul style="list-style-type: none"> - Scaling up climate finance to match the need for adaptation in Africa. Climate finance should be distinct from development assistance and half of climate funds should be dedicated to adaptation - Operationalise a loss and damage funding facility for the most vulnerable countries.
Scheelbeek PF, 2021	<ul style="list-style-type: none"> - Promotion of behaviour change - Infrastructural and technological improvements - Increased access to clean water and sanitation - Improved food security - Infectious diseases early warning system - Communication, information and awareness raising.
Skah M, 2020	<ul style="list-style-type: none"> - Urging developed countries to provide sufficient and predictable financing, transfer of technologies and capacity building.
UN, 2022	<ul style="list-style-type: none"> - Advance the implementation of National Determined Contributions (NDCs), including adaptation and mitigation efforts and delivery of finance to enhance implementation - Reach a concrete decision on the global goal for adaptation <p>The latest IPCC Working Group Report on impacts, adaptation and vulnerability highlighted that the annual cost of adaptation in developing countries would rise from \$140 billion to \$300 billion by 2030, and adaptation financing should reach these figures.</p>
WHO, 2012	International financial assistance is needed to prepare national action plans, risk and capacity assessments, integrated environmental and health surveillance responses, research, monitoring and evaluation, and management and coordination.

3.3 Health systems advocacy and policy issues raised by ESA countries

While the advocacy and policy issues cited in the included articles were not specific for health systems, they do also impact on them. Several papers raise financing adaptation measures (WHO Regional Office for Africa, 2012; Pichon, 2022; United Nations, 2022; Skah, 2020; Madziwa & Betzold, 2014), while others refer to financing loss and damage facilities. These are identified as financial resources that should be availed to low- and middle-income countries (LMICs) by high-income countries (HICs), to address the impacts of climate change and associated consequences in the region (Mantlana & Jegede, 2022; Pichon, 2022; Madziwa & Betzold, 2014).

ESA countries point out that international financial assistance is required for the preparation of national action plans, risk and capacity assessments, integrated environmental and health surveillance responses, research, monitoring and evaluation, and management and coordination at the African Ministerial Conference on Environment (WHO Regional Office for Africa, 2012). At the UN Climate Change Conference of Parties (COP27), African countries have also raised the point that climate finance should be increased to match the region's need for adaptation, with the annual cost of adaptation for all LMICs globally estimated to be USD140–300 billion by 2030, (Pichon, 2022; United Nations, 2022).

Another issue raised by African countries at COP27 is that climate finance should be distinct from development assistance, and that half of the climate funds should be dedicated to adaptation (Pichon, 2022). Countries in ESA stressed at COP25, that HICs should provide sufficient and predictable funding, technology transfer and capacity building (Skah, 2020). They also advocated at COP meetings for the operationalisation of a loss and damage funding facility for the most vulnerable countries, which they believe is an historic responsibility of industrialised countries (Pichon, 2022; Madziwa & Betzold, 2014; Mantlana & Jegede, 2022). At COP 27, they argued that climate change mitigation and adaptation must be designed to directly address the pressing issues of poverty alleviation and economic development in the region (Mantlana & Jegede, 2022).

4. Discussion

This rapid review has revealed that climate change has increased the demand for health care services in ESA. This finding concurs with the results of a narrative review that showed that extreme weather events were associated with increased admission rates and lengths of hospital stays (Al-Marwani, 2023). The increase in health care utilisation may result in negative psychosocial effects on health care workers in the region, who are already overworked due to inadequate staffing, resulting in burnout. This may, in turn, lead to medical errors and poor quality of patient care, as well as the emigration of health care workers to regions with more favourable staffing and working conditions (Bari et al., 2016).

The review found that climate change also reduces access to health care services because it can result in extreme weather events that may disrupt transport networks. According to Salas et al. (2020), climate change can lead to hospital evacuations, facility damage and closures, power outages and displacement of health care workers (Salas et al., 2020). The review also found that climate change is increasing the unaffordability of health care services, when income from agricultural activities is reduced.

Health systems in ESA use early warning systems to adapt to climate change – early warning of weather events can alert at-risk populations to relocate before disasters strike, which may reduce casualties and the consequent increase in health care utilisation. Early warning systems can also warn populations of impending disease outbreaks such as malaria (Neta et al., 2022). Another important adaptation mechanism used by health systems in ESA is public education and awareness; this helps communities be aware of the risks posed by climate change and to understand the options available for responses to keep themselves safe (Khatibi et al., 2021).

Infectious disease control was noted to be essential for health system adaptation to climate change because diseases can quickly spread in extreme weather events such as floods and may result in health systems being overwhelmed by the need for health care services (Lugten & Hariharan, 2022). The One Health approach, which recognises the interaction between health in people, animals, plants and their shared environment, is an essential pillar of infectious disease prevention that countries in ESA could utilise. Countries in the ESA region can also take advantage of mobile technologies to collect and analyse data in real-time to ensure the early detection of zoonoses, so that interventions can be implemented before a few infections turn into an epidemic (Zinsstag et al., 2018).

Improving the climate resilience of public health infrastructure and technology may reduce water and sanitation infrastructure disruption, preventing infectious disease outbreaks during extreme weather events; climate-resilient health care facilities may also be able to continue functioning during extreme weather events, thereby maintaining access to health care services.

In climate change negotiations, ESA countries are raising the issue of the financing of adaptation measures and loss and damage facilities to address these pressing regional issues. These issues are essential to ESA because the region is unable to finance the necessary climate adaptation measures due to budgetary constraints.

Furthermore, since Africa contributes little to climate change but is the region worst affected by it, it is therefore reasonable for the region to demand funding for mitigation and adaptation measures; but it also needs to specify that the funds will be reserved for adapting health systems to climate change to support health in the region. Given greater burdens placed on low-income groups by climate change this is also a key equity issue.

Climate change is a significant threat to human health and well-being, and health systems are on the frontline of responding to its health impacts. Recommendations for responding to these effects on health systems can be divided into adaptation and mitigation measures.

Adaptation measures aim to reduce health systems' vulnerability to the impacts of climate change and include:

- Strengthening early warning systems for extreme weather events, such as heat waves, floods and droughts, so that health systems are prepared to respond effectively.
- Develop climate-resilient health infrastructure, such as hospitals and clinics, that can withstand extreme weather events and power outages.
- Training of health workers on managing the impacts of climate change, such as heatstroke, vector-borne disease and mental health problems.
- Building partnerships between the health sector and other sectors, such as disaster management and urban planning, to coordinate climate change adaptation efforts.

Mitigation measures aim to reduce greenhouse gas emissions and slow the progression of climate change and include:

- Transitioning to clean energy sources, such as solar and wind power.
- Improving the energy efficiency of buildings and transportation.
- Reducing deforestation and promoting sustainable agriculture practices.
- Promoting sustainable consumption and production patterns.

In addition to adaptation and mitigation measures, it is also essential to strengthen health systems overall so that they are better able to respond to the impacts of climate change. This includes measures such as:

- Investing in universal health coverage so everyone can access good quality health care.
- Strengthening primary health care so that people can get the care they need close to home.
- Building a resilient health workforce by training and supporting health workers.
- Improving the governance of health systems to improve their efficiency and effectiveness.

Despite the growing recognition of the threats posed by climate change to human health and health systems, there are still many knowledge gaps that need to be overcome. Some of the critical knowledge gaps, all of which require more research, include:

- Understanding the full extent of the health impacts of climate change, including the long-term health and life course impacts of climate change, and the impact of rising sea levels on displacement and consequently, on people's mental health.
- Understanding the distribution of the health impacts of climate change across different populations, both within and across countries. This will help to plan and implement appropriate and effective measures to respond to them.
- Assessing the effectiveness of different adaptation and mitigation measures. Identification of the most effective ways to adapt health systems to climate change impacts will strengthen efforts to mitigate the consequences of climate change on human health.
 - Research on the cost-effectiveness of different adaptation and mitigation measures, to identify the most cost-effective ways to adapt health systems to climate change and mitigate its health impacts.

Addressing these knowledge gaps through informed research will contribute to effective, equitable and efficient strategies to protect health systems and health from the impacts of climate change.

5. Conclusion

Climate change is perceived to be one of the most significant global health challenges of the 21st century and the African continent is amongst the most vulnerable to its impact globally. ESA populations are susceptible to illness and injury from the natural emergencies and extreme weather events and to increased infectious diseases as a result of vector spread. Extreme weather events may compromise access to clean water and sanitation, food production, transport and energy infrastructures and other factors that affect health.

There are several documented health impacts of climate change that affect the six pillars of health systems, threatening their ability to function effectively. In ESA these include increased demand for health care services, reduced delivery of and access to health care services and an inadequate health workforce to address rising disease burdens from climate change. Cost barriers to health care provision and access from climate emergencies also raise health financing issues. Health systems adaptations to climate change in ESA include early warning systems for weather events, public education and awareness, infectious disease control, requiring changes in social conditions, and health technologies, and improved climate resilience of public health infrastructure and technology. It also calls for information, research, leadership and governance to support service and population capacities for prevention of climate related risks, and for effective, equitable responses to climate change.

ESA countries face significant financial constraints in scaling up these measures. Low-income households and vulnerable groups are both directly and indirectly affected, and face cost barriers to uptake of services despite rising need. Given this, the review suggests that climate change appears to be exacerbating existing inequities in health and that health systems are key in confronting this inequity.

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Acronyms

ESA	East and Southern Africa
IPCC	International Panel on Climate Change (IPCC)
LMICs	Low- And Middle-Income Countries
NCDs	Non-Communicable Diseases
PRISMA-P	Preferred Reporting Items for Systematic Reviews and Meta-Analysis Protocols
TARSC	Training and Research Support Centre
COP	UN Climate Change Conference of Parties

The Regional Network for Equity in health in east and southern Africa (EQUINET) implements work in a number of areas identified as central to health equity in east and southern Africa, including

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Training and Research Support Centre (TARSC)
Box CY651, Causeway, Harare, Zimbabwe Tel + 263 4 705108/708835
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