

Climate and Health Vulnerability Assessment

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MALAWI

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MALAWI

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CONTENTS

ACKNOWLEDGMENTS	vii
LIST OF ABBREVIATIONS	viii
EXECUTIVE SUMMARY	1
INTRODUCTION	5
Country Context	5
Aims of this assessment and conceptual framework	7
CLIMATOLOGY	9
Malawi's Geography	9
Observed and Projected Climatology	10
Temperature	10
Precipitation	12
Climate-related Hazards.....	13
Floods.....	13
Drought.....	14
Cyclones.....	15
Landslides	15
CLIMATE-RELATED HEALTH RISKS	19
Nutrition risks	20
Vector-borne disease risks	21
Malaria.....	22
Water-borne disease risks.....	24
Heat-related morbidity and mortality risks	25
Air quality related health risks.....	26
Direct injuries and mortality	27
Mental health and well-being risks.....	28
ADAPTIVE CAPACITY OF THE HEALTH SYSTEM	31
Health System Overview	31
Leadership and governance	32
Health Financing	37
Health workforce.....	39
Health Information Systems.....	42
Essential Medical Products and Technologies	43
Health Service Delivery	43

RECOMMENDATIONS TO ENHANCE HEALTH SYSTEM RESILIENCE TO CLIMATE CHANGE	47
Component 1. Leadership and Governance	47
Component 2. Health Workforce	48
Component 4. Integrate risk monitoring and early warning	49
Component 7. Management of the environmental determinants of health.....	49
Component 10. Climate & Health Financing.....	49
ANNEXES.....	51
Annex A. Methods for the estimation of mosquito suitability in Malawi, under RCP 8.5	51
Annex B. Adaptive Capacity Rapid Assessment	57
Annex C. Categorization of recommendations	60
Annex D. Key recommendations and relevant line ministries in Malawi.....	61
Annex E. Recommendations by climate-related health risk	62
Annex F. Projected average monthly temperature and precipitation patterns in Malawi, under SSP3-7.0.....	66
REFERENCES	67

LIST OF TABLES

Table 1. Annual number of very hot days (>35°C) and tropical nights in the 2030s and 2050s throughout Malawi, under SSP3-7.0	12
Table 2. Projected average largest 5-day cumulative precipitation, under the SSP3-7.0 scenario	14
Table 3. Projected percentage of suitable habitat area, by region, for the malaria vector species in Malawi, under RCP8.5, through the mid-century.....	22
Table 4. Two-week prevalence of diarrhea in children under five years in Malawi, 2017	24
Table 5. Extreme weather event related, injuries, and mortality in Malawi from 2000 to 2022	27
Table 6. Summary of the Climate Change Risks on Health Outcomes	29
Table 7. Vacancy rate of eight selected essential health staff per established position for MoH and CHAM.....	41
Table 8. Summary of the Health System Adaptive Capacity Gaps for Malawi	45
Table A1. Model parameterization and data sources for habitat characterization	52
Table A2. Copernicus Global Land Cover Layers: CG:S-LC100 Collection 2 Global Landcover Map Classifications for <i>Anopheles gambiae</i> s.s.	53
Table A3. Copernicus Global Land Cover Layers: CG:S-LC100 Collection 2 Global Landcover Map Classifications for <i>Anopheles arabiensis</i>	54
Table A4. Copernicus Global Land Cover Layers: CG:S-LC100 Collection 2 Global Landcover Map Classifications for <i>An. funestus</i>	55

LIST OF FIGURES

Figure 1. World Health Organization (WHO) operational framework for climate-resilient healthcare systems	6
Figure 2. Administrative boundaries of Malawi	8
Figure 3. Elevation map of Malawi	10
Figure 4. Projected average monthly temperature and precipitation patterns in Malawi under SSP3-7.0.....	11
Figure 5. Rainfall-triggered landslide hazard index in Malawi.....	16
Figure 6. Comparison of the suitable area for the malaria vector species in Malawi under Representative Concentration Pathway (RCP) 8.5, across three epochs: 1986–2005 (historical baseline), 2020–2039, and 2040–2059.....	23
Figure 7. WHO Health System Building Blocks	32
Figure 8. WHO’s Operational Framework for Building Climate-Resilient Health Systems.....	48

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LIST OF ABBREVIATIONS

AAP	Ambient Air Pollution
AIDS	Acquired Immunodeficiency Syndrome
AR6	Assessment Report 6 [of the IPCC]
CARD	Chronic and Acute Respiratory Diseases
CCKP	Climate Change Knowledge Portal [World Bank]
CD	Communicable Disease
CHAM	Christian Health Association of Malawi
CHVA	Climate and Health Vulnerability Assessment
CHW	Community Health Worker
CMIP	Coupled Model Intercomparison Project
CMIP6	Coupled Model Intercomparison Project Phase 6
COVID-19	Coronavirus disease 2019
CRU	Climatic Research Unit [University of East Anglia, UK]
CVD	Cardiovascular Disease
DALYs	Disability Adjusted Life Years
DFID	Department for International Development
DHIS	District Health Information System
DoCCMS	Department of Climate Change and Meteorological Services
DoMS	Department of Meteorological Services
DRM	Disaster Risk Management
EAD	Environmental Affairs Department
eHIN	Electronic Health Information Network
EHP	Essential Health Package
EHRP	Emergency Human Resources Program
EIAs	Environmental Impact Assessments
ENSO	El Niño Southern Oscillation
GDP	Gross Domestic Product
GHG	Greenhouse Gas [emissions]
HCCT	Health and Climate Change Core Team
HMIS	Health Management Indicators System
HIS	Health Information Systems
HIV	Human Immunodeficiency Virus
HRH	Human Resources for Health
HNP	Health, Nutrition and Population [World Bank]
HSJF	Health Services Joint Fund
HSSP	Health Sector Strategic Planning
HSS	Health Systems Strengthening
IDSR	Integrated Disease Surveillance and Response
INDC	Intended Nationally Determined Contribution
IPCC	Intergovernmental Panel on Climate Change
ITCZ	Intertropical Convergence Zone
LDHEA	Libreville Declaration on Health and Environment in Africa
LUANAR	Lilongwe University of Agriculture and Natural Resources

LULC	land use and land cover
MAGICC	Model for the Assessment of Greenhouse Gas Induced Climate Change
MDHS	Malawi Demographic and Health Survey
MGDS	Malawi Growth and Development Strategy
MNRCC	Ministry of Natural Resources and Climate Change
MoE	Ministry of Education
MoH	Ministry of Health
NAIP	National Agriculture and Investment Strategy
NAPA	National Adaptation Program of Action
NCD	Noncommunicable Disease
NCCIP	National Climate Change Investment Plan
NCCMP	National Climate Change Management Policy
NDA	National Designated Authority
NDE	National Designated Entity
NDC	Nationally Determined Contribution
NEP	National Environmental Policy
NGO	Nongovernmental Organization
NSCCC	National Steering Committee on Climate Change
NTDs	Neglected Tropical Diseases
OOP	Out-of-Pocket (spending on health)
PFP	Private for-profit
PNFP	Private not-for-profit
PM2.5	Fine Particulate Matter (with a diameter of less than 2.5 micrometers)
RCP	Representative Concentration Pathway
SDG	Sustainable Development Goals
SOPs	Standard Operating Procedures
SSA	Sub-Saharan Africa
SSP	Shared Socioeconomic Pathway
TB	Tuberculosis
TBA_s	Traditional Birth Attendants
TH_s	Traditional Healers
TN20	Tropical Nights > 20°C
TN26	Tropical Nights > 26°C
UHC	Universal Health Coverage
UNDP	United Nations Development Programme
UMCM	University of Malawi College of Medicine
UNFCCC	United Nations Framework Convention on Climate Change
USAID	United States Agency for International Development
VBD	Vector-Borne Disease
WASH	Water, Sanitation, and Hygiene
WBD	Waterborne Disease
WHO	World Health Organization



EXECUTIVE SUMMARY

Malawi faces significant climate-related challenges that directly and indirectly impact health. Coupled with human-made health stressors, climate change can exacerbate the existing health burdens while creating new health risks. Changes in the temperature and precipitation patterns affect the geographic range and burden of a variety of climate-sensitive health risks while impacting the functioning and capacity of Malawi's health system. Climate change-related challenges that increase Malawi's vulnerability to poor health outcomes include a wide range of climate hazards, such as extreme temperature and humidity conditions, potential changes to precipitation patterns, extreme precipitation events, seasonal aridity, droughts, and cyclones. The country is affected by these climate hazards due to its geographical position; a strong dependency on rainfed agriculture, which is susceptible to regular climatic shocks; ongoing population growth; chronic and widespread malnutrition; as well as the high prevalence rates of HIV/AIDS.

Considering Malawi's high exposure and vulnerability to climate change, the World Bank, through the Health Climate and Environment Program (HCEP), is conducting a Climate and Health Vulnerability Assessment (CHVA). The objective of this CHVA is to assist decision-makers with planning effective adaptation measures to address climate-related health risks. This is first done by capturing the characteristics of the climatology of Malawi, with a focus on the observed and future health-related climate exposures. Further, climate-related health risks are examined by considering the projected climate variability, including identifying the vulnerable populations most at risk. Finally, the adaptive capacity of the health system to manage the current and future climate-related health risks is assessed to inform a series of recommendations that are aimed at reducing climate-related health vulnerability in Malawi. Where available, these measures are also provided at the subnational level to assist regional health planners. The recommendations of this CHVA are primarily aimed at the health sector, as well as the related sectors with influence on climate change-related health risks, such as disaster risk management (DRM).

The observed and projected climatology data, obtained from the Climate Change Knowledge Portal (CCKP) and climate hazards to inform this discussion of climate-related health risks, highlights the following:

- **The mean annual temperatures in Malawi have risen by 0.64°C over the past half century, occurring alongside increases in the minimum (0.60°C) and maximum (0.68°C) temperatures.** The maximum temperature is highest during October and November, with people in the Southern Region experiencing the greatest risk of extreme heat.
- **The median average precipitation ranges from 1000 millimeters (mm) in the rainy season to 140 mm during the dry season; it has declined by 100 mm since the 1960s.** The Northern Region has experienced the largest declines in annual precipitation, followed by the Southern Region.

- **Floods are among the most significant and recurring climate-related hazards in Malawi, especially for the low-lying areas along the Lake Malawi lakeshore in the Central and Southern Regions.** Extreme precipitation is projected to increase for the 2030s and 2050s, exacerbating flooding risks during the rainy season, especially in the Southern Region.
- **Droughts are common in Malawi, and the projected decline in precipitation will likely increase their frequency and intensity.**

Malawi faces significant health challenges from communicable diseases (CDs) and noncommunicable diseases (NCDs); climate change will worsen the severity of these health challenges. It is also important to point out that climate-related health risks are not evenly distributed within the population: some groups are at greater risk than others. This will be reflected in Malawi's CHVA that assesses seven climate-related health risk categories: (a) nutrition risks, (b) vector-borne disease (VBD) risks, (c) waterborne disease (WBD) risks, (d) heat-related morbidity and mortality risks, (e) air quality health risks, (f) direct injuries and mortality risks, along with (g) mental health and well-being risks.



Nutrition risks: In a country that primarily practices rainfed agriculture, projected warmer temperatures and water deficits, along with the increasing frequency and intensity of climate-related hazards, are very likely to aggravate food insecurity and nutritional deficiencies, though with significant geographical variations.



Vector-borne disease (VBD) risks: Malaria is endemic in Malawi; its transmission is seasonal throughout the country, peaking during or just after the conclusion of the rainy season. The malaria transmission risk in the Southern Region will likely decline in the 2050s due to ongoing climate change, while the transmission throughout the remainder of the country is expected to remain stable.



Waterborne disease (WBD) risks: The burden of WBDs throughout Malawi is significant, characterized by high rates of morbidity and mortality across the country, especially among children under five years of age. The projected increases in the intensity of precipitation in Malawi will likely increase the occurrences of floods and droughts, with implications on the frequency of WBD outbreaks.



Heat-related morbidity and mortality risks: Health effects caused by heat include the direct effect of heat stress, heat rash, cramps, exhaustion, and dehydration, as well as the acute exacerbation of pre-existing conditions. Extreme heat and its impact on excess heat-related morbidity and mortality is very likely to increase under the high- and low-emissions scenarios in Malawi.



Air quality health risks: The high levels of pollution from harmful airborne particulates have led to increased incidences of illness and deaths stemming from chronic lung diseases and acute respiratory infections among the population.



Direct injuries and mortality risks: Mortalities and direct injuries, associated with heavy rains-induced flash floods, mudslides, and landslides, are becoming a serious threat to life and human health in Malawi. The Central and Southern Regions, particularly the districts of Chikwawa, Phalombe, Nsanje, and Zombe, are more susceptible to flooding than other parts of the country.



Mental health & well-being risks: Impacts of extreme weather events, such as droughts, floods and cyclones on agriculture and other sources of livelihoods affect mental health and well-being of Malawians. Rural farming communities are more vulnerable to mental health impacts triggered by climate change-related hazards due to their dependence on agriculture and the environment for sustenance.

The extent to which the health system in Malawi is prepared for the changes in hazards, exposures, and susceptibility, and its capacity for managing them will determine its resilience in the coming decades. In this CHVA, Malawi's adaptive capacity to prevent and manage climate-related health risks is examined according to the six health system building blocks¹⁴³.

- **The Government of the Republic of Malawi recognizes climate change and its impacts on the country's development.** It ratified the Paris Agreement in 2015. Furthermore, the government has developed several policy frameworks that aim to reduce the country's vulnerability to climate change-related impacts, including human health outcomes.
- **Malawi's health sector is heavily donor-dependent and the government's low public financing on health has worsened healthcare access and widened health inequality gaps.** Although health has been incorporated into national policies, gaps remain at the subnational level, and there is no precise strategic planning for climate-health finance, nor are there any resource allocations for climate-related health risks and vulnerabilities.
- Malawi faces numerous health workforce challenges that are likely to be exacerbated by climate change. There are significant staffing gaps in the number of skilled health workers, which is further affected by their geographical distribution throughout the country; the health workforce is relatively limited in the rural areas. Climate health impacts will likely exacerbate these inequalities.
- Health information systems (HIS) are incorporated as a key pillar into the government's Health Sector Strategic Planning II (HSSP II). The information, monitoring, and surveillance systems in Malawi are identified as an area to be strengthened.
- Malawi has historically experienced regular shortages of essential medical products. Furthermore, weak quality assurance and accreditation, coupled with inadequate biosafety and biosecurity mechanisms, significantly affect the availability of laboratory and imaging services throughout the country.
- Inequalities in the accessibility of healthcare persist due to poor transport and a lack of ambulances for emergencies, which will likely be exacerbated by climate hazards. The country has a weak health infrastructure that is unable to withstand climate change shocks, which will affect healthcare service delivery.

Recommendations to reduce climate-related health risks could include the following activities:

- Enhance the coordination mechanisms for climate action and articulate climate action in subnational plans. The progress on climate change commitments and objectives in development plans should be monitored and should address the rural-urban disparities in climate-health risks. Specific strategic planning should also account for subnational differences.
- Articulate climate-health actions in subnational plans.
- Create and promote health workforce retention packages, including risk reduction and emergency protocols, to ensure that there are sufficient skilled health workers for the areas at the highest risk of climate-related hazards.
- Scale up the formal training that was developed by Malawi's Health and Climate Change Core Team (HCCT) on climate and health and incorporate it into the medical and paramedical as well as the refresher courses for continued learning and on-the-job training opportunities.
- Strengthen communication networks between the Department of Climate Change and Meteorological Services (DoCCMS) and the communities at risk of extreme weather events.
- Support community-led efforts to improve sanitation practices and controls to prevent WBDs and foodborne illnesses and diseases, including the generation of educational materials and public communication. Focus should be placed in particular on rural communities and temporary disaster shelters.
- Engage medical colleges and the Ministry of Education (MoE) to integrate with district-level community groups in developing and implementing health promotion programs that are focused on climate-related health risks.
- Ensure that strategic purchasing is guided by detailed, subnational climate information on population needs and supported by a provider mechanism that incentivizes providers.

INTRODUCTION

COUNTRY CONTEXT

1. **Malawi faces significant climate-related challenges that will directly influence its population health outcomes.** Coupled with human-induced health stressors, climate change exacerbates existing health burdens while creating new health risks. Specifically, the changes in temperature and precipitation patterns will affect the geographic range and burden of a variety of climate-sensitive health risks, while impacting the functioning and capacity of Malawi's health system. Climate change-related challenges increasing Malawi's vulnerability to poor health outcomes include a wide range of climate hazards that affect the country due to its geography (for example, floods, droughts, and cyclones); a strong dependency on rainfed agriculture, which is susceptible to regular climatic shocks; ongoing population growth; chronic and widespread malnutrition; as well as the high prevalence rates of the human immunodeficiency virus (HIV) and the acquired immunodeficiency syndrome (AIDS). Compounding these challenges, climate also exerts impacts on health and economic inequalities, which are not uniformly distributed due to demographic, socioeconomic, geographical, and environmental factors, thereby significantly influencing the distribution of population health risks.
2. **Malawi is among the poorest countries in the world, despite the appreciable efforts in making reforms for sustaining economic growth.** By 2021, its gross domestic product (GDP) had risen to USD12.6 billion, compared with USD1.7 billion in 2001.¹ Malawi's GDP per capita had also risen steadily from USD 116.6 in 1994 to USD 584.4 in 2019.² However, the coronavirus disease 2019 (COVID-19) pandemic, along with the government's expansionary policies, contributed to the widening of the fiscal deficit by 7.1 percent of the country's GDP in FY2021.³
3. **Poverty, which is widespread in Malawi, is characterized by significant distributional inequalities.** The population living in poverty was 50.8 percent during 2019/2020, with 56.6 percent residing in rural areas, compared with 19.2 percent residing in urban areas. Subnationally, the Central Region reported the highest poverty rate at 55.8 percent, followed by the Southern Region at 51 percent and the Northern Region at 32.9 percent. Between 2010 and 2019, the number of poor Malawians increased from 50.6% (7.4 millions) to 50.7% (9.4 millions) respectively.⁴ Although income

inequality, as measured by the Gini index, has decreased slightly from 45.5 in 2010 to 38.5 in 2018, it still represents a severe inequality gap.⁵

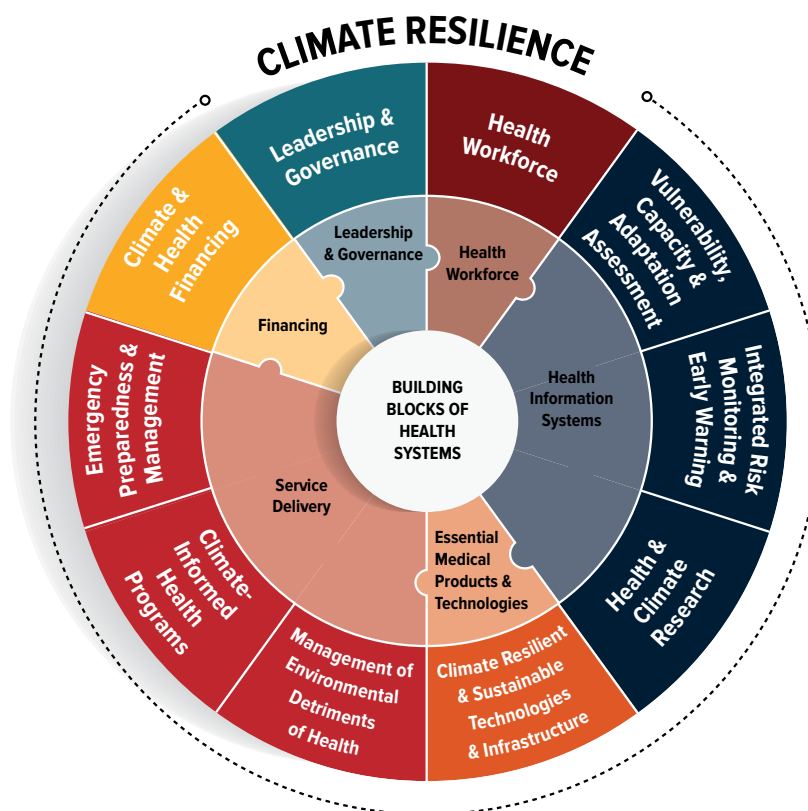
4. **Malawi has an estimated population of 19.1 million (2020) that is expected to double by 2050.**⁶ The population is disproportionately young: approximately 15 percent is under 5 years old and around 42 percent is under the age of 15. Only 1 percent of the population is over 65.⁷ In 2018, the Northern Region had the smallest population (2.3 million), while the Central (7.5 million) and Southern Regions (7.8 million) had similar population sizes.⁸ Eighty-four percent of the population of Malawi lives in rural areas, while the remainder primarily resides in four urban cities: Lilongwe,

Blantyre, Mzuzu, and Zomba. Urban population growth is projected to increase by 214,000 per annum between 2020 and 2025.⁹

5. **Malawi is committed to meeting the climate challenge through both adaptation and mitigation measures.** Malawi ratified the Paris Agreement in 2015, which aims to limit the global mean temperature increase to well below 2°C, compared to pre-industrial levels. It has developed several policy frameworks that aim to reduce the country's vulnerability to climate change-related impacts on various areas, including human health outcomes. Section IV of this assessment highlights the key steps adopted by the government of Malawi to meet its climate aspirations.

FIGURE 1.

World Health Organization (WHO) operational framework for climate-resilient healthcare systems



Source: World Health Organization, 2015, *Operational Framework for Building Climate Resilient Health Systems*.

AIMS OF THIS ASSESSMENT AND CONCEPTUAL FRAMEWORK

6. **The objective of this Climate and Health Vulnerability Assessment (CHVA) is to support decision-makers with planning effective adaptation measures to address climate-related health risks.** Where available, these measures are provided at the subnational level to assist regional health planners. The recommendations of this CHVA are primarily aimed at Malawi's Ministry of Health (MoH), but also include other related sectors that exert an impact on climate-related health risks, such as disaster risk management (DRM), agriculture, and natural resources and climate change.

7. **Adaptation priorities need to be accompanied by fundamental and urgent action to mitigate climate change.** It is important to stress how complex the climate challenge is and how hard it is to predict exactly how severe the climate exposures facing populations will become. There are many factors that could slightly slow or significantly speed up rates of change, including positive feedback effects and cascading climatological tipping points that are the most worrisome. For this reason, though not the focus of this assessment, mitigating existing greenhouse gas emissions (GHGs), as well as developing and implementing measures to protect human health from the changing climate, is of paramount importance.

8. **The World Health Organization's (WHO) operational framework for building climate-resilient health systems¹⁰ is adopted to analyze the adaptive capacity to adequately deal with the current and future identified risks.**

Following this framework (Figure 1), the adaptive capacity section of this CHVA structures the assessment of adaptive capacity around the six health systems strengthening (HSS) building blocks for considering the gaps now and into the future. The CHVA then considers the 10 components of health system climate resilience to guide its recommendations.

9. **This CHVA follows a stepwise linear approach.**

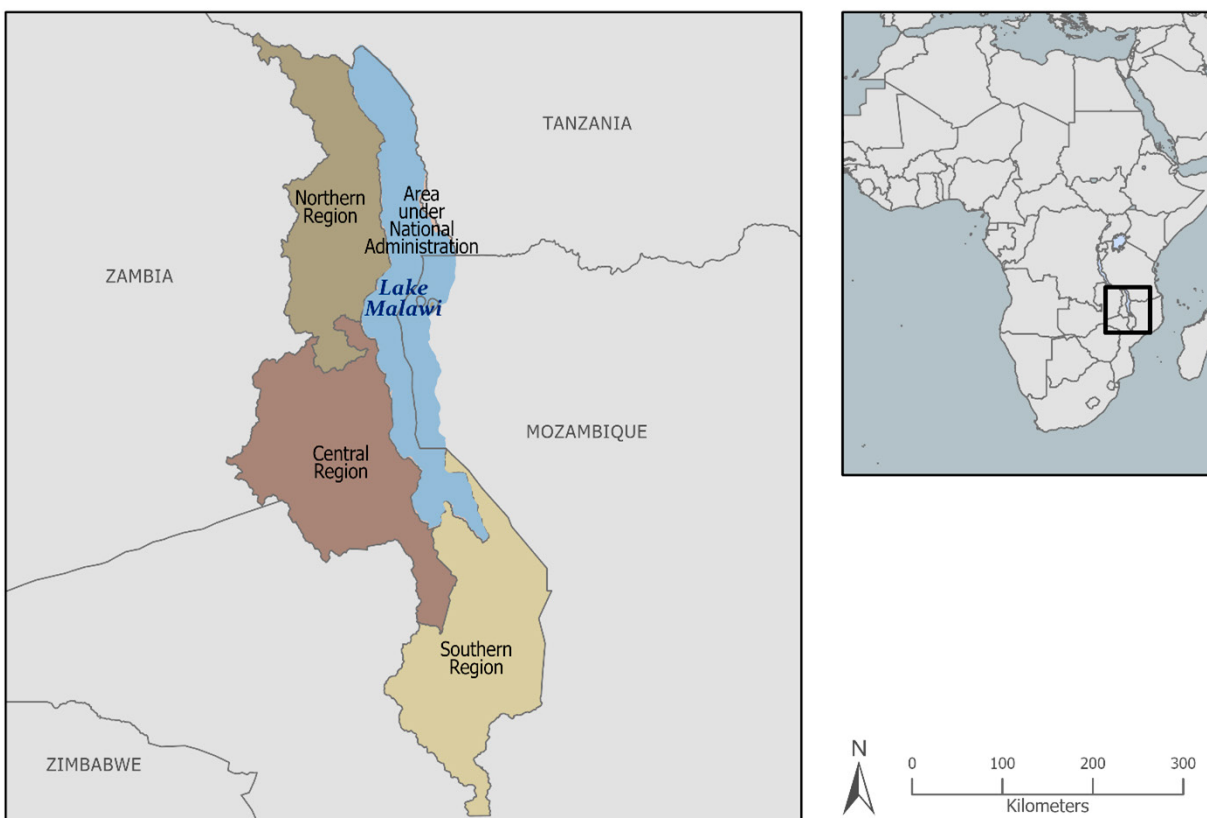
The first step describes the characteristics of the *climatology* in Malawi, highlighting the observed and future climate exposures that are relevant to health. The second step examines *climate-related health risks*. The final step assesses the adaptive capacity of the health system, identifying gaps in the management of current and future climate-related health risks. Together, these steps inform a series of *recommendations* for reducing climate-related health vulnerability in Malawi. This CHVA is based on a review of the published literature and reports, national statistics, and consultations with key stakeholders including MoH, the Ministry of Natural Resources and Climate Change (MNRCC), the Department of Climate Change and Meteorological Services (DoCCMS), and the Public Health Institute of Malawi.

10. This CHVA incorporates subnational considerations for health-related climate action.

Malawi is divided into three areas — the Southern, Northern, and Central Regions (Figure 2) — and further subdivided into 28 districts.

FIGURE 2.

Administrative boundaries of Malawi



Source: World Bank Cartography Unit

CLIMATOLOGY

- 11. This section describes the observed climatic changes and projected trends in Malawi, highlighting the priority climate-related hazards in relation to human health risks.** Climate information is taken from the World Bank Group's Climate Change Knowledge Portal (CCKP), where historical, observed data is derived from the Climatic Research Unit, University of East Anglia (CRU). Climate data used in the World Bank Group's CCKP is derived from the Coupled Model Intercomparison Project, Phase 6 (CMIP6). The CMIP efforts are overseen by the World Climate Research Program: it supports the coordination of the production of global and regional climate model compilations that advance the scientific understanding of the multiscale dynamic interactions between the natural and social systems affecting climate. CMIP6 is the source of the foundational data used to present the global climate change projections set out in the Sixth Assessment Report (AR6) of the Intergovernmental Panel on Climate Change (IPCC). CMIP6 relies on the Shared Socioeconomic Pathways (SSPs), which represent the possible societal development and the policy scenarios for meeting the designated radiative forcing (watt per square meter [W/m^2]) by the end of the century. Scenarios are used to represent the climate response to different plausible future societal development storylines and the associated contrasting emission pathways in order to outline how future emissions and land use changes translate into responses in the climate system.

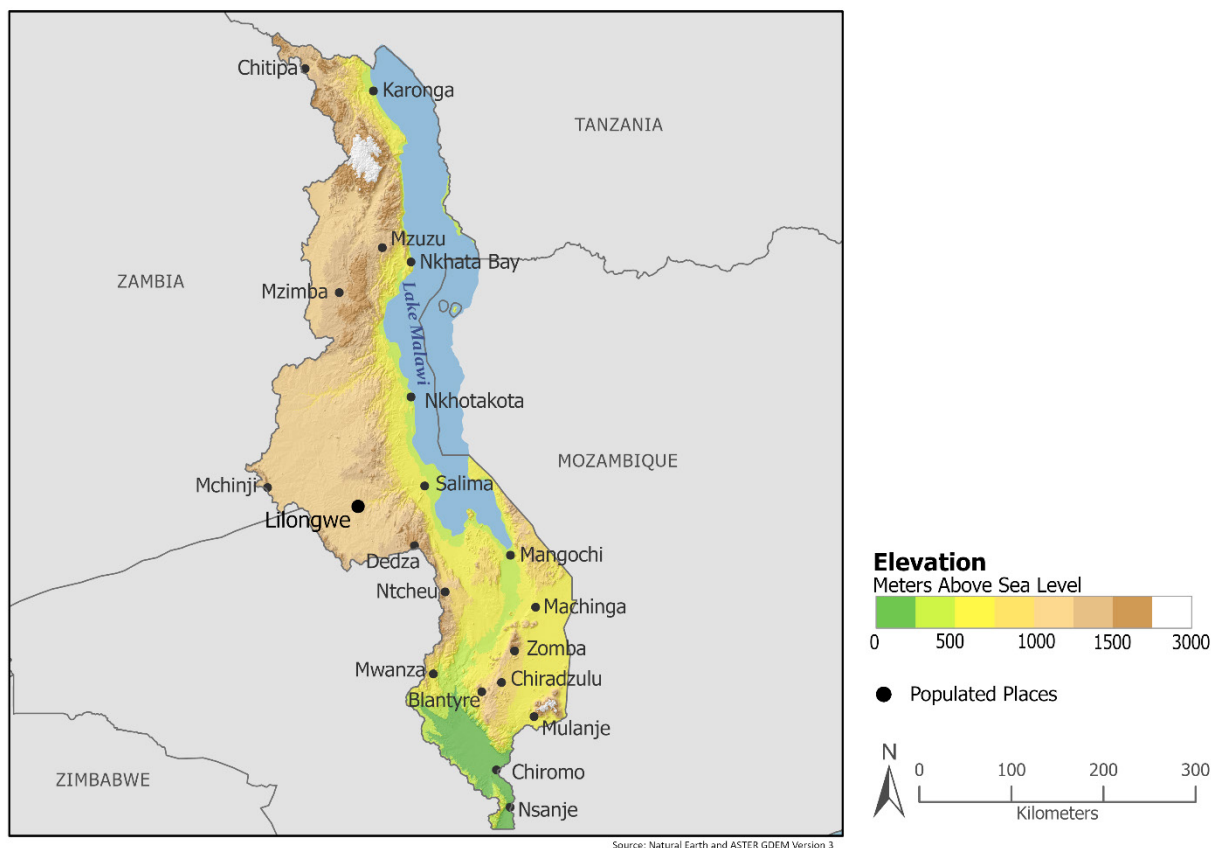
MALAWI'S GEOGRAPHY

- 12. Malawi is a landlocked country located in southern Africa: it borders Tanzania to the north, Mozambique to the east and south, and Zambia to the west (Figure 3).**¹¹ Malawi's eastern land border is predominantly with Lake Malawi, the third-largest of the African Great Lakes; the lake, together with the country's six major rivers, provides

abundant surface water resources throughout the country. Topography is highly variable in Malawi due to the north-south orientation of the Great Rift Valley that spans the country. The elevation ranges from less than 200 feet (ft) to approximately 10,000 ft at the peak of Mount Mulanje in the southeast. Malawi has four main landscape features: the highlands, isolated mountains, the Great Rift Valley, and the central plateaus.¹²

FIGURE 3.

Elevation map of Malawi



Source: Natural Earth and Aster GDEM Version 3

OBSERVED AND PROJECTED CLIMATOLOGY

13. Malawi's tropical climate is strongly influenced by the seasonal migration and intensity of the Intertropical Convergence Zone (ITCZ) and the El Niño Southern Oscillation (ENSO). There are two main seasons: a cool, dry season from May to October and a hot, wet season from November to April. Temperature varies latitudinally: the mean annual temperatures are highest in the Southern Region and lowest in the Northern Region. National and local-scale precipitation patterns vary according to elevation. Mountainous areas receive around 1,600 mm of rainfall per annum, while lowland areas experience approximately 600 mm.

TEMPERATURE

14. The mean annual temperatures in Malawi have risen by 0.64°C over the past half century, occurring alongside increases in the minimum (0.60°C) and maximum (0.68°C) temperatures. Warming is biased toward the dry season (May–October), with added marked increases in the mean monthly temperatures in November (0.85°C) and December (0.73°C) since 1960. Subnational monthly mean temperatures are fairly uniform, ranging from 17.3°C in the Northern Region to 26.6°C in the Southern Region. The maximum temperatures are highest during October and November — the transition months from the end of the dry season to the beginning of the

rainy season (November–April) — and range from approximately 30°C to 32°C.

15. Extreme heat exposure will become more common through the mid-century, with people in the Southern Region at the greatest risk. The mean monthly median temperature anomaly is projected to increase from 0.4 to 0.9°C, with a possible anomaly range of -1°C to +2.4°C across Malawi, in the 2030s; the projected increase during the 2050s is from 1.38°C to 1.54°C, with a possible anomaly range of -0.5°C to +3.8°C (Figure 4).

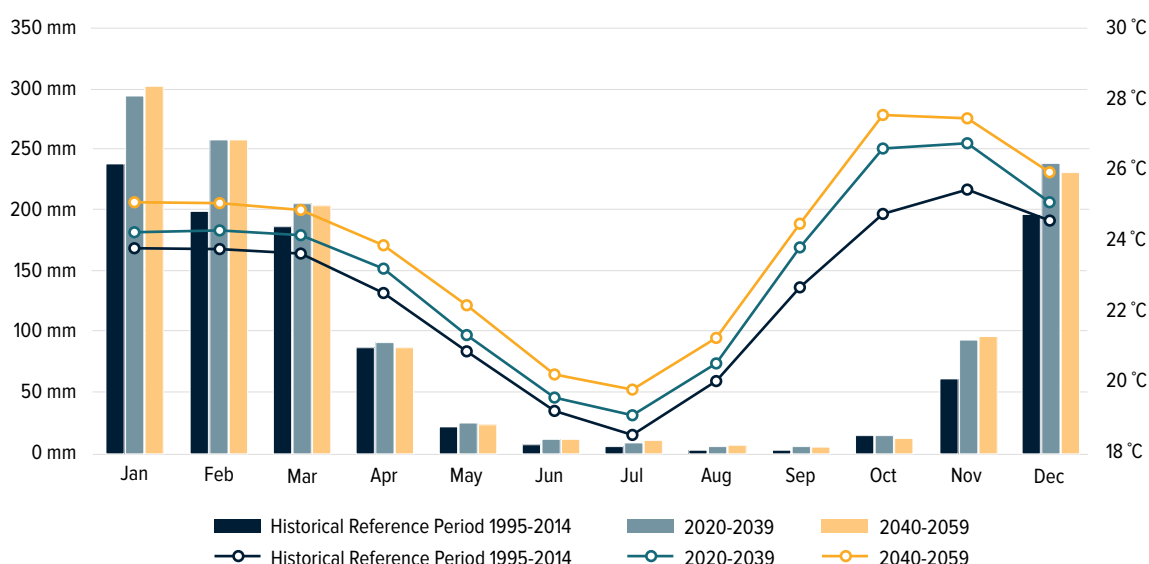
People in the Southern Region will be the most vulnerable to extreme heat conditions. Already, the Southern Region experiences more than double the median number of very hot days ($T_{\text{max}} > 35^{\circ}\text{C}$) ($N=42$ [30, 55]), compared to the Central ($N=20$ [11, 33]) and Northern ($N=6$ [1, 18]) Regions, mostly occurring from September to November each year. Projected temperature increases for the Southern Region will increase

the number of very hot days by 14 (1, 29) and 31 (11, 47) days in the 2030s and 2050s, respectively (Table 1).

Notably, daytime temperature increases will be coupled with high nighttime temperatures (that is, tropical nights). A tropical night is characterized by nighttime temperatures that are not low enough to allow the human body to adequately cool down after experiencing high daytime temperatures. Herein, two temperature thresholds are used to characterize tropical nights: $T_{\text{min}} > 20^{\circ}\text{C}$ (TN20) and $T_{\text{min}} > 26^{\circ}\text{C}$ (TN26). By the 2030s, the annual number of TN20 is expected to experience a median increase of 16 percent, with a 33 percent increase during the 2050s (Table 1). The Southern Region will be particularly vulnerable to high nighttime temperatures by the mid-century. By the 2050s, the region is projected to experience 200 days (181, 215) at TN20 annually, 15 of which will have temperatures at or above 26°C.

FIGURE 4.

Projected average monthly temperature and precipitation patterns in Malawi under SSP3-7.0



Source: World Bank Climate Change Knowledge Portal. This figure presents the median values of the multi-model ensemble range; for a full presentation of projected monthly precipitation and temperature projections please see Annex E.

TABLE 1.

Annual number of very hot days (>35°C) and tropical nights in the 2030s and 2050s throughout Malawi, under SSP3-7.0

	HIS. REF. PERIOD	2030S	2050S
	NO. DAYS	NO. DAYS	NO. DAYS
Very Hot Days (>35°C)			
Central	20 (11, 33)	30 (21, 43)	43 (30, 58)
Northern	6 (1, 18)	15 (6, 24)	24 (15, 41)
Southern	42 (29, 55)	57 (44, 71)	73 (53, 90)
Tropical Nights (>20°C)			
Central	54 (37, 99)	78 (57, 122)	110 (75, 157)
Northern	13 (4, 31)	28 (13, 59)	51 (28, 105)
Southern	150 (131, 167)	174 (156, 191)	200 (181, 215)
Tropical Nights (>26°C)			
Central	<1 (<1, 1)	1 (<1, 2)	2 (.5, 5)
Northern	0 (0, 0)	0 (0, 0)	0 (0, <1)
Southern	3 (0.5, 8.5)	7 (2, 15)	15 (4, 27)

Note: This table presents the median (50th percentile) with the 10th and the 90th percentiles of the range of the multimodel ensemble in brackets.

Source: World Bank Climate Change Knowledge Portal

PRECIPITATION

16. The average annual rainfall in Malawi has declined by nearly 100 mm since the 1960s, most notably during the dry season (May–October). Across the country, the average precipitation during the rainy season (November–April) is nearly 1,000 mm, while the rainfall during the dry season is barely over 140 mm. The Northern Region has experienced the largest declines in the annual precipitation, followed by the Southern Region. There has been considerable interannual climatic variations across the country, which has led to occurrences of extreme weather and related events (see the following section on climate-related hazards).

17. The total precipitation in Malawi is projected to decline through the mid-century compared with the historical reference, despite a slight increase between the 2030s and the 2050s,

which is reflective of the natural climate variability. It is important to note that the occurrences of extreme rainfall events are likely to increase (see the Floods section below). The median values for average annual precipitation at the national scale are projected to decline by nearly 40 mm (905 mm, 1,758 mm) during the 2030s. These projections do though reflect high uncertainty in precipitation projections for the region. The largest deficits are expected to occur in the Southern Region during the rainy season. By the 2050s, the average annual deficit for Malawi could be approximately 33 mm (893 mm, 1,742 mm), with the Southern Region projected to experience an even larger deficit than the 2030 period. By the mid-century, Malawi's dry season is expected to experience a reduction in rainfall, which would have important implications for agricultural production and food security.

CLIMATE-RELATED HAZARDS

18. Malawi is vulnerable to several climate-related hazards, many of which have already increased in frequency and intensity. The most pressing climate-related hazards are floods, droughts, cyclones, and landslides. The overall impacts of such events in Malawi cannot merely be attributable to changing environmental conditions, including changes to the climatology described in the previous section; rather, they are compounded by anthropogenic causes, including rapid deforestation, urbanization, and inadequate housing.

FLOODS

19. Floods are among the most significant and recurring climate-related hazards in Malawi, especially for the low-lying areas along the Lake Malawi lakeshore in the Central and Southern Regions. Vulnerability to floods is associated with the El Niño and the La Niña phenomena, the seasonal rainfall patterns, the variability of water levels in Malawi's three major lakes (Malawi, Chilwa, and Chiuta), and the cyclonic activity in the region.¹³ The greatest flood potential occurs in the rainy season between November and April, peaking in December and January; approximately 100,000 people are exposed to flooding each year.¹⁴ From 1991 to 2020, extreme precipitation resulted in 37 flood events, leaving 935 dead and affecting 3,501,645 people.¹⁵ In 2015, the country experienced the most devastating floods on record. Flooding occurred in 15

districts: there were an estimated 1.1 million people affected, 230,000 people displaced, and 106 deaths, along with damages and losses totaling USD335 million.¹⁶

20. Extreme precipitation is projected to increase for the 2030s and 2050s, exacerbating flooding risks during the rainy season, especially in the Southern Region. Projected figures for the five-day cumulative rainfall show an average increase of 7.01 mm (-70 mm, 149 mm) in the 2030s and 15.78 mm (-58 mm, 172 mm) in the 2050s, respectively. These increases will be the most profound during the rainy season (November–April), with the highest overall increases expected to occur in the Southern Region. Heavy cumulative rainfall is associated with a higher likelihood of runoff entering river channels and subsequent flooding, as soil reaches saturation. Intense single-day events of heavy rainfall can have the same effect, but within a shorter period of time, and may result in flash flooding events.

Nationally, there will be an increase for both the 2030s and 2050s in the largest 1-day precipitation events (+6.57 mm [-28mm, 51mm] and +10.86 [-24mm, 65mm] respectively), with the largest increases expected in February. The Southern Region is likely to experience the largest increases during the 2030s (+10.7mm annually), with the average largest 1-day rainfall totals ranging from 35 mm to 114 mm during the rainy season. By the 2050s, despite the projected increases for the Central Region being greater than those

The overall impacts of the most pressing climate-related hazards in Malawi are compounded by anthropogenic causes, including rapid deforestation, urbanization, and inadequate housing.

predicted for the Southern Region (+15.9 mm versus +7.6 mm), the Southern Region will still be at the greatest risk of flooding associated with intense 1-day rainfall events, especially from January to March. Overall, rainfall will increase during the rainy season, based on the assumption that the wet / dry seasons stay the same. However, the days with consecutive rainfall will remain the same for the 2030s and the 2050s, based on the assumption that the wet / dry seasons remain the same (Table 2). The models estimate that floods may cause an average GDP loss of almost 1 percent every year.¹⁷

DROUGHT

21. Droughts are common in Malawi, affecting approximately 1.5 million people each year on average.¹⁸ Over the last four decades, the frequency, intensity, and geographical area affected by droughts have increased across the country.¹⁹ The most substantial droughts in recent years occurred during 2015 / 2016 in response to strong El Niño conditions. Erratic rains and prolonged dry spells led to severe crop failures in the Southern and Central Regions, resulting in 6.5 million people requiring food aid²⁰ and depressed macro-economic growth. The Southern and Central

TABLE 2.

Projected average largest 5-day cumulative precipitation, under the SSP3-7.0 scenario

		2030S			2050S		
		ANNUAL TOTAL	WET SEASON (NOV–APR)	DRY SEASON (MAY–OCT)	ANNUAL TOTAL	WET SEASON (NOV–APR)	DRY SEASON (MAY–OCT)
Avg 5-day cumulative (mm)	Central	189.00 (130, 344)	137.72 (87.22, 236.4)	31.03 (87.2, 236)	209.27 (144, 353)	157.02 (93.5, 256.7)	29.75 (8.5, 43)
	Southern	251.48 (121, 402)	169.01 (83.5, 270)	37.07 (83.5, 270)	239.56 (130, 437)	177.94 (92.6, 285)	35.40 (11.2, 51)
	Northern	163.25 (125, 291)	135.64 (86.25, 204)	29.82 (86.2, 204)	173.94 (124, 295)	138.72 (87.3, 212.8)	28.83 (7.8, 40)
Avg 1-day (mm)	Central	77.88 (48, 134)	56.97 (33, 94)	13.38 (4.4, 20)	84.99 (52, 153)	46.82 (33.4, 100)	12.88 (4.3, 20)
	Southern	105.37 (48, 165)	66.21 (32, 108)	16.68 (7, 25)	102.30 (52, 173)	70.39 (34.7, 114)	16.15 (6, 30)
	Northern	64.59 (42, 106)	50.79 (30, 82)	12.41 (4, 19)	69.54 (45, 122)	53.31 (31, 85)	12.05 (4, 20)
Consecutive wet days (days)	Central	103.21 (77, 152)	16.6 (10.7, 23)	1.5 (0.6, 4)	103.25 (74, 155)	16.44 (10.2, 23.3)	1.5 (0.5, 3.7)
	Southern	90.53 (60, 152)	13.6 (7.8, 22)	2.4 (0.9, 5)	91.66 (55, 154)	13.4 (7.6, 22)	2.3 (0.9, 5)
	Northern	115.17 (80, 169)	18.7 (11.5, 25)	1.3 (0.4, 5)	115.71 (72, 172)	17.9 (10.5, 25)	1.2 (0.4, 4.4)

Source: World Bank Climate Change Knowledge Portal

Regions, especially the Balaka, Chikwawa, and Nsanje districts, have historically been the most vulnerable to meteorological and hydrological drought conditions, with the Southern Region at the highest overall risk.²¹

22. The projected declines in precipitation are very likely to increase the frequency and intensity of drought events. By the 2050s, rainfall during the dry season is projected to become scarce enough that the projected number of consecutive dry days during August–October will nearly equal the number of days in each month. Further, the number of consecutive dry days in November in all regions is projected to be around 18 days. As maize is commonly planted in November throughout Malawi, the late onset or the lack of rain as early as November may continue to impact food security and nutrition outcomes, in the absence of drought-tolerant maize varieties and conservation agricultural practices.

CYCLONES

23. Although cyclonic events have historically been infrequent in Malawi, they have become more common over the last decade, characterized by greater intensity and associated destruction. Since 2012, Malawi has experienced more cyclonic events than from 1946–2008 combined.^{22,23,24} According to the Assessment Report 6 of the Intergovernmental Panel on Climate Change (IPCC AR6 2021), it is likely that the proportion of major cyclones will increase, coupled with an increased severity of these events in Malawi.²⁵ Since 2019 alone, four cyclonic events have occurred — two of which have been among the most devastating the country has ever experienced. Cyclone Idai (2019) affected an estimated one million people in Malawi's Southern Region, resulting in the destruction of

300,000 homes, the displacement of approximately 87,000 people, and 60 deaths.²⁶ Heavy rainfall, approximately 255 mm within a 24-hour period, resulted in flooding in 15 out of 18 of Malawi's districts.²⁷ Cyclone Ana (2022) is estimated to have affected nearly 1 million people, displaced over 220,000, injured 206, and killed 46. Waterborne diseases (WBDs), particularly diarrheal diseases, in the disaster camps constructed to house displaced and affected persons are a common concern in the aftermath of cyclonic events.²⁸ Moreover, cyclones can have devastating cross-sectoral impacts across sectors that include energy, transport, healthcare service delivery, and food security.²⁹ Malawi's Southern Region is the most vulnerable area to cyclones and it is where 75 percent of the country's hydro-electric power stations are located.³⁰

LANDSLIDES

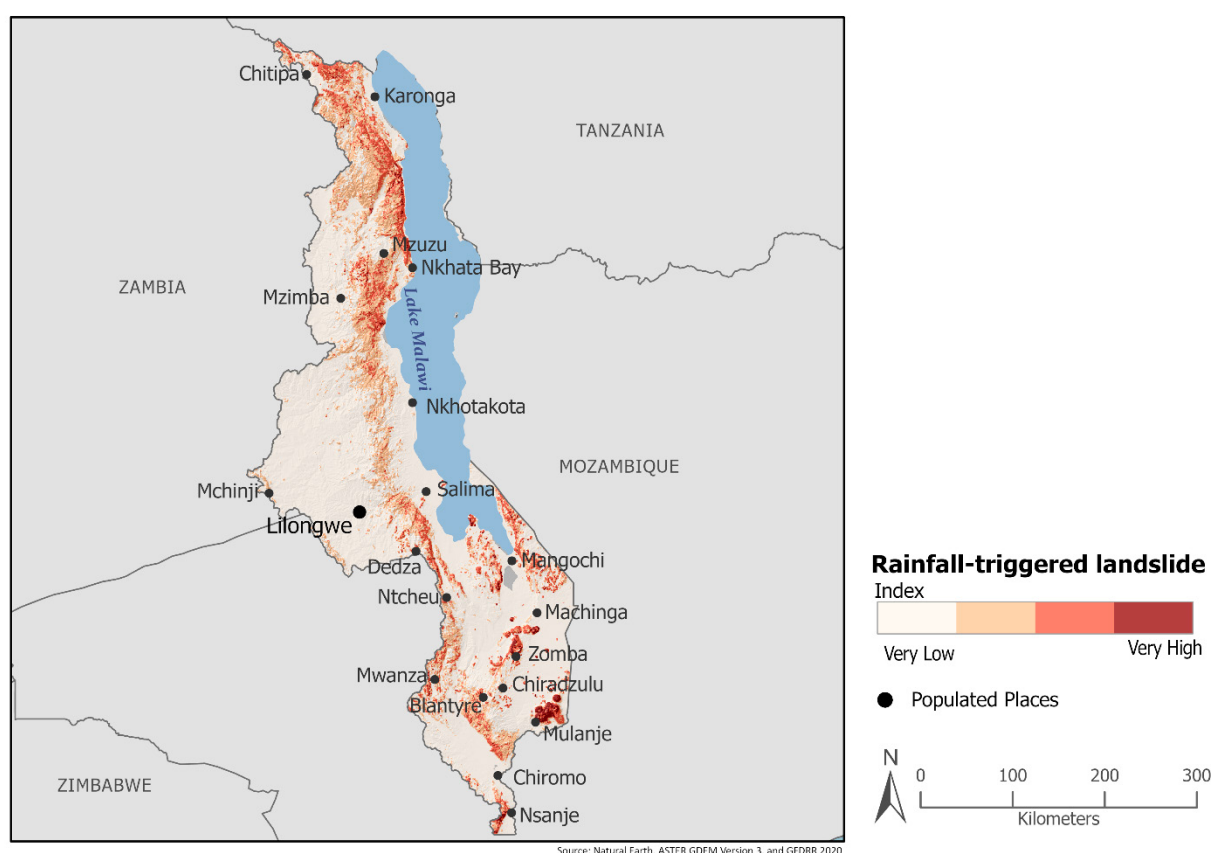
24. The most vulnerable areas of Malawi to landslide risks are located in the country's highlands, mountains, and the isolated mastiffs of the Southern Region (Figure 5). Landslides often result from a combination of factors, most of which are not directly influenced by weather or climate (for example, terrain, tectonic activity, soil type, and land cover), except for intense or prolonged rainfall. Rainfall can trigger landslide events by saturating slope's soils, therefore leading to slope instability and subsequent landslides. The conditions that produce landslide events can take hours or, in some cases, days to develop.³¹ The most devastating landslides in recent years include the 1991 Phalombe landslide, the 1997 Banga landslide, and the 2019 landslide event in the Rumphi district.

25. Projected increases in the intensity of rainfall events through the mid-century will

exacerbate landslide risks across Malawi, especially in the Southern Region. In the Southern Region, the projected median average largest 1-day precipitation in January and February will be approximately 75 mm in the 2030s and 80 mm in the 2050s. This amount of precipitation over such a short time, coupled with normal rainy season rainfall

totals, is very likely to aggravate and intensify slope failures in highland areas. The models suggest that, on average, 10 fatalities will be associated with landslide events annually, along with structural damages amounting to USD150,000 on average. By 2050, the number of persons affected by landslide events could increase from one to 300.³²

FIGURE 5.
Rainfall-triggered landslide hazard index in Malawi



Source: Natural Earth, ASTER GDEM Version 3, and GFDRR 2020.

KEY MESSAGES

- The mean annual temperatures have risen by 0.64°C over the past half century in Malawi, occurring alongside increases in the minimum (0.60°C) and maximum (0.68°C) temperatures. Extreme heat exposure is projected become more frequent through the mid-century, with the Southern Region at greatest risk.
- The average annual rainfall in Malawi has declined by nearly 100 mm since the 1960s, most notably during the dry season, and is expected to continue to decline compared with historic levels through the mid-century.
- Extreme precipitation is projected to increase for the 2030s and 2050s, thus exacerbating flooding risks during the rainy season, especially in the Southern Region.
- Projected declines in precipitation are very likely to increase the frequency and intensity of drought events.
- Although cyclones have been historically infrequent, they have become more recurrent in the last decade. Projections estimate that cyclones will become more severe under the climate change high-emissions scenarios.
- The escalating intensity of rainfall events, predicted through the mid-century, are expected to exacerbate landslide risks across Malawi, especially in the Southern Region, this would triple the affected population by 2050.



CLIMATE-RELATED HEALTH RISKS

26. Malawi faces a multitude of health challenges from communicable diseases (CDs) and non-communicable diseases (NCDs), which will likely be exacerbated by climate change.

In 2019, life expectancy in the country was 65.62 years, giving it a ranking of 17th out of 49 countries within the Sub-Saharan Africa (SSA) region.³³ CDs represent the largest share of the overall burden of disease: six of the leading 10 causes of premature mortality are attributable to CDs, along with maternal, neonatal, or nutritional diseases,³⁴ many of which are climate-sensitive (for example, diarrheal disease, malaria, tuberculosis, and lower respiratory infection). AIDS and neonatal disorders have been the two leading causes of death since 2009. Malawi's HIV prevalence among adults is one of the highest in SSA,³⁵ and climate change is already threatening the progress made in the fight against HIV by undermining food security, doubling the burden of infectious diseases, causing human migration, limiting access to HIV treatment, and eroding the public health infrastructure.³⁶

27. The risks to health outcomes from the climate are not evenly distributed within the population: some groups are at greater risk than others.

The factors that affect a population's vulnerability to climate are often similar to those that affect health more broadly.³⁷ Therefore, climate may further exacerbate health inequalities, especially among certain vulnerable population groups, including the poor, rural populations, those living in informal urban settlements, women and young children, the elderly, those living with pre-existing conditions and disabilities, and displaced populations. Therefore, investments in adaptation and mitigation measures must carefully consider groups who would directly benefit from or may be disadvantaged by adopted measures.

28. Malawi's CHVA assesses seven climate-related health risk categories.

They include (a) risks to nutrition, (b) vector-borne disease (VBD) risks, (c) WBD risks, (d) heat-related risks, (e) air quality health risks, (f) mental health and well-being challenges, along with (g) the direct injuries and mortalities related to natural hazard events. Each category is assessed, in terms of current and future risks, with considerations for both national and subnational peculiarities, where possible. It is important to note that these risk categories represent only the most pressing health risks to the population in Malawi. Other climate-related health risks have not been included in this assessment, and they may include, but are not limited to, direct injuries and mortalities associated with natural hazard events.

NUTRITION RISKS

29. Weather and climate are the foundational drivers of healthy and sustainable diets.

The mechanisms by which climate change affects nutrition via the food system are profound; they exert acute and chronic effects on agricultural production, storage, processing, distribution, and consumption. Nutritionally secure and stable diets not only depend on agricultural production but also the complex interactions of demand, economics, legislation, conflict, food waste, nutrient losses, food safety, and access.³⁸ Climate variability is already contributing to increases in global hunger and malnutrition. While a comprehensive analysis of climate change's impact on the food system is beyond the scope of this assessment, this CHVA examines climate and nutrition linkages through a food security lens in Malawi, as it relates to the weather and climate impacts on agricultural productivity. Agricultural productivity, which is a key determinant of food availability, is affected by weather and climate in a multitude of ways, from short-term shocks (for example, natural disasters) to longer-term changes in agroecological conditions that can drastically reduce yields or redefine the spatio-temporal patterns of crop suitability.

30. Food insecurity and malnutrition are chronic, and they are worsening challenges throughout Malawi, with profound impacts on human capital, economic growth, and development. In 2019, an estimated 81 percent of the population (15.2 million) lived with moderate to severe food insecurity³⁹ and 17.3 percent of the population (3.2 million) was undernourished.⁴⁰ Women and children are especially vulnerable to malnutrition in Malawi: approximately 31 percent of women of reproductive age are anemic,⁴¹ as are 55 percent of children under the age of five.⁴²

Further, 41 percent of the children in the under-five age category are stunted (have a low height for their age)⁴³ and 0.6 percent experience wasting.⁴⁴ Stunting has historically been the most prevalent in the Central Region, while the average household caloric intake shortfalls have occurred most often in the Southern Region.⁴⁵ The consequences of malnutrition, especially in children, are far-reaching, with profound implications on human and physical capital, which can constrain a country's overall economic growth and development. It is estimated that Malawi's high levels of stunting and malnutrition have led to an annual estimated loss of USD597 million, due to the lowered labor productivity and the high costs of healthcare.⁴⁶

31. The quantity, both in terms of food availability and calories consumed, and the quality of food products play a considerable role in the nutrition outcomes. Additional drivers of malnutrition include poor feeding practices and infectious diseases, such as diarrhea.⁴⁷ Dietary diversity in Malawi is low, with diets heavily dominated by maize to the point that food security in Malawi is often equated with sufficient access to maize.⁴⁸

Smallholder farming is the backbone of Malawi's economy: 94 percent of the rural population and 38 percent of the urban population are engaged in agriculture.⁴⁹ Nearly all farmers (95 percent) are subsistence farmers: essentially, they are farming to meet their households' food requirements and / or sell at local or regional markets. Maize is cultivated by approximately 97 percent of farmers throughout the country.

32. Food security and poor nutrition outcomes in Malawi are compounded by shifting climate baselines and shocks, including climate-related hazards. The Southern Region,

responsible for approximately one-third of the maize production, is highly vulnerable to floods that annually cause approximately 12 percent of maize production losses. Likewise, droughts are responsible for approximately 4.6 percent of maize production losses each year.

Nutrition surveying, conducted from November to December 2020 in Malawi's flood- and drought-prone areas, showed that the prevalence of global acute malnutrition and the proportion of underweight children in the Shire Valley in the Southern Region was higher than elsewhere in the country and was increasing.⁵⁰ Perhaps the most profound example of the direct climate impacts on food security in Malawi was the 2015/2016 drought in the Southern and Central Regions and the subsequent flooding in the Northern region: they resulted in an overall maize production decline of 42 percent compared with the 2013/2014 season³¹ and left nearly 40 percent of the population in need of food assistance.⁵¹

33. Projected warmer temperatures and water deficits, along with the increasing frequency and intensity of climate-related hazards, are very likely to aggravate food insecurity and nutritional deficiencies, with significant geographical variations. The agricultural sector is overwhelmingly dependent on rainfed agriculture for crop production: only 5 percent of farmers use irrigation throughout the country; this thus makes the sector highly susceptible to climate change.²⁹ Maize yields are highly sensitive to water deficits and temperatures over 35°C,⁵² erratic rainfall and changing temperatures therefore risk significantly reduced maize production. In response to this, irrigation, fertilizers applied to support crops, and the adoption of drought-resistant maize varieties are common adaptation

measures under consideration throughout Africa, including Malawi.

Projections of maize yields in Malawi show important geographic variations. Maize yields are expected to increase across the highlands and, to a lesser degree, the western plateau: the warming temperatures at these elevations provide comparatively more optimal conditions for growing. Conversely, yields are expected to decline in the Southern Region due to even higher temperatures leading to more rapid phenology, higher evapotranspiration, and added water stress.⁵³ While food security and nutrition in Malawi is not entirely dependent on maize, it does represent 60 percent of the caloric intake for the majority of the population. Therefore, production shortfalls are very likely to aggravate food insecurity, especially at the household level in the Southern Region where temperatures continue to increase, along with prolonged dry spells and recurrent flooding.

VECTOR-BORNE DISEASE RISKS

34. Weather and climate are the foundational drivers of spatio-temporal vector-borne disease (VBD) distribution and transmission dynamics. Climate variability causes vector and host ranges to expand or contract, thereby shifting disease distribution and seasonality, and / or facilitating the emergence or re-emergence of VBDs. Investigating species distribution and the seasonality of vectors is invaluable for understanding plausible VBD distributions and planning efficient, spatially targeted methods of control. This assessment focuses on malaria — the most important VBD in Malawi. Though there are other VBDs (for example, schistosomiasis, dengue, and chikungunya) present in Malawi, there is limited information and surveillance.⁵⁴

Spatial models were constructed to demonstrate the plausible spatial distributions of the vectors of malaria to assess the risk propensity of these diseases. The results of these analyses should be taken as a conservative estimation of the areas of Malawi that provide suitable conditions for vector breeding and the suitable conditions for vector breeding where humans are present (that is, populated areas). For further information on the modeling methodology and the inputs, see Annex C.

MALARIA

35. Despite a long history of prevention and control efforts in Malawi, malaria remains endemic, constituting the leading cause of morbidity and mortality in children under five. In 2020, there were an estimated 4.3 million cases and 7,100 deaths; *Plasmodium falciparum* is the most common form of infection.⁵⁵ Data from the 2017 Malaria Indicator Survey show that 24.3 percent of children aged six to 59 months tested positive for malaria via microscopy, ranging from 11.2 percent in the Northern Region to approximately 26.0 percent in the Central and Southern Regions.⁵⁶ Malaria transmission is seasonal throughout the country, peaking during or just after the

conclusion of the rainy season. The primary mosquito vectors responsible for transmission are *Anopheles funestus*, *Anopheles arabiensis*, and *Anopheles gambiae* s.s.⁵⁷ they are widely considered to be among the most efficient of all the malaria vector species at transmitting malaria.

36. The malaria transmission risk in the Southern Region is expected to decline in the 2050s due to ongoing climate change, while the transmission throughout the remainder of the country is expected to remain stable.

The suitability for malaria vectors through the mid-century is projected to largely remain unchanged throughout the country, as projected temperature increases will not exceed the thermal tolerance of malaria vector species. Only in the Southern Region during the 2050s, near Nsanje, will temperature increases likely limit the Anopheline vector survival (Figure 6). The projected decline in the suitable area is estimated to reduce the vulnerable population by approximately 300,000 people (Table 3).

37. The geography of the malaria risk in Malawi through the mid-century is expected to be affected by the human modification of the

TABLE 3.

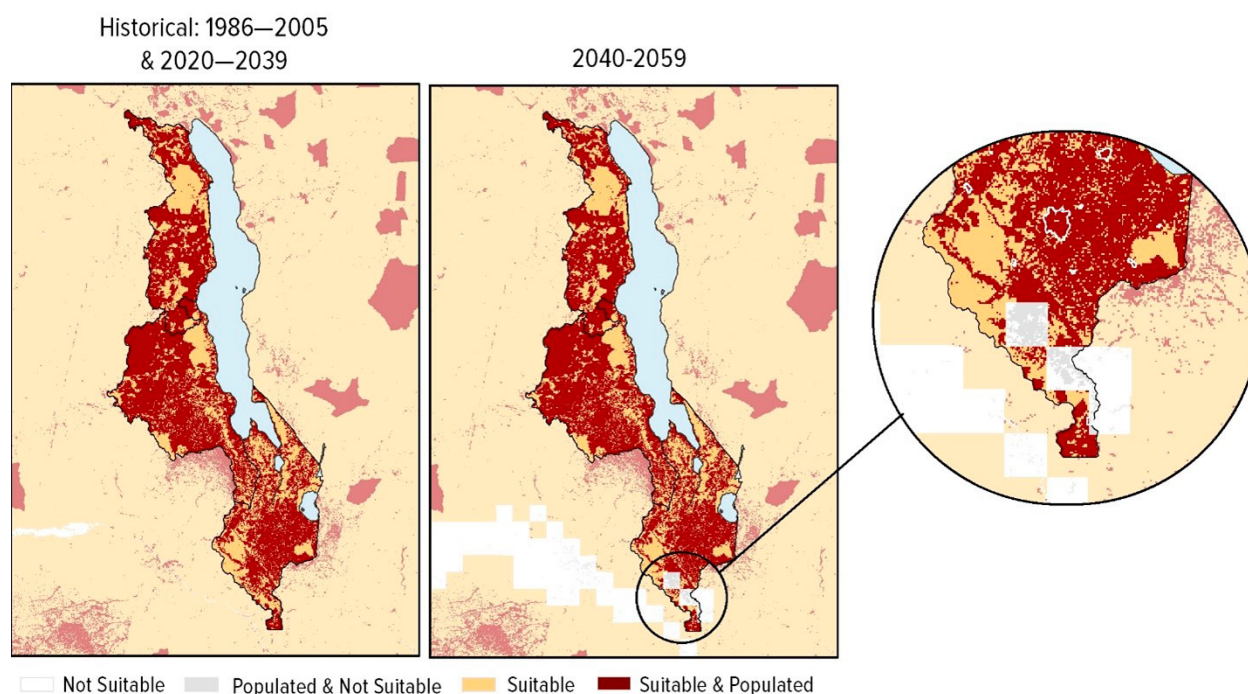
Projected percentage of suitable habitat area, by region, for the malaria vector species in Malawi, under RCP8.5, through the mid-century

	PERCENT AREA					
	POPULATED, SUITABLE		OVERALL SUITABILITY			
	Historic & 2030s	2050s	Historic & 2030s	2050s	Historic & 2030s	2050s
Central	72.71	72.71	99.86	99.86	7,432,016	7,432,016
Northern	62.60	62.60	99.14	99.14	2,309,787	2,309,787
Southern	55.35	97.45	52.68	92.89	7,486,733	7,181,201
TOTAL					17,228,536	16,923,004

Sources: Temperature (NASA, NEX-GDDP) Land Cover (Copernicus Global Land Service, Proba-V-C3), Water Resources (European Commission's Joint Research Centre, GSW1_0), Flow Accumulation (World Wide Fund for Nature, HydroSHEDS), Population (European Commission's Joint Research Centre, GHSL/P2016/POP_GPW_GLOBE_V

FIGURE 6.

Comparison of the suitable area for the malaria vector species in Malawi under Representative Concentration Pathway (RCP) 8.5, across three epochs: 1986–2005 (historical baseline), 2020–2039, and 2040–2059



Sources: Temperature (NASA, NEX-GDDP), Land Cover (Copernicus Global Land Service, Proba-V-C3), Water Resources (European Commission's Joint Research Centre, GSW1_0), Flow Accumulation (World Wide Fund for Nature, HydroSHEDS), Population (European Commission's Joint Research Centre, GHSL/P2016/POP_GPW_GLOBE_V)

Note: The analysis was conducted prior to the CMIP6 release.

landscape for irrigated agriculture; the adoption of malaria prevention, treatment, and control strategies; and ongoing climate changes. As this analysis has shown, the temperature and precipitation changes in Malawi through the mid-century will likely not substantially impact the geography of vector breeding throughout the country. However, what cannot be accurately projected are the human-induced changes to land use and land cover (LULC), which can have profound implications on the distribution of malaria vector species. For example, in response to food insecurity concerns, including those associated with climate variability and changes' impact on agricultural production, the government of Malawi has adopted several national policy

frameworks to promote the expansion of irrigated agriculture throughout the country (for example, the Green Belt Initiative, the National Irrigation Policy, and the National Agriculture and Investment Strategy [NAIP]). While irrigated agriculture can increase crop production, the agrarian transformation of the landscape for irrigation is also associated with several water-related diseases including malaria, thereby exacerbating the malaria risk. Recent findings from the Bwanje Valley Irrigation Scheme in central Malawi demonstrate that proximity of human dwellings to irrigated agriculture significantly influences malaria risk. Individuals whose households were located within three kilometers of the irrigation scheme had a significantly higher

prevalence of malaria infection than those residing further away.⁵⁸ As Malawi expands its irrigated agriculture throughout the country in response to food security concerns (including those driven by the climate impact on agricultural production), its vulnerability to malaria infection is very likely to change in distribution, thus placing communities closer to irrigated schemes at greater risk than others.

WATER-BORNE DISEASE RISKS

38. The burden of waterborne diseases (WBDs) throughout Malawi is significant, with high rates of morbidity and mortality across the country, especially among children under five years of age. Approximately 50 percent of all illnesses are attributable to WBDs, especially diarrheal illnesses including cholera. Diarrhea alone accounts for an estimated 8,000 deaths per year, with the highest burden among children under five years old.⁵⁹ In 2017, diarrhea accounted for 7 percent of under-five mortality.⁶⁰

The prevalence of WBDs in Malawi is primarily attributable to the poor water quality stemming from water contamination, coupled with the lack of access to an improved drinking water source and poor sanitation, each of which may be affected by weather and climate change. Findings from the Malawi Demographic and Health Survey (2015–2016 MDHS) show that within the two weeks before the survey, 22 percent of children under the age of five had diarrhea, with those aged six to 11 months comprising 41 percent of the cases.⁶¹ Prevalence rates were highest in the Central Region (24 percent) and lowest in the Northern Region (17.8 percent) (Table 4).

39. Climate change can impact water quality and associated WBDs through several pathways, including temperature increases, flood events, and drought conditions. Rising temperatures can facilitate the proliferation of waterborne bacteria and algal toxins, while flood waters can be contaminated with human and animal waste, as well as agricultural and other pollutants. Further, flies and other pests

TABLE 4.

Two-week prevalence of diarrhea in children under five years in Malawi, 2017

PERCENTAGE WITH DIARRHEA	
Region	
Central	24.0
Northern	17.8
Southern	20.4
Source of Drinking Water	
Improved	21.3
Unimproved	21.0
Type of Toilet Facility	
Improved	19.9
Shared	24.3
Unimproved Sanitation	21.9

Source: Demographic Health Surveys in Malawi, 2017.

proliferate in flood waters, risking food contamination. Bacterial pathogens attach to leafy crops, such as lettuce, under both flooding and drought conditions.⁶² Just as significantly, droughts affect not only water quality but may also exacerbate WBD risks through limiting water quantity. A limited water supply can force populations to use contaminated water for drinking, bathing, and agricultural irrigation.

Flooding and drought events, which are common in Malawi, are often associated with WBD outbreaks, especially in the lowlands of the Southern Region and, to a lesser extent, in the Central Region. For example, flash floods, following the heavy rains from December 2008 through April 2009, triggered a cholera outbreak in southeastern Malawi. During this period, Malawi's MoH reported a total of 5,198 cholera cases and 113 deaths throughout the country, especially in the southern fishing districts of Machinga, Phalombe, and Zomba on the shores of Lake Chilwa and the central district of Lilongwe.⁶³ Additionally, in March 2022, a cholera outbreak was declared in the southern districts of Machinga and Nsanje in the aftermath of Tropical Cyclone Gombe.⁶⁴ Furthermore, poor rural households, especially those located in the lowlands of the lower Shire Valley, are more likely to be displaced by floods caused by erratic rains, which increase their vulnerability to WBDs due to the limited access to safe drinking water and proper sanitation; there is also the increased incidence of WBDs in displacement camps.^{65,66} Despite the strong association between climate and WBDs, the exact attribution of Malawi's burden of WBDs to climate change is unknown.

40. The projected increases in the intensity of precipitation in Malawi will likely increase the occurrences of floods and droughts, with implications on the frequency of WBD

outbreaks. The predicted increase in flash floods may overwhelm the country's sanitation sewer and drainage systems, resulting in contaminated drinking water sources, especially in the urban areas of Lilongwe, Blantyre, Zomba, and Mzuzu. An increase in WBDs will overwhelm the already fragile health system.⁶⁷ Further increases in temperatures are also likely to compromise drinking water quality through reduced water levels and increase in water temperatures leading to high nutrient concentrations. Droughts will likely be more frequent, thus causing water scarcity and forcing communities in drought-prone areas, especially Nsanje, Chikwawa, Zomba, Salima, and Karonga,⁶⁸ to resort to unsafe, contaminated water sources for drinking water, such as watering holes and ponds. As Malawi works to eliminate poverty, climate shocks and natural disasters will continue to frustrate these efforts by exacerbating social and economic inequalities, increasing the WBD burden among the poor, and limiting the adaptive capacity of this vulnerable group.

HEAT-RELATED MORBIDITY AND MORTALITY RISKS

41. The health risks of heat are wide-ranging, including effects on mortality, heat-related injuries, mental health, and well-being. The health effects caused by heat include the direct effect of heat stress, as well as heat rash, cramps, exhaustion, dehydration, and the acute exacerbation of pre-existing conditions including respiratory diseases and cardiovascular diseases (CVDs).

Longer-term mental health risks are also an important effect to consider. In addition to the impacts on individuals, the whole-of-population exposure that occurs with an extreme heat event can lead to significant increases

in hospitalizations, thus imposing strains on the country's health system.⁶⁹ Further, increased heat stress has reduced labor productivity in Malawi: in 1995, the working hours lost from heat stress, estimated at an equivalent of 8,000 full-time jobs at that time, is projected to increase to 47,000 by 2030.⁷⁰

42. Extreme heat and its impact on excess heat-related morbidity and mortality are very likely to increase under the high- and low-emissions scenarios in Malawi. Historically, “very hot days” ($\geq 35^{\circ}\text{C}$) have mostly affected the Southern Region for approximately 40 days per year, which occur predominantly in October and November. As the climate section of this report described, however, projected increases in temperatures and the number of very hot days will become more common throughout the country through the mid-century. This trend will place the populations of the Southern Region at particular risk for excess heat-related morbidity and mortality, with a disproportionate burden on the elderly, children, and those with chronic illness.

Routine statistics of annual heat-related morbidity and mortality in Malawi are not available. However, the modeled annual heat-related deaths in SSA for 2000–2019, estimated at 2 per 100,000 (95 percent CI:1–3),⁷¹ could be extrapolated to the Malawi context to show that there could be nearly 400 heat-related deaths annually. By 2080, under a high-emissions scenario, this number would increase to 73 per 100,000 and 16 deaths per 100,000 under a low-emissions scenario.⁷² With the increased prevalence of NCDs, the risk of rising temperatures is currently and will continue to be compounded by poor housing, urban and rural poverty, water insecurity, and an aging population.

AIR QUALITY RELATED HEALTH RISKS

43. The high levels of pollution from harmful airborne particulates have led to an increased incidence of illness and deaths stemming from chronic lung diseases and acute respiratory infections among the population. Chronic and acute respiratory diseases (CARD), including pneumonia, tuberculosis (TB), asthma, cystic fibrosis, and chronic obstructive pulmonary disease, continue to be a major health issue in Malawi. Acute respiratory infections (especially pneumonia) are one of the most common causes of morbidity and mortality among children under five, causing over 70 percent of hospital visits and 6–40 percent of deaths.⁷³

The major cause of CARD in Malawi is exposure to indoor and ambient air pollution (AAP). In their study on air pollution in rural Malawi, Saleh et al. (2021) reported a high concentration of fine particulate matter with a diameter of less than 2.5 micrometers ($\text{PM}_{2.5}$) at 35.2 micrograms per cubic meter ($\mu\text{g}/\text{m}^3$) (24-hour mean); this figure is higher than the World Health Organization's (WHO) recommended 24-hour mean of 15 $\mu\text{g}/\text{m}^3$.⁷⁴ The main sources of air pollution in Malawi are biomass, charcoal burning, vehicle emissions, waste incineration, tobacco processing, and industrial emissions. An estimated 95 percent of people use biomass (firewood and charcoal) as the main source of household energy, especially for cooking and heating, making household air pollution the leading cause of respiratory illnesses and diseases in the country. Women and children, especially girls, experience higher exposure to air pollution from biomass due to their customary role in cooking. Young children are equally exposed to indoor air pollution because of their regular proximity to their mothers during cooking.

44. The changes in the precipitation patterns of Malawi's rainy season will indirectly influence the air quality health outcomes via exposure to indoor biomass air pollution.

The exposure to biomass air pollution increases during the rainy season when cooking must be done indoors in rooms with, at best, poor ventilation. Further, during the rainy season, there is limited access to dry wood for burning. Wet firewood is not only harder to burn but also produces more smoke, thereby increasing air pollution. As the climate section of this assessment has shown, overall precipitation is likely to decline in Malawi; however, what is less certain and most important in this instance is the frequency and timing of rainfall events, because they relate to cooking times and subsequent exposures to biomass air pollution.

45. The predicted temperature increases by 2050, coupled with high wind speeds and prolonged droughts, are likely to increase the frequency of wildfires and the associated deterioration of air quality in Malawi. Malawi, especially in the dry months of August through November, is already experiencing an increase

in the number of wildfires, estimated at 153 each year.⁷⁵ Prolonged droughts will likely increase the frequency, intensity, geographic proximity, and length of the wildfire season in Malawi, thus worsening wildfire-induced air pollution. Rising temperatures and atmospheric carbon dioxide will likely extend the allergy season due to its impact on plant phenologies. Although not well-documented in Malawi, recent research elsewhere has shown that poor air quality is significantly associated with the risk of autoimmune diseases,^{76,77} such as connective tissue disorders, inflammatory bowel diseases, and rheumatoid arthritis.

DIRECT INJURIES AND MORTALITY

46. Mortalities and direct injuries in Malawi are often associated with heavy rains-induced flash floods, mudslides, and landslides.

Globally, floods are one of the leading causes of natural disaster-related injuries and mortalities; they were responsible for over 6,000 deaths in 2020 alone. In Malawi, Tropical Storm Ana led to 33 deaths, displaced over 100,000 people, and affected over 200,000 households.⁷⁸ The

TABLE 5.

Extreme weather event related, injuries, and mortality in Malawi from 2000 to 2022

EXTREME EVENTS	SUBTYPE	EVENTS COUNT	TOTAL DEATHS	TOTAL AFFECTED
Flood	Flash flood	5	21	192,246
	Riverine flood	15	297	1,052,301
	Coastal flood	2	67	518,500
	Other	9	73	1,334,070
Drought	Drought	5	500	17,049,435
Landslide	Landslide	1	8	109
Storm	Convective storm	2	18	55,901
	Tropical cyclone	3	60	116,958
	Other	1	11	19

Source: The International Disasters Database (2022). <https://public.emdat.be/data>.

Central and Southern Regions, especially the districts of Chikwawa, Phalombe, Nsanje, and Zombe, are particularly susceptible to flooding.

MENTAL HEALTH AND WELL-BEING RISKS

47. Severe weather related to climate change impacts the livelihoods and the well-being of individuals and communities.

Notably, the impact of climate change-related events on mental health can be direct or indirect, and short-term or long-term. Acute events (for example, floods and cyclones) can precipitate psychopathological experiences of traumatic stress, depression, anxiety, loss, and grief, which can even lead to suicide. In the case of exposure to extreme or prolonged weather-related impacts, it may result in delayed mental impacts, such as the symptoms of post-traumatic stress in the future or the psychological impacts on younger generations.⁷⁹

48. Mental health in Malawi has been an ongoing challenge for public health: 20–28.8 percent of primary care patients are diagnosed with common mental disorders.

⁸⁰ Overall, mental disorders constitute a burden of disease of 1,348.07 per 100,000 disability adjusted life years (DALYS) in the country, with depressive disorders (including anxiety) specifically constituting 497.58 per 100,000 DALYS.⁸¹ Despite the high prevalence of common mental disorders, mental health services in the country are scarce. Addressing mental health is also exacerbated by stigma, cultural beliefs, and a lack of scientific knowledge on the impact of climate change on mental health. The precise impacts of climate and climate-related events on mental health outcomes in Malawi are unknown.

49. People in Malawi face a double mental health burden from the consequences of climate-related events, coupled with the lack of access to mental health services.

Mental health and overall well-being are affected by contextual and societal factors that do not necessarily cause mental disorders, though they can affect overall mental well-being by curtailing the cognitive energy needed to develop the coping mechanisms to deal with the increasing intensity of extreme weather events. Chronic exposure to food insecurity has also been shown to decrease overall mental energy, as well as affecting individual and collective resilience. Exposure to extreme weather events, such as floods and storms that end up affecting livelihoods, can abruptly impact mental health, leading to symptoms that are similar to those of the post-traumatic stress disorder.⁸²

50. Rural farming communities are more vulnerable to the mental health consequences of events related to climate change.

The impacts of climate change hazards, such as floods, storms / winds, and droughts, threaten the limited sources of livelihood — mainly the crop yields available for local communities, thereby causing stress, distress, and mental disorders including anxiety and depression, as well as unhealthy coping behaviors like gender-based violence, alcoholism, and substance abuse.⁸³ The impacts of climate change on mental health and well-being can be worsened by poverty, food insecurity, and the sudden loss of property, along with personal or family diseases and illness, among others.⁸⁴ After experiencing these cumulative shocks, these households would be even less able to develop effective coping mechanisms that are built upon structural and social support,⁸⁵ therefore, worsening their well-being and prospects of improving their livelihoods.

TABLE 6.

Summary of the Climate Change Risks on Health Outcomes

	CURRENT RISK	PROJECTED RISK
Food Security and Nutrition 	- Food security and malnutrition are chronic and worsening problems in Malawi. - Food security and poor nutrition outcomes are being compounded by shifting climate baselines and shocks, including climate-related hazards.	- Projected warmer temperatures and water deficits, along with the increasing frequency and intensity of climate-related hazards, will aggravate food insecurity and nutritional deficiencies, by causing production shortfalls of maize. - While maize yields are projected to increase across the country's highlands and the western plateau, they will likely decline in the Southern Region.
Vector-borne Diseases 	- Malaria is the leading cause of morbidity and mortality in children under five. - The prevalence in 2017, according to microscopy, was 24.3 percent among children aged 6–59 months at the national level. - The prevalence of malaria is highest in the Central and Southern Regions (approximately 26 percent) compared with the Northern Region (11.2 percent).	- Malaria transmission risk in the Southern Region will decline in the 2050s due to ongoing climate change, thus reducing the vulnerable population by around 300,000 in the region. The transmission for the remainder of the country is likely to remain stable. - The geography of malaria risk in Malawi through the mid-century will likely be attributable to the human modification of the landscape for irrigated agriculture and the adoption of malaria prevention, treatment, and control strategies, as well as ongoing climate changes.
Waterborne and Water-related Diseases 	- Water-borne diseases (WBDs) are among the leading causes of illnesses and child mortality in Malawi. - Floods are associated with diarrhea and cholera outbreaks in the country, due primarily to the fecal contamination of water sources. - High temperatures, associated with droughts, affect drinking water quality due to eutrophication and algal growth.	- Projected increases in extreme rainfall and related floods will increase drinking water contamination and WBD outbreaks, especially in the Southern and Central Regions of Malawi. - Drought-induced water scarcity will force more households to use unsafe drinking water sources, leading to an increase in waterborne illnesses and WBDs.
Heat-related Morbidity and Mortality 	Estimating heat-related morbidity and mortality in Malawi is challenging, in the absence of routine vital health statistics on heat-related illnesses.	- Extreme heat, as well as its impact on excess heat-related morbidity and mortality, will increase under high- and low-emissions scenarios in Malawi. - The Southern Region is at the highest risk for excess heat-related morbidity and mortality through the mid-century.

Air Quality and Respiratory Health



- Chronic and acute respiratory diseases, triggered by air pollution, are a major health issue.
- The use of biomass energy for cooking and heating is the leading cause of indoor air pollution in Malawi. Women and children from low-socioeconomic status households are comparatively more vulnerable to acute and chronic respiratory diseases associated with biomass air pollution than their socioeconomically advantaged counterparts.
- Rising temperatures and precipitation will likely increase the occurrences and spread of wildfires, thereby increasing air pollution and the incidences of Chronic and Acute Respiratory Diseases.
- The expected increase in air quality deterioration will likely increase the emergence and frequency of autoimmune diseases among the population.
- With increased air pollution, NCDs, including strokes, chronic obstructive pulmonary diseases, asthma, and ischemic heart diseases, will likely become the leading cause of the disease burden and deaths in Malawi.

Direct Injuries and Mortalities



- Floods are responsible for most deaths and injuries.
- Heavy rains-induced flash floods, mudslides, and landslides threaten lives and livelihoods in Malawi.
- Projected increases in flooding, related to increasing temperatures and precipitation, will likely cause more deaths and direct injuries.

Mental Health and Well-being



- More than 20 percent of primary care patients are diagnosed with common mental disorders.
- Extreme weather events, such as cyclones, have a direct impact on mental health. They can lead to the development of symptoms of traumatic stress, anxiety, and depression after the climate shock.
- Rural farming communities have exhibited comparatively worse mental health and well-being issues during floods and prolonged drought periods than urban communities.
- Based on the projections indicating that cyclones will increase in intensity and drought periods would be prolonged, these climate trends will likely worsen mental health and well-being outcomes.
- The rural communities' strong dependence on subsistence farming and the possible losses of livelihoods will have a compounding effect on population mental health and well-being.

ADAPTIVE CAPACITY OF THE HEALTH SYSTEM

HEALTH SYSTEM OVERVIEW

51. The health services in Malawi are diverse: they include the government or the public sector, the private not-for-profit sector (PNFP), and the private for-profit sector (PFP). The public sector, which provides about 60 percent of all the health services, is organized under a four-tier referral system: community, primary, secondary, and tertiary.⁸⁶ Health services are also provided by the Christian Health Association of Malawi (CHAM) — the largest nongovernmental health service provider in the private sector. Community health workers (CHWs), traditional healers (THs), herbalists, and traditional birth attendants (TBAs) also provide health services, particularly in the remote rural areas of Malawi, where there is limited access to health facilities.

52. The health sector in Malawi faces several managerial, financing, and staffing challenges.

The public health sector provides services at no cost to the whole population under the Essential Health Package (EHP). However, informal payments, inadequate staffing, the limited domestic resources available, the constant stockouts of essential medicines, the poor coordination between health providers, and the low service delivery leave most of the poor population with no health services, especially in the rural communities.^{87,88}

53. The underfunded and struggling health system in Malawi, which has been largely donor-dependent, has further been strained by the COVID-19 pandemic. The financial challenges of Malawi's health system have

limited its capacity to respond to the existing and new healthcare needs. In 2019, the government's expenditure on health was about USD9.9 per capita per annum,⁸⁹ with an additional USD27 from donors;⁹⁰ this is significantly lower than WHO's recommendation of USD86. Underfunded and poorly performing health systems, as with that of Malawi, may not have the ability needed to respond swiftly to health emergencies and new pandemics such as COVID-19, while still struggling with epidemics such as malaria, HIV, and cholera.

54. The extent to which the health system in Malawi is prepared for and has the capacity to manage changes in hazards, exposures, and susceptibility will determine the country's

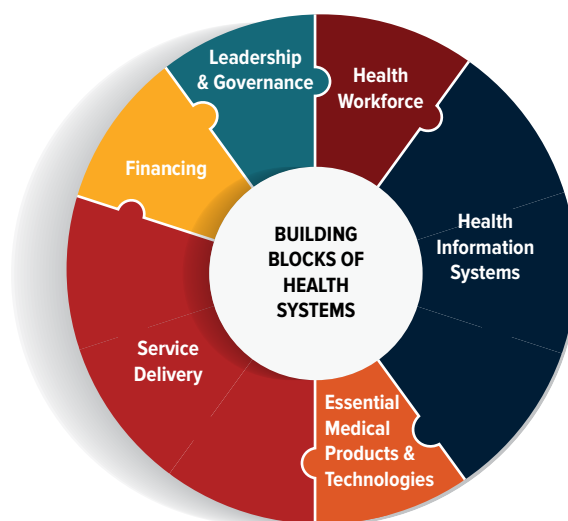
resilience in the coming decades. In this assessment, Malawi's adaptive capacity⁹¹ to prevent and manage climate-related health risks is examined according to WHO's six health system building blocks, as shown in Figure 7. See also Annex B for the Adaptive Capacity Rapid Assessment and a summarized Adaptive Capacity and Climate Change-Related Health Risks Gap Analysis.

It should be noted that several factors outside the scope of the health sector can also drive reductions in adaptive capacity to manage the health risks of climate change in Malawi's institutions and people. These factors include the country's economic challenges, sustained rapid population growth combined with accelerated urbanization, and slowly improving social conditions. The promotion of equity, as a cross-cutting theme for enhancing the adaptive capacity and the resilience to the health risks of climate change, is also critical. Adaptive capacity is likely to be greater when access to resources within a community, nation, or the world is equitably distributed.

LEADERSHIP AND GOVERNANCE

55. The government of Malawi is acutely aware of the potential negative impacts of climate change on various areas, including health; therefore, it is committed to meeting the climate challenge through both adaptation and mitigation measures. Since ratifying the United Nations Framework Convention on Climate Change (UNFCCC) in 1994, the government of Malawi has demonstrated its political commitment and action to address climate change challenges through the implementation of several legislative frameworks and strategies, programs, and activities. The formulation and enforcement of environmental policies and legislative frameworks in Malawi, including those related to climate change, are the responsibility of the Environmental Affairs Department (EAD) in the Ministry of Natural Resources, Energy, and Environment. EAD, in collaboration with the Department of Meteorological Services (DoMS), coordinates climate change issues throughout the county. The additional efforts to increase adaptive

FIGURE 7.
WHO Health System Building Blocks



Source: World Health Organization, 2015, Operational Framework for Building Climate Resilient Health Systems

capacity and resilience include the appointment of a National Designated Entity (NDE) that is responsible for the development and transfer of climate change technologies for adaptation and mitigation; a focal point and a National Designated Authority (NDA) for the Green Climate Fund; and the establishment of a Health and Climate Change Core Team (HCCCT) comprising various government sectors and partners that provide guidance on health and climate change.

56. The evolution of the climate and health policy landscape in Malawi since 1998 is summarized as follows:

- **1998 — Malawi Vision 2020 (1998–2020).** Malawi's Vision 2020 formed the basis for the preparation of short- and medium-term national goals, policies, and strategies to improve the country's development management through 2020. Vision 2020 follows a multisectoral approach in both the public and private sectors to address nine primary strategic challenges, including health promotion and environmental management. Air pollution and climate change issues, along with strategic options to address these concerns, are outlined, though they are not explicitly linked to human health.
- **2002 — The 1st National Communication to UNFCCC provides a review of climate-change related issues in Malawi.** The impacts of climate change on health, while acknowledged, were not among the key socioeconomic sectors assessed as part of the vulnerability and adaptation assessment of climate change.
- **2004 — The Revised National Environmental Policy (NEP) works to create and enable a policy and legal framework for cross-sector coordination.** It is the key instrument and standard in Malawi for environment and natural resources policies and legislation to guide all sectoral activities at all levels. The

cross-sectoral policy objectives, principles, and strategies include the minimization of the adverse impacts of climate change by reducing air pollution and GHG. Further, the NEP works to develop and administer the guidelines for environmental impact assessments (EIAs) that consider not only biophysical impacts, but also address environmental impact on health outcomes, among other things. The policy expressly states that human settlements should incorporate environmental concerns and includes strategies, such as the following:

- Develop sanitation master plans and provide environmentally friendly services to district, town, and city assemblies;
 - Improve waterborne sanitation systems and solid waste disposal, using appropriate technology, as well as adopting the proper design, selection, and licensing of disposal sites and routes;
 - Strengthen the health inspectorate for urban and rural areas to assess the risks and consequences of environmentally related health problems;
 - Promote the development, adoption, and use of cost-effective technologies for building works to prevent deforestation and land degradation arising from brick making and other building activities; as well as
 - Develop pollution control and disaster management mechanisms to protect communities from disasters.
- **2006 — The Malawi Growth and Development Strategy I (MGDS I, 2006–2011) provides guidelines to the government of Malawi on resource allocations and use in various sectors to attain the Malawi Vision 2020.** The MGDS includes sections on improving health outcomes through social development, though it is not among the four key focus areas, nor is there explicit consideration for

the impacts of climate change on human health outcomes across scales.

The National Adaptation Program of Action (NAPA) identifies and provides potential adaptation options to minimize the impacts of climate change on various areas, including human health. Priority areas for urgent and immediate adaptation include enhancing food and water security to improve health outcomes, especially among communities most vulnerable to droughts and floods throughout the country. Project activities to improve health outcomes in light of climate change include (a) the promotion and development of integrated sustainable livelihoods; (b) the improvement of agricultural production under changing climatic conditions to ensure food security and improved nutrition; (c) the strengthening of preparedness to cope with droughts and floods, through establishing flood forecasting and warning systems, for example; and (d) the enhancement of climate monitoring to bolster the early warning capabilities on Lake Malawi and the lakeshore areas.

The Environmental Management Act was developed as a legal instrument for implementing Malawi's regulatory frameworks for the protection of the environment and enforcing compliance with them.

- **2008 — Malawi signed the Libreville Declaration on Health and Environment in Africa (LDHEA).** The LDHEA is a WHO-supported framework that is aimed at building the national, subregional, and regional capacities to prevent climate-related health problems through establishing health and environment strategic alliances and promoting government investments that address climate-related issues affecting human health outcomes.
- **2009 — The MGDS II (2011–2016) is the second medium-term development strategy formulated to meet the aspirations of Vision**

2020. In this version, public health, sanitation, malaria, HIV, and AIDS management, along with climate change, natural resources, and environmental management, are identified as key priority areas, with subsequent strategies to improve overall livelihoods. However, the strategies for improving health outcomes do not directly address the influence or the potential impact of climate change on population health.

- **2011 — The National Health Sector Strategic Plan (2011–2016) was developed to guide the implementation of interventions to improve the health status of the people of Malawi.** The plan includes a section on environmental health where the impact of climate change on the environment is acknowledged as influencing health outcomes. The strategies and key interventions presented consist of efforts to reduce morbidities and mortalities associated with environmental factors (for example, foodborne diseases and water- and sanitation-related diseases), as well as to strengthen responses to disasters and emergencies and promote sustainable vector-control measures.

Malawi's 2nd National Communication to UNFCCC is well-informed and includes sections on climate-related health issues, such as the increasing incidence of WBDs, VBDs, the direct and indirect health impacts of climate-related hazards, and malnutrition. A vulnerability and adaptation assessment was performed by using a model for the assessment of greenhouse gas-induced climate change (MAGICC) to identify and develop the appropriate adaptation responses to the impacts of climate change across multiple sectors, including health.

- **2013 — The National Climate Change Investment Plan (NCCIP, 2013–2018) was developed to increase climate change investments in Malawi, while simultaneously**

addressing gaps identified in the 1st and 2nd National Communications to UNFCCC and the NAPA.

Climate change management projects, related to health, include improving health services to handle health challenges associated with climate change in all regions of Malawi and strengthening the sanitation infrastructure to handle climate change-related pressures. The NCCIP identified that a critical challenge faced by the health sector, when managing climate change, was a lack of research that established the magnitude of the relationship between climate variability and disease incidence, occurrence, and severity. The NCCIP outlined that the inter-institutional coordination of climate change management is provided by the National Steering Committee on Climate Change (NSCCC). Chaired by DoMS, NSCCC includes members of various stakeholders, including MoH.

- **2015 — The Updated NAPA provides an overview of the linkages of climate change and human health outcomes and serves as an instrument to increase the adaptive capacity of vulnerable communities to the adverse effects of climate change.** The updated NAPA is operationalized through six adaptation activity areas, some of which are directly relevant to health outcomes (for example, enhancing disaster preparedness and response through improving established early warning systems). Health is identified as a vulnerable sector in need of urgent adaptation, given the impact of climate change impact on temperatures, floods, and droughts, which influence the distribution of malaria, diarrhea, and cholera. Likewise, erratic rainfall, which can lower agricultural production, results in hunger and malnutrition.
- **2016 — The National Climate Change Management Policy (NCCMP) is a key instrument for managing climate change in Malawi.** The policy serves as a guide for

development planning and implementation by all stakeholders from local to national levels. It aims to (a) effectively manage the impacts of climate change through building social and ecological resilience of all Malawians; (b) contribute towards stabilizing GHGs; (c) incorporate climate change into planning, development, and coordination; and (d) integrate cross-cutting issues into climate change management. However, the management of climate-related health outcomes is not expressly included as one of the policy objectives of the NCCMP.

- **2017 — Malawi's HSSP II (2017–2022) includes sections on climate change-related health issues, such as VBDs, malnutrition, and sanitation; however, it lacks information on the impact of climate change on health and does not identify climate change as a current or a future threat to human health.** The aim of the HSSP II is to move toward universal health coverage (UHC) that provides quality, equitable, and affordable care, while improving health outcomes through the provision of a revised EHP. This is operationalized through eight strategic objectives that are similar to WHO's six health systems building blocks described in this assessment, along with socioeconomic determinants that work to reduce environmental and social risk factors with direct impacts on health.

The National Health Policy was developed to guide stakeholders in the implementation of initiatives for improving the functioning of Malawi's health system. However, climate change is not listed among the key challenges to Malawi's health system; thus, the National Health Policy will not be operating in line with any climate-change related policies.

Malawi's first intended nationally determined contributions (INDCs) include a section on human health as a function of climate change, including malaria, diarrhea, and malnutrition.

Adaptation measures, related to climate-sensitive health outcomes, include the following:

- Build capacity to diagnose, prevent, and control climate-sensitive diseases, such as malaria, diarrheal diseases, and malnutrition;
- Enhance public awareness about water, sanitation, and hygiene (WASH) practices, along with health surveillance;
- Support expanded programs for preventing and controlling climate-sensitive diseases;
- Construct additional health centers to improve access to health facilities within a walking distance of 8 km; as well as
- Support the establishment of a center of excellence for research and disease control that targets climate-sensitive diseases.

The Malawi National Community Health Strategy (2017–2022) operates in line with the HSSP II, with an emphasis on improving health and livelihoods through community health. This is operationalized through a redefinition of community health to include a package of basic preventive, promotive, curative, rehabilitative, and surveillance health services at the community level. Considerations for climate change impacts on health outcomes are not expressly included among the six strategic objectives, but occupational health promotion, including climate and health, is incorporated in the list of EHP interventions.

- **2018 — Malawi’s National Environmental Health Policy provides a basis for environmental health conditions in healthcare settings across Malawi.** The policy addresses five themes: food safety and hygiene; health and safety; vector and disease prevention and control; WASH; along with emergencies, climate change, and human health.

Breaking the cycle of food insecurity in Malawi and poverty reduction are the primary aims of the National Resilience Strategy (2018–2030), which is led by the

Department of Disaster Management Affairs.

The policy reflects a commitment to climate-resilient development to reduce overall food insecurity and malnutrition, which also takes into consideration the impact of the ongoing climate change.

- **2020 — The National Adaptation Plan (NAP) Framework was established to guide efforts for the development of the NAP.** The framework is built on the NAP Roadmap (2016) and the NAP Stocktaking Report (2016). The overall aim is to reduce the country’s vulnerability to climate change through building its adaptive capacity and resilience, while integrating climate change adaptation into its national programming. It was developed, in part, through consultations with 21 different institutions, including MoH. MoH participates as a member of the NAP’s core team of national experts. Food security — as a function of improved community resilience, infrastructure development, and DRM — is the only expressed climate-related health risk that is covered by updated mandates.
- **2021 — Malawi’s updated nationally determined contributions (NDCs) outline the country’s climate change priorities from 2020–2040 and provide specific strategies for addressing climate change impacts on various areas, including health.** Strategic adaptation options include elaborating existing NAPs for the health sector and other priority sectors. Changes in the incidences of VBDs and WBDs; undernutrition; and increased migration, as a function of extreme events, which leads to increased human suffering are identified as key climate-related risks in the health sector.

To promote public health and social protection, adaptation actions are proposed and grouped into three categories: (a) resilient health, (b) the scaling up of resilient nutrition, and

(c) social support. Examples of adaptation actions include promoting insecticide-treated mosquito nets, encouraging dietary diversity and integrating nutrition-sensitive practices, as well as establishing a social support fund to cover climate shock-related events and social protection services.

57. Malawi has made substantial efforts in further incorporating health into the country's policies and strategies to address climate change. Yet despite health being identified in many of the climate change policies and plans included above, there are few health sector policies where climate change is addressed as a challenge or prioritized for strategic planning. Further, the engagement of MoH appears to be limited and the coordination mechanisms for supporting climate change and health actions seem to be ineffective. Although a health-climate core group comprising actors from MoH, among others, has been formed, strategic planning remains absent, and a national climate change and health-specific strategy / action plan has not been developed. Furthermore, while policy makers have demonstrated an awareness of the health impacts of climate change, the engagement of MoH with its climate change, disaster risk management, and agriculture counterparts has been slow.

58. At the subnational level, the development of policies and plans to address climate-related health risks is lacking. Although MoH has developed district-level operational plans, so far, climate change and health in these subnational plans have not been well-integrated into local-level planning initiatives. Regions that are highly vulnerable to climate-related hazards, such as the Southern Region, would require tailored programs and strategic planning in order to address the compounded effect of different climate hazards

and climate-related health risks (for example, floods, cyclones, and WBDs).

HEALTH FINANCING

59. Malawi's budget allocation to the health sector is low, and the country faces huge financing gaps to address health needs.

Health is the third priority in government spending, after education and agriculture, constituting 9.3 percent of the total budget in 2020/2021 (which includes COVID-19 spending). However, this still falls behind the Abuja Declaration target for African states to allocate 15 percent of the total budget to the health sector. By the 2017/2018 period, the government's health allocation (USD528.3 million) fell behind by 66 percent of the required budget, according to the HSSP II. Although there has been an improvement in the 2020/2021 period, the gap still represents 48 percent of the required budget.

The low public funding to the health sector poses a significant challenge in ensuring sufficient drugs, equipment, labor, and infrastructure for adequate service provision. It is not helped by the fact that more than half of the public funds are spent on personnel emoluments, leading to low expenditures on drugs and medical supplies.⁹² Within the context of Africa, Malawi's public spending on drugs (16 percent) is lower than the share spent by other African countries, with health facilities in the country having only 38 percent of the essential medicines in 2019. Finally, only half of the required health infrastructure is available, even though spending in this area had increased from 5 percent in FY2014/2015 to 16 percent in FY2015/2016.

60. Malawi is among the most donor-dependent countries in the world, but donor funds

are off-budget and may not be aligned to national priorities. For FY2017–2018, the country's health budget was USD639 million, of which 75 percent (USD477 million) came from external partners in bilateral and multilateral contexts, nongovernmental organizations (NGOs), private companies, and private individuals.⁹³ The government contribution is estimated to be around 25 percent (USD163 million). Overall, the budget is derived from the following financing sources: (a) the Global Fund (28 percent), (b) MoH (25.3 percent), (c) the United States (US) (16.5 percent), (d) the Health Services Joint Fund (HSJF) (5.6 percent), (e) the United Kingdom (UK) (5.1 percent), (f) the World Bank (3.9 percent), and other financing sources (15.7 percent).⁹⁴

Moreover, international financing and aid tend to be detached from a national plan, due to the absence of a systemic approach of consolidating the information on the contributions and the programs from foreign aid and NGOs. Malawi's health financing gap is covered by donors, who typically allocate resources to communities through off-budget means. Off-budget resource allocations⁹⁵ complexify health financing, as resources are hard to track and might not be aligned with national health priorities. Despite donors contributing substantial resources to cover the health sector's financing gap, there is a need to better coordinate and align donor resources with MoH's priorities to improve transparency, better access, and the equitable distribution of healthcare.

61. The financial burden of health expenditures on households has been increasing. Malawi's health finance system comprises resources from the government, donors, the private sector, and households.⁹⁶ In terms of the current health expenditure, the govern-

ment's share in 2019 was 32.59 percent, while private health expenditure was 23.84 percent. Although the government and the private health expenditure have a higher share of the total current health expenditure, the out-of-pocket (OOP) expenditure increased by approximately 60 percent between 2013 and 2019. Specifically, the OOP expenditure increased from 6.71 percent as a share of current health expenditure in 2013 to 16.86 percent by 2019.⁹⁷ Although the share of the OOP expenditure is lower than the recommended WHO threshold of 20 percent, the increase in the OOP expenditure burden likely hampers the access of poor households, who have low disposable income, to health services.

62. There is insufficient funding to cover Malawi's EHP that is aimed at achieving universal coverage, and risk pooling does not appear to account for climate vulnerabilities. As part of its goal toward achieving universal healthcare coverage,⁹⁸ Malawi has in place the EHP that seeks to provide free health care and covers the following conditions: (a) reproductive, maternal, neonatal, and children health; (b) vaccines for preventable diseases; (c) malaria; (d) the integrated management of childhood illnesses (such as diarrheal diseases and nutrition); (e) community health; (f) neglected tropical diseases (NTDs); (g) HIV / AIDS; (h) nutrition; (i) TB; (j) NCDs (such as mental health and diabetes); and (k) oral health. However, the EHP does not have sufficient funding to cover the care outlined in the benefits package.

Furthermore, the EHP does not appear to take climate vulnerability into consideration. The climate vulnerability differences of the different population groups are not integrated with risks for diseases, such as malaria, nutrition risks, or

mental disorders; in that sense, it is not clear if the EHP considers climate-related risks for these diseases.^{99, 100}

In general terms, illnesses and health care costs are not evenly distributed, with some population groups facing higher health risks, which may be exacerbated by climate change. Climate change can intensify underlying health burdens, while increasing the potential and size of certain catastrophic financial health risks, especially among the most vulnerable. Therefore, structuring spending to support the most vulnerable to climate change and hazards can improve human capital outcomes in the country.

63. Although environmental health is incorporated as a health financing priority, MoH does not seem to have committed an allocation for addressing the impacts of climate change on health and the health system. Although there is a commitment in the NAP to climate change for addressing climate-related health risks, there is no precise strategic planning for climate-health finance and resource allocations for climate-related health risks and vulnerabilities. Building resilient health systems for climate change requires the budget allocation to be an integrated component in the overall planning of a national health plan.

Furthermore, while Malawi has prioritized climate change projects — mostly on resilience in food production systems / agriculture, water management and irrigation, and climate information systems, these efforts are being developed without incorporating health outcomes into their strategic planning. Guidelines for integrating a climate-resilient approach for health care and public health systems are not available to ensure rationalized resource allocations. For example,

nutrition risks (causing the highest burden of disease in the country) do not have a budget line in the government's budget allocation strategy. Instead, the country is dependent on donors, which tend to have their own objectives in finance planning. Considering that food insecurity and malnutrition are a historic challenge in Malawi, it is pivotal to develop a financing strategy to improve resource allocations and pooling for nutrition management.

64. The health co-benefits of climate change mitigation have not been adequately promoted as cost-effective options in the health sector. The arguments for implementing climate change mitigation policies are often focused on perceived short-term financial costs. However, cost assessments rarely account for the health co-benefits of these policies, resilience strengthening, and the outcomes for human health, while also reducing costs for the health sector. Therefore, additional studies are needed to quantify the longer-term cost savings through the health co-benefits of climate change adaptation and mitigation policies in Malawi.

HEALTH WORKFORCE

65. Despite considerable investments to improve health service delivery, there are ongoing challenges in training, recruiting, and maintaining an adequate health workforce. To address the shortages of skilled workers in the public health sector, MoH, with the support of the Ministry of Finance, the Global Fund, and the Department for International Development (DFID), introduced the six-year Emergency Human Resources Program (EHRP)¹⁰¹ in 2004, which led to an increase in the number of skilled health workers by 53 percent (8,369 in 2009 from 5,453 in 2004).¹⁰² Similar strategies

to improve health services and systems include the Program of Work 2004–2010, the HSSP 2011–2016, the human resources for health (HRH) strategic plan,¹⁰³ HSSP II 2017–2022,¹⁰⁴ and the HRH2030 program of the United States Agency for International Development (USAID) and CHAM.

Although Malawi's six-year EHRP achieved its main goal of increasing the health workforce, the achievements were not sustained due to a lack of appropriate strategic planning. Overall, the recruitment of healthcare workers to meet service delivery demand has and will continue to be limited by the availability of fiscal resources available to MoH.

66. There are significant staffing gaps in the number of skilled health workers and their geographical distribution throughout the country. According to WHO's recommended Sustainable Development Goals (SDG) index threshold of 4.45 skilled health workers (physicians, nurses, and midwives) per 1,000 population, Malawi is in the critical shortage zone: it has just 0.019 doctors and 0.283 nurses and midwives per 1,000 population.¹⁰⁵

There is an estimated shortage of at least 7,000 CHWs, with an overall unequal distribution of skilled health workers between rural and urban areas.¹⁰⁶ According to MoH's HRH country profile for 2008, 95 percent of the specialist medical practitioners, 77 percent of the general medical practitioners, 79 percent of the paramedical practitioners, 71 percent of the nursing professionals, 79 percent of the medical imaging and therapeutic equipment operators, and 75 percent of the environmental health officers practiced in urban areas.¹⁰⁷ In the public health sector, there are gaps in the human resource capacity across the different essential cadres, levels, and regions.

Furthermore, a healthcare needs assessment and census in the health sector is not conducted on a routine basis, which is crucial for ensuring the equal distribution of skilled health workers and identifying healthcare needs. Among the eight selected essential health staff positions, just 17,298 of the 25,755 positions were filled in 2016, leaving 33 percent of the positions vacant (Table 7). As the population continues to expand, coupled with climate change-related healthcare challenges, needs assessments are and will continue to be vital to the (re)distribution of health workers to meet healthcare needs.

67. The labor conditions of health workers have curtailed the health workforce capacity. The recruitment and retention of skilled health workers — especially in higher cadres, including medical and clinical officers, nursing officers, and nurse-midwives — is an ongoing challenge. This is mainly attributed to low salaries, heavy workloads, poor working conditions, a lack of medical supplies / resources, and poor management, along with a lack of housing, transport, and allowances.¹⁰⁸ In 2000, the healthcare system suffered a drastic decline in the number of skilled health workers due to emigration, low pay, and poor working conditions.¹⁰⁹ This led to an overburdened and understaffed public health system, thus affecting the coverage and quality of health services. Furthermore, the migration of skilled health workers for better job opportunities within and outside the country has created staffing gaps within Malawi's health system and created gaps in the service delivery to rural populations. The health impacts of climate change will further strain the capacity of health workers, due to an increase in the burden of disease.

TABLE 7.

Vacancy rate of eight selected essential health staff per established position for MoH and CHAM

CADRE	ESTABLISHMENT	FILLED	VACANT	% VACANT
Medical Officer	398	284	114	29%
Clinical Officer	3,135	1,159	1,976	63%
Nursing Officer	3,275	1,098	2,177	66%
Nurse Midwife Technician	8,626	3,475	5,151	60%
Medical Assistant	1,506	1,199	307	20%
Pharmacy Technician	1,063	218	845	79%
Lab Technician	1,053	397	656	62%
Health Surveillance Assistants	6,699	9,468	(2,769)	-41%
Total	25,755	17,298	8,457	33%

Source: Government of Malawi (2017) Health Sector Strategic Plan II - 2017-2022. https://extranet.who.int/countryplanning-cycles/sites/default/files/planning_cycle_repository/malawi/health_sector_strategic_plan_ii_030417_smt_dps.pdf.

68. Malawi has limited in-country human resource capacity, with few medical training institutions and teaching hospitals.

The country has only one medical school — the University of Malawi College of Medicine (UMCM) — and 18 nursing training schools with a limited number of medical courses.¹¹⁰ The in-country training of the cohort of doctors in family medicine began only in 2015.¹¹¹ At the current rate, the production of skilled health workers is not adequate to meet the health needs of a population that is increasing at a rate of 2.9 percent per year and projected to double by 2042. Further, the lack of adequate on-the-job trainings, continuous education, and career development makes the provision of health care challenging.

In a country with limited health professionals, short refresher training courses are crucial to keep the available health workers up to date on public health needs, including those directly related to climate change. The results of a training needs assessment on climate and gender by the Lilongwe University of

Agriculture and Natural Resources (LUANAR) and the School of Public Health and Family Medicine at the University of Malawi revealed that overall, health workers lacked training on climate change and its impacts on health, as well as climate change and gender-based health inequalities.¹¹²

69. The extent to which Malawi's health workforce has adequate knowledge, technical capacity, and resources to prevent and manage current and future climate change-related health risks is largely uncertain.

Healthcare professionals and CHWs lack adequate skills and competencies to attend to patients showing up with unfamiliar climate-related health issues, including respiratory illnesses, allergies, mental health, and diarrhea. There is a lack of evidence on the knowledge and capacity of Malawi's health workforce to deal with climate health risks and the awareness of risks. Although there is some level of integration of climate in the national health policy and planning, little is known about the existence of capacity development programs that train the health

workforce to identify, prevent, and manage climate health risks. Evidence shows that climate change will be a key defining factor for health systems in the 21st century; yet no assessment on climate change knowledge and the health workforce's ability to identify climate health risks has been conducted.

HEALTH INFORMATION SYSTEMS

70. Health information systems (HIS) in Malawi are incorporated as a key pillar into the HSSP II.

MoH gathers data by following the main guidelines: (a) the HSSP II and guidelines in the monitoring and evaluation section;¹¹³ (b) the Malawi Monitoring and Evaluation Task Force Priorities 2017–2021; (c) the Malawi National Health Indicators Handbook;¹¹⁴ (d) the Malawi National Health Information System Policy;¹¹⁵ (e) the WHO's global reference list of 100 Core Health Indicators;¹¹⁶ and (f) the Health Management Indicators System (HMIS) that includes the District Health Information Software (DHIS 2).

71. The Epidemiology Unit at MoH is responsible for integrated disease surveillance and response (IDSR): it monitors 15 diseases, including climate-related health risks such as VBDs and WBDs.

However, it is not clear if climate data, including the projections of temperature and precipitation patterns and change, are integrated into IDSR or how it is used in strategic planning. Researchers highlighted that the current IDSR has proven to be extensive, in terms of the data it gathers, but it faces challenges around timeliness and implementation, mostly due to the lack of capacity for case identification, as well as the compilation and submission of reports.¹¹⁷

72. Malawi has already developed a climate-health vulnerability assessment and is aiming at updating and expanding its scope.

The assessment identified gaps in the HIS and research, namely, the relationship between VBDs and climate, the capacity of the health sector to address the current and future climate, the integration of weather and climate information systems into health projects and strategic planning, along with the incorporation of Indigenous knowledge and practices.¹¹⁸ Overall, the information, monitoring, and surveillance systems in Malawi, which have been identified as an area to be strengthened, are included in MoH's HSSP II 2017–2022.¹¹⁹

73. The Department of Climate Change and Meteorological Services, together with the United Nations Development Programme (UNDP), is currently working on a project to scale up the use of modernized climate information for early warning systems and integrating the data with food-insecure departments and DRM and preparedness.

^{120,121} The project is aimed at (a) providing tailored climate-based agricultural advisories for 14 food-insecure districts; (b) scaling up community-based early warning systems in communities that are vulnerable to floods, while strengthening the capacities for emergency response; (c) expanding hydrometeorological monitoring stations in order to improve flood monitoring and water resource planning and management; and (d) installing 34 automatic weather stations to improve the coverage of existing forecasting capabilities by providing information on extreme weather events.

Although the project includes working with food-insecure districts and flood-prone areas, there is no integration with MoH in order to integrate data from early warning systems with health outcomes, such as direct morbidity

and mortality from extreme weather events or nutritional risks. Other projects including the Capacity Building for Managing Climate Change in Malawi programme are being developed, with the support of international stakeholders; they are focused on enhancing the HMIS and integrating climate information with health planning, research, and responses to climate-related health risks.^{122,123,124}

ESSENTIAL MEDICAL PRODUCTS AND TECHNOLOGIES

74. Malawi has historically experienced regular shortages of essential medical products.

In FY2015/2016, less than 25 percent of the health facilities across the country could maintain adequate stock to cover 23 HSSP I tracer medicine and medical supplies for 1–3 months. These shortages have been attributable to weak supply chain management and persistent stockouts, inadequate funding, irrational prescriptions, leakages, and regular pilferages. The management, warehousing, and storage of health products constitute additional challenges across all levels of the health system.¹²⁵

To expedite the management of medical supplies, MoH, with support from UNDP, recently launched the Electronic Health Information Network (eHIN) in three districts, with the intention of expanding it to all health facilities later. eHIN utilizes mobile technology to track medicines from the Central Medical Stores Trust to end-users in real time; its aim is to better deal with the expiry of medicines, reduce stockouts, as well as improve accountability and transparency.¹²⁶

75. Weak quality assurance and accreditation, coupled with inadequate biosafety and biosecurity mechanisms, are affecting

the availability of laboratory and imaging services throughout the country significantly. Malawi's National Medical Laboratory policy and strategic plans were developed to support laboratory services in the public healthcare system and ensure patient safety and quality diagnostics. The highlighted areas of support included laboratory regulation, quality assurance, safety, ethics, research and development, monitoring and evaluation, laboratory premises, human resources, financing and budgeting, medical laboratory service provision, laboratory equipment and supplies, as well as the management and organization of laboratory services.¹²⁷

However, gaps and challenges remain. Although there are several laboratories in Malawi, including more than 211 laboratories owned by MoH and CHAM,¹²⁸ only 10 of them have international accreditation. According to USAID's assessment of Malawi's laboratory services and supply chain, the laboratories lacked standard operating procedures (SOPs) for some diseases, or they were not available at all in the laboratories, nor did they have SOPs for the proper disposal of expired or unused items. The increased disease burden, due to climate hazards, is likely to overwhelm the poorly equipped laboratories, thus causing more shortages in testing supplies.

HEALTH SERVICE DELIVERY

76. Health service delivery in Malawi is challenged by the regular stockouts of essential medicines, the lack of equipment, and the shortage of skilled health workers.

The reintroduction of user fees in some CHAM health facilities is also a hindrance to the access of health services for women and the poor who cannot afford to pay.¹²⁹ The high prevalence of informal payments in public

health facilities further widens inequalities in health care access and violates the right of poor people to obtain free health services.¹³⁰

77. Inequalities in the accessibility of healthcare persist, due to poor transport and the lack of ambulances for emergencies, and these are likely to be exacerbated by climate hazards.

There are barriers associated with both the availability and affordability of transportation to health facilities, especially for the rural population. The distance is even longer (median of 2.5 hours to a district hospital) for specialized health services, including access to surgical services.¹³¹ The limited access to healthcare is a major contributor to under-five mortality in rural Malawi.¹³² In Southern and Central Malawi, where floods are common, the access to public health facilities is comparatively more challenging due to damaged and impassable roads.¹³³

78. There are geographical inequalities in the distribution of higher-level public health facilities between rural and urban areas.

Laboratory, surgery, and specialized services are provided at the district hospitals, which are often too far away from rural populations.^{134,135} Private clinics offer services at a cost that is not affordable by the majority of the poor.¹³⁶ Health facilities in rural areas — especially for treating some illnesses like mental disorders, and delivering services such as diagnostic imaging and radiology, as well as maternity, services — are limited. This reality forces people to visit THs, herbalists, and TBAs, who are not trained to provide skilled health services, which can lead to complications and premature deaths.¹³⁷

79. There is a lack of comprehensive integration of climate change in the health sector's policies, strategic planning, and programming.

In the Malawi HSSP I (2011–2016), climate is briefly mentioned as a threat to health, but no action plans are outlined. Climate and related hazards are not mentioned in the Malawi HSSP II (2017–2022). As climate is not included in the health sector's planning and program, this means that no budget line is allocated to account for climate impacts on health at the national level, thus undermining the health system's capacity to respond to climate health risks.

80. The country's health infrastructure is weak; its inability to withstand climate change shocks thus affects healthcare service delivery adversely.

In the aftermath of Tropical Storm Ana, a situation analysis in the Nsanje and Chikwawa districts revealed that 19 out of the 23 health facilities were inoperable, due to infrastructure damage, flooding, and destroyed medical supplies, thereby leaving only four health facilities operational and people desperate for healthcare. Furthermore, these four facilities struggled to keep their medical equipment functioning due to power outages. In a limited-resource and climate-vulnerable country like Malawi, the lack of a climate-resilient and sustainable health care infrastructure will exacerbate geographical health disparities and compromise the quality of health service delivery, particularly in the flood-prone regions of southern Malawi. However, in the absence of climate resiliency assessments of healthcare facilities and health infrastructure, the magnitude of the service delivery risk due to climate change remains uncertain.

TABLE 8.

Summary of the Health System Adaptive Capacity Gaps for Malawi

BUILDING BLOCK	SUMMARY OF GAPS IN ADAPTIVE CAPACITY
Leadership and Governance	• The prioritization of climate change, health risks, and adaptation options in the national policies and plans remains varied, with less specificity from MoH on strategic planning for climate change effects on health outcomes. • The engagement of MoH is limited, with coordination mechanisms to facilitate integrated, cross-sectoral action on climate change ineffective. • There is a lack of policies and plans at the subnational level to address climate-related health risks.
Health Workforce	• The health sector faces an imbalance in the number, skill mix, and deployment of the health workforce, including large urban-rural disparities. • The EHRP suffers from a lack of sustainable planning. • On-the-job training, continuous education, and career development plans are insufficient, and they do not account for the impact of climate-related events on health and the health system. • The overdependence on NGOs and other international stakeholders for capacity building, due to the lack of financing commitments from Malawi Ministry of Health, increases the burden of high workload, burnout and stress on health workers.
Health Information and Disease Surveillance Systems	• The climate data produced by the Department of Climate Change and Meteorological Services are not well-integrated into MoH's activities. • The IDSR lacks the capacities for case identification, as well as for collating and organizing reports and data.
Essential Medical Products and Technologies	• The regular shortages of essential medical products are a pervasive challenge. Further, the management, warehousing, and storage of available health products pose additional challenges that impede quality service delivery. • Weak quality assurance and accreditation, coupled with inadequate biosafety and biosecurity mechanisms, significantly affect the availability of laboratory and imaging services.
Health Service Delivery	• Inequalities in the accessibility of health care persist due to poor transport and a lack of ambulances for emergencies. • There are geographical inequalities in the distribution of higher-level public health facilities between rural and urban areas. • Climate change and associated impacts are not mainstreamed into the operations of health programs at all levels. • Climate-resilient healthcare facilities and health infrastructure assessments are lacking; this makes assessing the magnitude of the climate change impact on service delivery especially challenging.
Health Financing	• There is no evident MoH budget allocation dedicated to addressing climate change's impacts on health and the health system. • Risk pooling in Malawi does not account for climate vulnerability differences among the different population groups. • Guidelines for integrating the climate-resilient approach for health care and the public health systems are not available to ensure rationalized resource allocations.



RECOMMENDATIONS TO ENHANCE HEALTH SYSTEM RESILIENCE TO CLIMATE CHANGE

81. This section outlines a set of recommendations for enhancing Malawi's health system resilience and adaptation to climate change, including the potential health interventions and strategies that can be put in place. The recommended options are based on an assessment of both the magnitude of the current and projected climate-related health risks and the existing gaps in adaptive capacity to manage and / or prevent these risks. This section is organized by using the 10 components of climate-resilient health systems (Figure 8) and drawing from consultations and the review of all relevant governmental policies. See Annex C for a summary of the recommendations for building a climate-resilient health system across the identified climate change-related health risks.

COMPONENT 1. LEADERSHIP AND GOVERNANCE

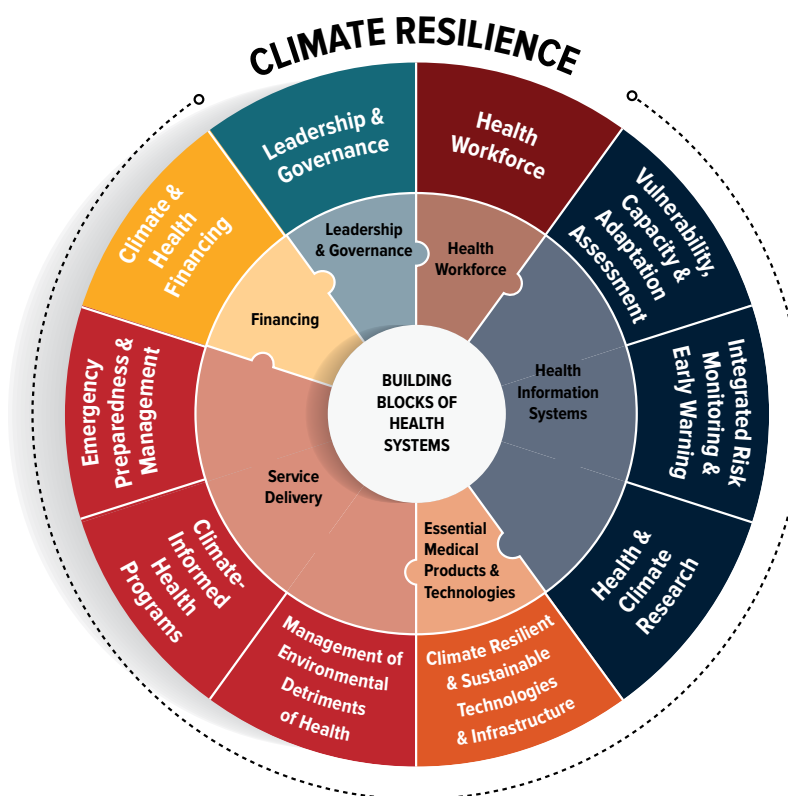
→ **Enhance the coordination mechanisms for climate action, championed by MoH and the HCCT, to liaise with stakeholders inside and outside the health sector.**¹³⁸ It is recommended that the key areas of focus include (a) developing further strategies that integrate and build knowledge on climate-related health risks into MoH's operational planning; (b) monitoring progress from strategies and action plans, such as the Climate Change and Health National Strategy and Action Plan, the NDCs, and the long-term strategies; and (c) ensuring the alignment of development partners and other organizations that are also

implementing projects and program on climate change and/or health in the country.

→ **Articulate climate-health actions in sub-national plans.** While national plans that consider climate-health risks have been developed (see Section 4), subnational planning is far from comprehensive. It is recommended that MoH develop specific strategic planning for climate-related health risks that account for subnational differences in climate-related exposures (see Section 2), highlighting the resilience of healthcare service delivery. Further, such policies and plans should work to address climate-related health risks specific to urban and rural areas within each region.

FIGURE 8.

WHO's Operational Framework for Building Climate-Resilient Health Systems



Source: World Health Organization, 2015, Operational Framework for Building Climate Resilient Health Systems.

COMPONENT 2. HEALTH WORKFORCE

- **Create and promote health workforce retention packages to ensure that there are sufficient skilled health workers in areas at the highest risk of climate-related hazards.** The retention packages should also include risk reduction and emergency protocols, as well as proper housing and basic services for health workers (and communities).
- **Scale up the formal pedagogical training developed by Malawi's HCCT on climate**

and health and incorporate it as part of the medical and paramedical curricula (targeted at medical professionals, including nursing professionals and CHWs) at higher education and vocational institutions. It is further recommended that regular refresher courses for continued learning and on-the-job training opportunities be made available. National curriculum and refresher courses would benefit from climate-health vulnerability assessments and the prioritization of key climate-related health risks.

COMPONENT 4. INTEGRATE RISK MONITORING AND EARLY WARNING

- **Strengthen communication networks between the Department of Climate Change and Meteorological Services (DoCCMS) and the communities at risk for extreme weather events.** While DoCCMS possesses the information necessary to provide at-risk communities with advance warning of extreme climate events, warning messages often do not reach at-risk communities, with sufficient time for adequate preparation. Options for strengthening communication may include (a) push notifications (both in English and Chichewa) to mobile users in anticipation of meteorological events through a partnership with Airtel; and / or (b) coordination with broadcasting stations (for example, Zodiac) to relay warning messages to listeners.

COMPONENT 7. MANAGEMENT OF THE ENVIRONMENTAL DETERMINANTS OF HEALTH

- **Support community-led efforts to improve sanitation practices and controls to prevent WBDs and foodborne illnesses and diseases, as well as communicate the potential climate change-related health risks.** It is recommended that such efforts include educational materials and communication on the hazards of open defecation, as this issue relates to water quality and WBD risks, especially among the rural communities and for those residing in temporary disaster shelters after extreme weather events.

- **Engage medical colleges and the Ministry of Education (MoE) and integrate with district-level community groups to support dialogues, awareness, and the development of prospective climate and health programs, such as health promotion programs focused on climate-related health risks.** The engagement could include the use of mainstream media or community-level climate and health training modules.

COMPONENT 10. CLIMATE & HEALTH FINANCING

- **Ensure strategic health purchasing that includes considerations for climate-related health risks.** It is recommended that the government moves toward a provider payment mechanism to incentivize healthcare providers with regards to managing and treating climate sensitive diseases, particularly for the Southern Region that is most vulnerable to climate change impacts. The mechanism should be guided by detailed, subnational climate information on population needs related to ongoing climate exposures.



ANNEXES

ANNEX A. METHODS FOR THE ESTIMATION OF MOSQUITO SUITABILITY IN MALAWI, UNDER RCP 8.5

MODEL CONSTRUCTION

The spatio-temporal distributions of *Anopheles (An.) gambiae* s.s., *An. funestus*, and *An. arabiensis* mosquitoes were determined, using a raster-based suitability model constructed in Google Earth Engine by adapting methodology presented by Frake et al.¹³⁹ This methodology uses abiotic variables specific to the thermal tolerances of vector species and biotic variables that give consideration to the species' habitat preferences.

Suitable areas are defined as patches of landscape that facilitate the development of malaria mosquitoes through the production and persistence of oviposition sites, and where temperatures do not exceed or fall below thermal tolerances. Parameter thresholds for all input variables were selected based on a literature review of *An. gambiae* s.s., *An. funestus*, and *An. arabiensis* habitats: temperature, land cover, precipitation, flow accumulation, and water resources (Table A1). Thresholds were then used to create binary maps for each predictor (that is, suitable [1] or unsuitable [0]) that were combined by using the Boolean logic to produce suitability maps across three epochs. They are the historical reference period (1986–2005), 2030–2049, and 2040–2059, during Malawi's historic malaria transmission period of November to April.¹⁴⁰

Population vulnerability was demonstrated by spatially overlaying suitability maps for malaria mosquitoes in Malawi with the population data from the Global Human Settlement Layers (2015) to calculate the number of people residing in suitable areas, by region. Population data were held constant in all models, in the absence of spatial population projection data.

The output spatial resolution of products is 1,000 m: this analysis is performed at the landscape, not the microscale, level. Microscale variations in climatology, as well as LULC, can and do affect the species' actual distributions.

TABLE A1.

Model parameterization and data sources for habitat characterization

INDICATOR	DATA SOURCE	PRODUCT	SPATIAL RESOLUTION	THRESHOLD
Temperature	The National Aeronautics and Space Administration (NASA)	NEX-GDDP	0.25 degrees	<i>An. gambiae</i> s.s. Min: 18°C Max: 34°C <i>An. arabiensis</i> Min: 13°C Max: 35°C <i>An. funestus</i> Min: 14°C Max: 35°C
Land Cover	Copernicus Global Land Service	Proba-V-C3	100 m	See Table A2*
Water Resources	Joint Research Centre (JRC)	GSW1_0	30 m	> 0% water occurrence
Flow Accumulation	World Wildlife Fund (WWF)	HydroSHEDS	500 m	
Population	JRC	GHSL/P2016/POP_GPW_GLOBE_V1		

SUITABILITY DATA AND PARAMETERS*Temperature*

Temperature is critical in the development and life history of mosquitoes. Temperatures that are either too low or too high can increase the mortality during the aquatic or adult stages. Bayoh and Lindsay¹⁴¹ demonstrated that the upper and lower thresholds for the aquatic development of *An. gambiae* s.s. were 18°C and 34°C, respectively. In the case of *An. arabiensis* and *An. Funestus*, the lower development thresholds have been demonstrated at 13°C and 14°C, respectively, while the upper limits are 35°C for both species.¹⁴² Data were acquired from the NASA NEX-GDDP at a 0.25-degree spatial resolution.

Land Use and Land Cover (LULC)

There is a significant relationship between LULC and the distribution of mosquito species, with many species demonstrating strong preferences for specific land cover types. LULC data were acquired from the Copernicus Global Land Service Proba-V-c3 product. To determine whether classes were suitable for *An. gambiae* s.s., *An. funestus*, *An. arabiensis* mosquitoes, class descriptions were compared to the habitat preferences of the species, according to the literature review. To account for these species preferences, Proba class values, 20, 30, 40, 50, 60, 90, 111, 112, 113, 114, 115, 116, 121, 122, 123, 124, 125, and 126 were set to “suitable” (Tables A2-A4).

TABLE A2.

Copernicus Global Land Cover Layers: CG:S-LC100 Collection 2 Global Landcover Map Classifications for *Anopheles gambiae* s.s.

CLASS VALUE	CLASS DESCRIPTION	SUITABLE AN. GAMBIAE S.L. LAND COVER
0	Unknown. No or not enough satellite data available.	No
20	Shrubs. Woody perennial plants with persistent and woody stems, and without any defined main stem being less than 5 m tall. The shrub foliage can be either evergreen or deciduous.	Yes
30	Herbaceous vegetation. Plants without persistent stems or shoots above the ground and lacking a definite firm structure. Tree and shrub cover is less than 10%.	Yes
40	Cultivated and managed vegetation / agriculture. Lands covered with temporary crops, followed by harvest and a bare soil period (for example, single and multiple cropping systems). Note that perennial woody crops will be classified as the appropriate forest or shrub land cover type.	Yes
50	Urban / built-up. Land covered by buildings and other constructed structures.	Yes
60	Bare / sparse vegetation. Lands with exposed soil, sand, or rocks, and vegetation cover never more than 10% during any time of the year.	Yes
70	Snow and ice. Lands under snow or ice cover throughout the year.	No
80	Permanent water bodies. Lakes, reservoirs, and rivers. Can be either freshwater or saltwater bodies.	No
90	Herbaceous wetland. Lands with a permanent mixture of water and herbaceous / woody vegetation. The vegetation can be present in salt, brackish, or fresh water.	Yes
100	Moss and lichen.	No
111	Closed forest, evergreen needle leaf. Tree canopy > 70%, almost all needle leaf trees remain green all year. Canopy is never without green foliage.	Yes
112	Closed forest, evergreen broadleaf. Tree canopy > 70%, almost all broadleaf trees remain green year-round. Canopy is never without green foliage.	Yes
113	Closed forest, deciduous needle leaf. Tree canopy > 70%, consists of seasonal needle leaf tree communities with an annual cycle of leaf-on and leaf-off periods.	Yes
114	Closed forest, deciduous broad leaf. Tree canopy > 70%, consists of seasonal broadleaf tree communities with an annual cycle of leaf-on and leaf-off periods.	Yes
115	Closed forest, mixed.	Yes
116	Closed forest, not matching any of the other definitions.	Yes
121	Open forest, evergreen needle leaf. Top layer — trees 15–70% and second layer — mixture of shrubs and grassland, almost all needle leaf trees remaining green all year. Canopy is never without green foliage.	Yes
122	Open forest, evergreen broad leaf. Top layer — trees 15–70% and second layer — mixture of shrubs and grassland, almost all broadleaf trees remaining green year-round. Canopy is never without green foliage.	Yes
123	Open forest, deciduous needle leaf. Top layer — trees 15–70% and second layer — mixture of shrubs and grassland, consists of seasonal needle leaf tree communities with an annual cycle of leaf-on and leaf-off periods.	Yes

124	Open forest, deciduous broadleaf. Top layer — trees 15–70% and second layer — mixture of shrubs and grassland, consists of seasonal broadleaf tree communities with an annual cycle of leaf-on and leaf-off periods.	Yes
125	Open forest, mixed.	Yes
126	Open forest, not matching any of the other definitions.	Yes
200	Oceans, seas. Can be either freshwater or saltwater bodies.	No

TABLE A3.

Copernicus Global Land Cover Layers: CG:S-LC100 Collection 2 Global Landcover Map Classifications for *Anopheles arabiensis*

CLASS VALUE	CLASS DESCRIPTION	SUITABLE <i>AN. GAMBIAE</i> S.L. LAND COVER
0	Unknown. No or not enough satellite data available.	No
20	Shrubs. Woody perennial plants with persistent and woody stems, and without any defined main stem being less than 5 m tall. The shrub foliage can be either evergreen or deciduous.	Yes
30	Herbaceous vegetation. Plants without persistent stems or shoots above the ground and a lacking definite firm structure. Tree and shrub cover is less than 10%.	Yes
40	Cultivated and managed vegetation / agriculture. Lands covered with temporary crops, followed by harvest and a bare soil period (for example, single and multiple cropping systems). Note that perennial woody crops will be classified as the appropriate forest or shrub land cover type.	Yes
50	Urban / built-up. Land covered by buildings and other constructed structures.	Yes
60	Bare / sparse vegetation. Lands with exposed soil, sand, or rocks, and vegetation cover never more than 10% during any time of the year.	Yes
70	Snow and ice. Lands under snow or ice cover throughout the year.	No
80	Permanent water bodies. Lakes, reservoirs, and rivers. Can be either freshwater or saltwater bodies.	No
90	Herbaceous wetland. Lands with a permanent mixture of water and herbaceous / woody vegetation. The vegetation can be present in salt, brackish, or fresh water.	Yes
100	Moss and lichen.	No
111	Closed forest, evergreen needle leaf. Tree canopy > 70%, almost all needle leaf trees remaining green all year. Canopy is never without green foliage.	No
112	Closed forest, evergreen broadleaf. Tree canopy > 70%, almost all broadleaf trees remaining green year-round. Canopy is never without green foliage.	No
113	Closed forest, deciduous needle leaf. Tree canopy > 70%, consists of seasonal needle leaf tree communities with an annual cycle of leaf-on and leaf-off periods.	No
114	Closed forest, deciduous broadleaf. Tree canopy > 70%, consists of seasonal broadleaf tree communities with an annual cycle of leaf-on and leaf-off periods.	No
115	Closed forest, mixed.	No
116	Closed forest, not matching any of the other definitions.	No

121	Open forest, evergreen needle leaf. Top layer — trees 15–70% and second layer — mixed shrubs and grassland, almost all needle leaf trees remaining green all year. Canopy is never without green foliage.	No
122	Open forest, evergreen broad leaf. Top layer — trees 15–70% and second layer — mixed shrubs and grassland, almost all broadleaf trees remaining green year-round. Canopy is never without green foliage.	No
123	Open forest, deciduous needle leaf. Top layer — trees 15–70% and second layer — mixed shrubs and grassland, consists of seasonal needle leaf tree communities with an annual cycle of leaf-on and leaf-off periods.	No
124	Open forest, deciduous broadleaf. Top layer — trees 15–70% and second layer — mixed shrubs and grassland, consists of seasonal broadleaf tree communities with an annual cycle of leaf-on and leaf-off periods.	No
125	Open forest, mixed.	Yes
126	Open forest, not matching any of the other definitions.	Yes
200	Oceans, seas. Can be either freshwater or saltwater bodies.	No

TABLE A4.

Copernicus Global Land Cover Layers: CG:S-LC100 Collection 2 Global Landcover Map Classifications for *An. funestus*

CLASS VALUE	CLASS DESCRIPTION	SUITABLE <i>AN. GAMBIAE</i> S.L. LAND COVER
0	Unknown. No or not enough satellite data available.	No
20	Shrubs. Woody perennial plants with persistent and woody stems, and without any defined main stem being less than 5 m tall. The shrub foliage can be either evergreen or deciduous.	Yes
30	Herbaceous vegetation. Plants without persistent stems or shoots above the ground and lacking a definite firm structure. Tree and shrub cover is less than 10%.	Yes
40	Cultivated and managed vegetation / agriculture. Lands covered with temporary crops, followed by harvest and a bare soil period (for example, single and multiple cropping systems). Note that perennial woody crops will be classified as the appropriate forest or shrub land cover type.	Yes
50	Urban / built-up. Land covered by buildings and other constructed structures.	Yes
60	Bare / sparse vegetation. Lands with exposed soil, sand, or rocks, and vegetation cover never more than 10% during any time of the year.	No
70	Snow and ice. Lands under snow or ice cover throughout the year.	No
80	Permanent water bodies. Lakes, reservoirs, and rivers. Can be either freshwater or saltwater bodies.	No
90	Herbaceous wetland. Lands with a permanent mixture of water and herbaceous / woody vegetation. The vegetation can be present in salt, brackish, or fresh water.	Yes
100	Moss and lichen.	No
111	Closed forest, evergreen needle leaf. Tree canopy > 70%, almost all needle leaf trees remaining green all year. Canopy is never without green foliage.	Yes
112	Closed forest, evergreen broadleaf. Tree canopy > 70%, almost all broadleaf trees remaining green year-round. Canopy is never without green foliage.	Yes

113	Closed forest, deciduous needle leaf. Tree canopy > 70%, consists of seasonal needle leaf tree communities with an annual cycle of leaf-on and leaf-off periods.	Yes
114	Closed forest, deciduous broadleaf. Tree canopy > 70%, consists of seasonal broadleaf tree communities with an annual cycle of leaf-on and leaf-off periods.	Yes
115	Closed forest, mixed.	Yes
116	Closed forest, not matching any of the other definitions.	Yes
121	Open forest, evergreen needle leaf. Top layer — trees 15–70% and second layer — mixed shrubs and grassland, almost all needle leaf trees remain green all year. Canopy is never without green foliage.	Yes
122	Open forest, evergreen broad leaf. Top layer — trees 15–70% and second layer — mixed shrubs and grassland, almost all broadleaf trees remain green year-round. Canopy is never without green foliage.	Yes
123	Open forest, deciduous needle leaf. Top layer — trees 15–70% and second layer — mixed shrubs and grassland, consists of seasonal needle leaf tree communities with an annual cycle of leaf-on and leaf-off periods.	Yes
124	Open forest, deciduous broadleaf. Top layer — trees 15–70% and second layer — mixed shrubs and grassland, consists of seasonal broadleaf tree communities with an annual cycle of leaf-on and leaf-off periods.	Yes
125	Open forest, mixed.	Yes
126	Open forest, not matching any of the other definitions.	Yes
200	Oceans, seas. Can be either freshwater or saltwater bodies.	No

Precipitation

Water is fundamental to mosquito larvae development. To estimate the areas that are likely to become inundated, the annual average precipitation was calculated from the Climate Hazards Group InfraRed Precipitation and Station Data (CHIRPS v2.0). Likewise, the flow accumulation was derived from the HydroSHEDS Flow Accumulation product to determine the natural drainage from a given pixel to the adjacent, downslope pixel in order to determine the areas of inundation for larval oviposition sites. Finally, a water resources layer, derived from the JRC Global Surface Water Bodies Mapping Layer v1.0 product, was developed: this was done by buffering water bodies by 250 m to approximate water-rich soils that would support larval development.

ANNEX B. ADAPTIVE CAPACITY RAPID ASSESSMENT

LEADERSHIP AND GOVERNANCE				
Questions	Assessment			
	Yes	No	Partial	N/A
1.1: Does the country have a national climate change and health plan / strategy?				
1.2: Is health mentioned as a priority in the Nationally Determined Contributions (NDCs)?				
1.3: Is there a designated focal point responsible for health and climate change in the ministry of health (MoH)?				
1.4: Is there a multisectoral technical working group / committee that is focused on climate change and health?				
1.5: Does MoH actively participate in climate change coordination and / or working groups?				
1.6: Is there a memorandum of understanding (MOU) between MoH and key climate change-related ministries / departments (for example, Environment, Meteorological Services, Agriculture, and Water)?				
1.7: Are decision-makers (both within MoH and outside) aware of climate change and health risks, as well as potential adaptation options?				
1.8: Does the relevant information related to climate change, health risks, and adaptation reach the key stakeholders across sectors?				
1.9: Is climate change included in health plans at subnational levels?				

HEALTH WORKFORCE				
Questions	Assessment			
	Yes	No	Partial	N/A
2.1: Are there dedicated full-time staff devoted to climate change and health?				
2.2: Is the number of healthcare workers above 4.5 per 1,000?				
2.3: Are health workers adequately distributed between urban and rural areas?				
2.4: Is the health workforce aware of the health risks of climate change?				
2.5: Are there capacity-building programs focused on climate change and health within MoH?				
2.6: Have the MoH staff received training on climate change and health in the last two years?				
2.7: Does the health workforce have the technical capacity to interpret and utilize climate change information (for example, scenarios, projections, and forecasts) to inform planning / decision-making?				
2.8: Are climate change and health included in the educational curriculum (for example, the schools of public health, medicine, and nursing)?				
2.9: Are there context- or country-specific climate change and health training / educational materials for the health workforce?				

HEALTH INFORMATION AND DISEASE SURVEILLANCE SYSTEM

Questions	Assessment			
	Yes	No	Partial	N/A
3.1: Has the country completed a climate change and health vulnerability and adaptation or risk assessment?				
3.2: Do surveillance systems exist for climate-sensitive diseases (for example, heat-related illnesses, VBDs, and WBDs)?				
3.3: Does the country have a centralized monitoring system for climate-related diseases?				
3.4: Do health surveillance systems integrate meteorological and / or environmental information?				
3.5: Are there efforts from MoH to utilize national climate / meteorological information?				
3.6: Does the country have a climate-informed early warning system for any health risks?				
3.7: Are there early warning systems in place for climate change-related extreme events / hazards (for example, floods, droughts, and storms)?				
3.8: Does MoH coordinate with disaster- / hazard-focused early warning systems?				

ESSENTIAL MEDICAL PRODUCTS, TECHNOLOGIES, AND INFRASTRUCTURE

Questions	Assessment			
	Yes	No	Partial	N/A
4.1 Have the country's healthcare facilities been assessed for climate resilience?				
4.2 Are health facilities accessible to rural communities?				
4.3: Do healthcare facilities implement measures to remove mosquito-breeding sites?				
4.4: Have healthcare facilities employed adaptive measures to protect against climate change-related hazards (for example, flood walls or drainage systems)?				
4.5: Does the national laboratory have the capacity to conduct diagnostic tests for climate-sensitive diseases?				
4.6: Are the building codes for healthcare facilities to protect against climate change-related hazards in place and enforced?				
4.7: Have healthcare facilities implemented "greening" activities (for example, tree planting and cooling designs)?				
4.8: Are there efforts to incorporate long-term planning (for example, urban design) to reduce climate change and health impacts?				
4.9: Are health facilities adequately equipped to prepare for and respond to climate change-related hazards (for example, a stockpile of medical / emergency supplies)?				

HEALTH SERVICE DELIVERY				
Questions	Assessment			
	Yes	No	Partial	N/A
5.1: Has the country enacted legislation to mandate universal healthcare coverage?				
5.2: Are there climate change-specific health programs underway in the country?				
5.3: Does health service delivery have contingency measures for extreme weather events (for example, floods, storms, and heatwaves)?				
5.4: Does the current public health planning consider climate change information (for example, scenarios, projections, and forecasts)?				
5.5: Has MoH implemented any climate-health awareness campaigns to increase public awareness?				
5.6: Is there access to safe water, sanitation, and hygiene (WASH) facilities for over 80 percent of the country?				
5.7: Do over 80 percent of the healthcare facilities have access to safe WASH and healthcare waste removal / storage?				
5.8: Have multihazard risk assessments been conducted in the country?				
5.9: If conducted, do the multihazard risk assessments include potential health risks?				

FINANCING				
Questions	Assessment			
	Yes	No	Partial	N/A
6.1: Is MoH currently receiving international funds to support climate change and health work?				
6.2: Is there dedicated funding for climate change and health activities under MoH?				
6.3: Is the health expenditure percentage of GDP above WHO's recommendation?				
6.4: Is the national health budget dependent on donors or foreign aid?				
6.5: Are there climate considerations in the national health budget?				

ANNEX C. CATEGORIZATION OF RECOMMENDATIONS

Short-term — less than 2 years; Medium — 2 to 5 years; and Long-term — more than 5 years

COMPONENTS	SUMMARY OF RECOMMENDATIONS
Leadership and Governance	Medium-term: Enhance the coordination mechanisms for climate action, championed by MoH and the HCCT, to liaise with stakeholders inside and outside the health sector. Articulate climate-health actions in subnational plans.
Health Workforce	Short-term: Create and promote health workforce retention packages to ensure that there are sufficient skilled health workers in areas at the highest risk of climate-related hazards. Long-term: Scale up formal pedagogical training developed by Malawi's HCCT on climate and health, by incorporating it into the medical and paramedical curricula (targeted at medical professionals, including nursing professionals and CHWs) at higher education and vocational institutions.
Integrated Risk Monitoring and Early Warning	Short-term: Strengthen communication networks between DoCCMS and communities at risk for extreme weather events.
Management of Environmental Determinants of Health	Short-term: Support community-led efforts to improve sanitation practices and controls to prevent WBDs and foodborne illnesses and diseases, as well as communicate about potential climate change-related health risks. Medium-term: Engage medical colleges and MoE and integrate with district-level community groups to support dialogues, the promotion of awareness, and the development of prospective climate and health programs, such as the health promotion programs that are focused on climate-related health risks.
Climate and Health Financing	Short-term: Ensure that strategic purchasing includes climate-related health risk considerations.

ANNEX D. KEY RECOMMENDATIONS AND RELEVANT LINE MINISTRIES IN MALAWI

HIGH-LEVEL RECOMMENDATIONS	RELEVANT LINE MINISTRIES	WHO'S CLIMATE AND HEALTH OPERATIONAL COMPONENT
- Enhance the coordination mechanisms for climate action, championed by MoH and the HCCT, to liaise with stakeholders inside and outside the health sector. - Articulate climate-health actions in subnational plans.	MoH, the Ministry of Natural Resources and Climate Change (MNRCC), and the Department of Climate Change	Leadership and Governance
- Create and promote health workforce retention packages to ensure that there are sufficient skilled health workers in areas at the highest risk of climate-related hazards. - Scale up the formal pedagogical training developed by Malawi's HCCT on climate and health and incorporate it into the medical and paramedical curricula (targeted at medical professionals, including nursing professionals and CHWs) at higher education and vocational institutions.	MoH, MoE, MNRCC	Health Workforce
Strengthen the communication networks between DoCCMS and the communities at risk for extreme weather events.	MoH, MNRCC	Integrated Risk Monitoring and Early Warning
- Reinforce public awareness on the health implications of poor sanitary and waste disposal practices, including open defecations, amidst a changing climate. - Engage medical colleges and MoE and integrate with district-level community groups to support dialogues, the promotion of awareness, and the development of prospective climate and health programs, such as health promotion programs that are focused on climate-related health risks.	Ministry of Health, Ministry of Local Government, MNRCC, and MoE	Management of Environmental Determinants of Health
Ensure that strategic purchasing includes climate-related health risk considerations.	MoH, the Ministry of Finance, MNRCC	Climate and Health Financing

ANNEX E. RECOMMENDATIONS BY CLIMATE-RELATED HEALTH RISK

	Food security and Nutrition	Vector-borne Diseases (VBDs)	Waterborne Diseases (WBDs)	Extreme Weather and Climate Hazard-Associated Mortality	Heat-Related Morbidity and Mortality	Air Quality	Mental Health and Well-being
Component 1: Leadership and Governance	Incorporate climate change risks into food security and nutrition strategic plans, including sustainable agriculture efforts. Strengthen the coordination mechanisms among MoH, MoAg, and international stakeholders.	Implement the malaria control strategic plan.	Develop an independent government agency to oversee water quality surveillance, monitoring, and the enforcement of water quality policies and laws. Enhance the coordination between rural water boards and national offices. Promote community-based water management and governance approaches.	Develop and implement a health-specific DRM plan for integration with national policies and support it with the necessary mandates.	Develop and implement a national heat health policy and city-level plans.	Develop an operational framework that integrates the impacts of climate change on air quality and health in climate change programs. Formulate a national climate and air quality policy / law that integrates health issues.	Promote mental health and advocate for it as a key component in MoH's strategic planning to also account for climate-related mental health risks Establish a coordination mechanism involving religious and local leaders, with the aim of reducing stigma around mental health.
Component 2: Health workforce	Incorporate educational materials on climate change impacts on food security and nutrition into health worker training.	Provide training at subnational levels to enhance the capacity of dengue prevention and control, as well as the knowledge of climate change-related factors.	Promote routine training and refresher opportunities for the health workforce, including CHWs, on the diagnosis and treatment of WBDs.	Conduct simulation exercises with health workers at subnational levels, focusing on service delivery during emergencies, including compounding / cascading climate-induced disasters.	Conduct heat-health training for health workers. Ensure occupational heat exposures are managed.	Map gaps and create training opportunities in air pollution and related health outcomes. Develop health-specific awareness and education materials for health workers on the risks of indoor and outdoor air pollution.	Promote and create incentives to increase the number of mental health workers and the avenues of training, which also take into consideration climate change risks. Develop mental health services aimed at providing services to healthcare workers. Develop mental health courses focused on emergency psychological services for healthcare workers who are going to be deployed in response to extreme weather events.

Component 3: Vulnerability, capacity, and adaptation assessment	Conduct a vulnerability assessment of nutrition to climate change. Assess the nutrition benefits of climate-smart agricultural interventions. Assess the capacities of the health system to respond to acute food insecurity and emergency-related nutritional risks.	Conduct district- and community-level assessments to better understand local risks related to VBDs and the capacities for managing outbreaks.	Enhance and promote routine vulnerability assessments and adaptation planning.	Conduct integrated multihazard vulnerability and risk assessments at the local / district levels.	Conduct the assessments of high-risk groups at the city level, including informal settlements, and incorporate economic analyses.	Assess indoor and outdoor air pollution levels and health impacts in both urban and rural areas.	Develop baseline data on mental health in relation to climate change and improve the surveillance of mental health outcomes. Assess the capacity of community-centered resilience building and targeted vulnerable populations.
Component 4: Integrated risk monitoring and early warning	Develop and include long-term strategies for nutrition interventions into the famine early warning system (FEWS).	Build from HIS to incorporate climate-informed seasonal outlooks.	Integrate climate change projections with WBD surveillance to strengthen WBD outbreak predictions.	Strengthen HIS to incorporate emergency preparedness and use technology for the monitoring and surveillance of health conditions in emergencies.	Strengthen the heatmap alert systems for urban and rural populations.	Develop air quality monitoring systems and public health risk communication.	Develop monitoring and surveillance systems that account for climate-related mental health risks, and mental health indicators related to well-being (for example, livelihoods and stressful events).
Component 5: Health and climate research	Analyze the long-term effects of climate change on food systems, nutritional outcomes, and the economy.	Conduct climate change modeling studies to estimate dengue risk projections and inform adaptation decisions.	Enhance scientific research to support a better understanding of climate change variability and health impacts, and guide climate change adaptation communication.	Develop and include extreme weather event attribution studies as evidence of impacts on human health.	Conduct studies to further explore the impacts of extreme heat on health systems, including urban heat island mapping.	Invest in more research on air pollution-related health effects and further the understanding of the linkage between climate change and air quality.	Include climate-related mental health risks into MoH's research agenda and promote partnerships with national universities and research institutions to better understand the impact of climate change on mental health.

Component 6: Climate- resilient and sustainable technologies and infrastruc- ture	Improve drainage systems in crop fields at risk of floods. Explore smart-agricul- ture and crop-diversi- fication practices.	Improve laboratory capabilities for testing and diagnosing endemic, novel, and re-emerging diseases. Develop a list of essential medicines needed for VBD outbreaks Adopt irrigation systems that take into consideration the increased exposure to VBDs, such as alternate wet-dry irri- gation or the system of rice intensification (SRI).	Improve WASH facili- ties (including appro- priate waste disposal systems), both at healthcare facilities and in the communi- ties, and ensure that these facilities are climate resilient.	Revise specifications to include climate risk projections in the siting and construc- tion, functioning and operation, energy and water supplies, and the sanitation services of healthcare facilities.	Ensure space cooling in healthcare facilities to prevent overheating and protect infor- mation technology (IT) and equipment. Implement energy-ef- ficient or passive measures of cooling to reduce energy costs.	Invest in the use of sustainable and renewable energy sources, such as the use of solar power, in healthcare facilities.	Explore technologies that could improve access to mental health services (for example, telemedi- cine).
Component 7: Management of environmen- tal determi- nants of health	Conduct communi- ty-led efforts to map food insecurity and inform interventions for improving the food system in a changing climate.	Conduct community awareness campaigns to increase the awareness of the impact of climate on VBD outbreaks and engage vulnerable groups in outbreak prevention.	Strengthen envi- ronmental public health programs and surveillance. Establish a plan to enhance the reliabil- ity of routine public water source cleaning and testing.	Develop and implement regulations for disease outbreak responses and other climate-related health emergencies and incorporate them into disaster management planning.	Provide occupational health management.	Enhance routine indoor and outdoor air pollution exposure assessments.	
Component 8: Climate- informed health program	Implement inter- ventions involving the establishment of gardens or food-growing oppor- tunities. Conduct a community-mediated delivery of nutrition services, including screening.	Incorporate climate change information into the prevention of VBDs and develop SOPs to respond to outbreaks.	Strengthen the public awareness program on proper hygiene and sanitation, along with climate change impacts on health.	Integrate DRM into public health training and implement public awareness campaigns that are focused on the links between disasters, climate change, and health.	Ensure that heat risks are incorporated into maternal health guidance, guidance for diabetes manage- ment, etc.	Raise awareness about air pollution and its impacts on health in communities and engage commu- nities in air pollution awareness programs.	Integrate mental health services that account for climate-related mental health risks into primary and secondary health services.

Component 9: Emergency preparedness and manage- ment	Reinforce the food production and distribution chain to withstand the impacts of extreme weather events.	Incorporate VBD outbreaks into DRM plans at the national, provincial, district, and community levels.	Enhance the emergency response planning to ensure safe and sustainable water supply and clean sanitation at healthcare facilities and displacement camps, as well as in communities.	Conduct exercises / testing of disaster preparedness plans (tabletop and real-world), along with the evaluations of the responses / uses of the plans in the health sector.	Include heat into DRM operations.	Integrate air quality emergencies into DRM plans and programs. Enhance routine air quality surveillance and monitoring.	Develop a program on the emergency psychology response to climate-related hazards.
	Component 10: Climate and health financing	Invest in the dissemination of crop varieties and breeds adapted to changing climatic conditions. Establish a budget line allocated to nutrition (and climate-related nutritional risks) within MoH.	Formulate proposals to seek support from external donors to improve the control of VBDs	Prioritize investments for building climate-resilient WASH infrastructures in healthcare facilities and displacement camps.	Deploy resources to support preparedness for extreme weather events and the response to them.	Finance sustainable cities / cool cities that address heat risks and other heat-health interventions, such as cool roofs.	Improve multisectoral coordination and international collaboration opportunities for financing air pollution research, equipment, training, and programs.
							Establish a budget line allocated to mental health within MoH.

ANNEX F. PROJECTED AVERAGE MONTHLY TEMPERATURE AND PRECIPITATION PATTERNS IN MALAWI, UNDER SSP3-7.0

MEAN TEMPERATURE (°C)			
	Historical Reference, 1995–2014	2020–2039	2040–2059
Jan	23.75 (22.64; 28.89)	24.3 (23.32; 25.54)	25.09 (24.08; 26.50))
Feb	23.83 (22.52; 24.82)	24.31 (23.27; 25.4)	25.07 (23.79; 26.31)
Mar	23.5 (22.38; 24.39)	24.18 (23.03; 25.05)	24.84 (23.63; 25.82)
Apr	22.48 (21.44; 23.31)	23.19 (22.24; 23.91)	23.89 (22.89; 24.71)
May	20.68 (19.91; 21.46)	21.33 (20.69; 22.03)	22.17 (21.32; 22.96)
Jun	18.8 (18.13; 19.47)	19.61 (18.83; 20.21)	20.27 (19.32; 21.02)
Jul	18.28 (17.41; 19.57)	19.09 (17.93; 19.91)	19.84 (18.79; 20.73)
Aug	19.75 (18.68; 21.38)	20.57 (19.32; 21.87)	21.23 (20.19; 22.53)
Sep	22.87 (21.21; 24.01)	23.78 (22.33; 24.49)	24.51 (23.14; 25.51)
Oct	25.73 (23.96; 26.64)	26.61 (24.81; 27.39)	27.56 (25.64; 28.35)
Nov	25.82 (24.95; 26.58)	26.77 (25.89; 27.9)	27.48 (26.77; 28.58)
Dec	24.42 (23.14; 25.54)	25.07 (24.23; 26.49)	25.9 (25.0; 27.45)
PRECIPITATION (MM)			
	Historical Reference, 1995–2014	2020–2039	2040–2059
Jan	297.35 (211.64; 375.72)	295.1 (216.55; 397.73)	302.64 (215.8; 389.36)
Feb	263.15 (172.15; 327.8)	257.4 (182.44; 354.79)	257.79 (183.42; 338.5)
Mar	199.96 (120.27; 280.09)	204.33 (123.72; 285.38)	204.25 (134.82; 300.16)
Apr	84.8 (41.41; 129.5)	90.78 (32.88; 130.03)	85.98 (36.43; 128.84)
May	27.88 (10.36; 48.95)	24.38 (9.44; 53.81)	23.8 (8.41; 48.12)
Jun	13.38 (4.52; 30.52)	11.34 (4.15; 33.34)	11.04 (4.34; 31.5)
Jul	10.33 (3.7; 25.38)	9.6 (3.75; 23.97)	9.88 (3.79; 25.77)
Aug	8.04 (2.95; 21.11)	6.02 (2.59; 22.26)	5.92 (2.02; 20.19)
Sep	7.01 (2.91; 18.84)	5.06 (2.23; 15.51)	4.29 (1.88; 13.85)
Oct	18.46 (8.84; 46.67)	14.76 (4.88; 36.41)	12.95 (4.99; 29.3)
Nov	103.14 (56.52; 150.19)	93.73 (46.51; 141.98)	95.59 (47.14; 145.72)
Dec	247.23 (156.53; 339.01)	239.05 (158.16; 329.02)	231.66 (140.55; 349.2)

Note: Data presented shows the median (50th percentile) and the 10th and 90th percentiles, in brackets, of the multimodel ensemble for the designated time periods, under SSP3-7.0.

Source: World Bank Climate Change Knowledge Portal

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