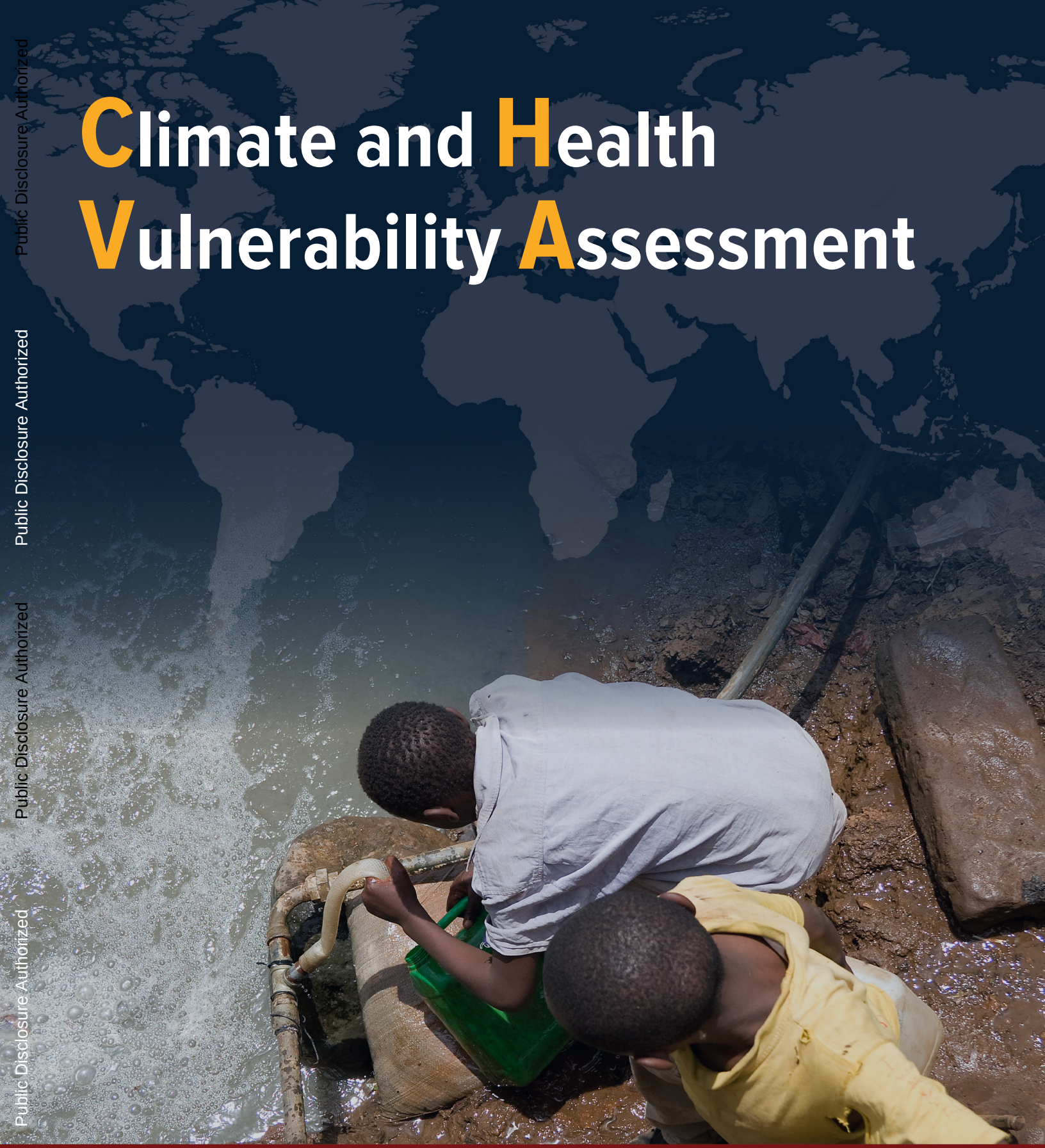
Climate and Health Vulnerability Assessment



TANZANIA

CIF CLIMATE INVESTMENT FUNDS

CSF CLIMATE SUPPORT FACILITY

THE WORLD BANK
IBRD • IDA | WORLD BANK GROUP

1818 H Street NW
Washington DC 20433
Telephone: 202-473-1000
Internet: www.worldbank.org

Cover photo: Shutterstock/jwebb.

TANZANIA

Climate and Health Vulnerability Assessment

CONTENTS

LIST OF TABLES

LIST OF FIGURES

ACKNOWLEDGMENTS

The authors are thankful to the Africa Climate Resilient Investment Facility (AFRI-RES) Trust Fund and the Climate Investment Funds (CIF) for funding this work.

This Climate and Health Vulnerability Assessment (CHVA) for Tanzania was produced by the Health, Climate, Environment and Disasters (HCED) program in the Health, Nutrition and Population (HNP) Global Practice of the World Bank, which is led by Tamer Rabie. It is authored by Judith Namanya, Mikhael Iglesias, Stephen Dorey, and Tamer Rabie.

The authors sincerely appreciate the valuable contributions provided by Ana Lucrecia Rivera-Rivera, Muloongo Simuzingili, Maria Gracheva, April Frake, and Peter Okwero.

This work also benefited from the administrative support of Fatima-Ezzahra Mansouri, and the editorial work of Kah Ying Choo, and the production of Sarah Jene Hollis.

The authors are also highly grateful to the HNP management for their strong support of the HCED program and this product and would like to extend their thanks to Juan Pablo Uribe and David Wilson.

LIST OF ABBREVIATIONS

AR6	IPCC Assessment Report 6
CCKP	Climate Change Knowledge Portal [World Bank]
CHVA	Climate and Health Vulnerability Assessment
CHF	Community Health Fund
CHMT	Council Health Management Team
CHW	Community Health Worker
CMIP6	Coupled Model Inter-comparison Project Phase 6
COVID-19	Coronavirus disease 2019
CRU	Climatic Research Unit [University of East Anglia, UK]
DMO	District Medical Officer
DRM	Disaster Risk Management
EMA	Environment Management Act
EWS	Early Warning Systems
FBO	Faith-Based Organization
GCM	General Circulation Model
GDP	Gross Domestic Product
GHG	Greenhouse Gas [emissions]
GHO	Global Health Observatory
HCED	Health Climate, Environment and Disaster Program
HIS	Health Information Systems
HMIS	Health Management Information System
HNAP	Health National Adaptation Plan
HNP	Health, Nutrition, and Population
HPAP	Health and Pollution Action Plan
HRH	Human Resources for Health
HSS	Health System Strengthening
HSSP	Health Sector Strategic Plan
HTA	Health Technology Assessment
IDSR	Integrated Disease Surveillance and Response
INDC	Intended Nationally Determined Contributions
IPC	Integrated Food Security Phase Classification
IPCC	Intergovernmental Panel on Climate Change
ITZC	Intertropical Convergence Zone
JRC	Joint Research Centre
LULC	Land Use and Land Cover
MAT	Medical Association of Tanzania
MHEWS	Multihazard Early Warning Service
MSD	Medical Stores Department
MoHSW	Ministry of Health and Social Welfare
MoW	Ministry of Water
NAPA	National Adaptation Programme of Action
NASA	The National Aeronautics and Space Administration
NCCCS	National Climate Change Communication Strategy
NCCRS	National Climate Change Response Strategy
NCCS	National Climate Change Strategy
NCD	Noncommunicable Disease

NDC	Nationally Determined Contributions
NEP	National Environmental Policy
NHIF	National Health Insurance Fund
NIMR	Tanzania National Institute for Medical Research
NGO	Non-Governmental Organization
PM2.5	Fine Particulate Matter
PPP	Public-Private Partnership
RCP	Representative Concentration Pathway
SMS	Short Message Service
SSP	Shared Socioeconomic Pathway
TAMSA	Tanzania Medical Student's Association
TBA	Traditional Birth Attendant
TDCS	Tanzania Disaster Communication Strategy
TEPRP	Tanzania Emergency Preparedness and Response Plan
TFNC	Tanzania Food and Nutrition Center
TH	Traditional Healer
TIKA	*Tiba Kwa Kadi*
TURP	The Tanzania Urban Resilience Program
UHC	Universal Health Coverage
UNDP-GEF	United Nations Development Programme Global Environmental Finance
UNFCCC	United Nations Framework Convention on Climate Change
VBD	Vector-Borne Disease
WASH	Water Sanitation and Hygiene
WBD	Waterborne Disease
WFP	World Food Programme
WHO	World Health Organization
WWF	World Wildlife Fund


TEST

EXECUTIVE SUMMARY

Tanzania is already experiencing the impact of climate change on health, the economy, and livelihoods. Climate-related hazards, such as extreme rainfall patterns, floods, and rising temperatures leading to the increased severity of droughts, are affecting food security and nutrition, as well as waterborne disease (WBD) transmission and spread, such as for dengue and malaria. The increasing burden of diseases puts pressure on an already precarious health system, while also deepening inequality in the country.

Considering Tanzania's high exposure and vulnerability to climate change, the World Bank, through the Health Climate, Environment and Disaster Program (HCED), is conducting a Climate and Health Vulnerability Assessment (CHVA). The objective of this CHVA is to assist decision-makers in planning effective adaptation measures to deal with climate-related health risks. Where available, these measures are also provided at a subnational level to assist regional health planners. The recommendations of this CHVA are primarily aimed at the health sector, as well as related sectors that have an influence on the health risks of climate changes, such as disaster risk management (DRM). The report provides information on both mainland Tanzania and Zanzibar (the main island off the coast).

The CHVA begins with an analysis of observed and projected climatology data from the Climate Change Knowledge Portal (CCKP) and climate hazards to inform climate-related health risks:

- **Mean annual temperatures have increased by 0.56°C over the past half century and are projected to increase by 0.68°C by the 2030s and 1.40°C by the 2050s.** Warming has been most pronounced in January, June, and September. While mean annual temperatures in Zanzibar will continue to accelerate through the mid-century, they will do so at a lower rate in mainland Tanzania.
- **Precipitation across mainland Tanzania has decreased by nearly 50 mm since the 1960s**, with the most substantial declines in the highlands of the Eastern Rift Valley. While future precipitation projections are less certain, rainfall is likely to increase slightly through the 2050s.
- **Sea-level rises pose a significant threat to coastal communities along the Tanzanian coastline and to Zanzibar.** Land and infrastructure damage is expected to amount to approximately USD200 million annually by 2050, based on projected sea-level rises ranging from 16 to 42 cm[1] and projected increases in storm surges of nearly 2 meters (m) by 2050.
- The escalating intensity of heavy rainfall events during the 2030s and 2050s is likely to exacerbate flooding risks, especially within the southeastern and northwestern regions of the mainland.
- While the rainy season will be more intense, there will be an overall increase in the occurrences of dry spells through the mid-century, especially in regions such as Mbeya, Tabora, Geita, Kigoma, Katavi, Rukwa, Shinyanga, Singida, and Ruvuma.

Tanzania faces significant health challenges from communicable diseases and noncommunicable diseases (NCDs), and climate change will worsen the severity of these health challenges. Climate-related health risks are not evenly distributed within the population, with some groups at greater risk than others. Tanzania's CHVA assesses seven climate-related health risk categories:

Nutrition risks: Tanzania is challenged by acute food insecurity: the prevalence of severe food insecurity was 56.4 percent among the Tanzanian population in 2019 — an increase from 55 percent in 2018. Rural Tanzanians (84 percent) are more vulnerable to food insecurity than urban residents (64 percent). Projected increases in population growth, coupled with climate change impacts on the agricultural sector, will continue to worsen extreme hunger, food insecurity, and malnutrition.

Vector-borne disease risks (VBDs): At 13.4 percent, Tanzania has one of the highest malaria prevalence rates in Eastern and Southern Africa. An estimated 93 percent of the population of mainland Tanzania is at risk of contracting malaria. Vector suitability ranges — in particular for mosquitoes — are highly sensitive to climate factors. Projected increases in rain-induced floods will likely lead to increased malaria transmission and cases in Tanzania

Waterborne disease risks (WBDs): Waterborne diseases (WBDs) are one of the leading causes of ill health and deaths among Tanzanian children; they are responsible for 23,900 deaths per year among the under-fives. Projected increases in extreme rainfall and associated floods will likely increase drinking water contamination and WBD outbreaks.

Heat-related morbidity and mortality risks: Populations in the Mara region and Dar es Salaam are more vulnerable to extreme heat-related injuries and mortalities. Extreme heat exposure will become more common throughout the mid-century, with populations in the Dar es Salaam region and the regions of Zanzibar at the greatest risk.

Air quality health risks: In Tanzania, indoor air pollution remains the single largest driver of poor health. Domestic biomass combustion is the biggest contributor to indoor air pollution in households, with women and children disproportionately affected due to their prolonged exposure.

Direct injuries and mortality risks: Heavy rains, which induce flash floods, mudslides, and landslides, threaten lives and livelihoods in Tanzania. Projected increases in flooding, associated with increasing temperatures and precipitation, will likely cause more deaths and direct injuries.

Mental health & well-being risks: Mental health conditions are a growing concern in Tanzania, with the country's neuropsychiatric disorders accounting for an estimated 5.3 percent of the global disease burden. Climate change, along with the resulting socioeconomic and livelihood insecurities, have affected the mental health of low-income Tanzanians immensely and created new vulnerabilities for those already experiencing mental health and substance use disorders.

The extent to which the health system in Tanzania is prepared for and has the capacity to manage changes in hazards, exposure, and susceptibility will determine its resilience in the coming decades. In this CHVA, Tanzania's adaptive capacity to prevent and manage climate-related health risks is examined according to the World Health Organization's (WHO) six health system building blocks:

- **The government of Tanzania recognizes climate change and its impacts on the country's development.** As a result, the government has already been developing strategies and policies to guide climate change mitigation and adaptation action. However, there is a need for coordination mechanisms that promote synergies between ministries in order to improve resilience and health outcomes.
- There are limitations in the health workforce, both in professional expertise and distribution, as well as an overarching lack of information on the awareness of climate change and health risks among health workers.
- **Tanzania has integrated disease surveillance and response (IDSR) systems that are currently monitoring 34 priority diseases and conditions. Other programs are aimed at strengthening early warning systems (EWs) and responses to climate-related hazards.** The Tanzania Urban Resilience Program (TURP), created in 2016, integrates weather and climate information for all decision-making levels in order to enable improved responses to climate-related emergencies in urban areas. It also collects data on vulnerable and at-risk households, as well as identifies their coping strategies.
- **The introduction and implementation of public-private partnerships (PPPs) in the health sector in Tanzania have improved the access and delivery of health services.** However, the health facilities in the country are mostly concentrated in urban areas, which means that those living in rural areas have to travel greater distances to receive health care.
- **While there have been improvements in national investments on health, Tanzania is still highly dependent on foreign donors.** In fact, it still lags behind the Abuja Declaration target for African states to allocate 15 percent of their total budgets to the health sector.

The extent to which the health system in Tanzania is prepared for and has the capacity to manage changes in hazards, exposure, and susceptibility will determine its resilience in the coming decades.

RECOMMENDATIONS

Recommendations to reduce climate-related health risk and improve overall health service delivery are focused on establishing climate-smart health systems.

- → **Climate change and health should be adequately integrated, in terms of policies, strategies, and programs.** Climate change should be put into consideration when national health policies, strategies, and programs are developed. The integration of health and climate change should be strengthened from the national level to the local government level.
- → **The Health Management Information System (HMIS) and monitoring / surveillance activities could account for climate-related health risks and indicators.** This would require cross-sectoral work that will involve the Tanzania Meteorological Agency, along with the water & sanitation, disaster risk management (DRM), agriculture, and environment, responsible entities among others. Weather data could be incorporated into the assessment of health risks for better surveillance and early warning mechanisms.
- → **Financing to cover climate-related health risks should be increasing.** A proportion of national health funding should be earmarked for adaptation and mitigation policies and allocated to cover climate-related health risks; strategic purchasing that considers climate considerations should be adopted.

SECTION I.

INTRODUCTION

COUNTRY CONTEXT

1. **Climate change is already taking a toll on Tanzania's economy, as well as its people's health and livelihoods.** The country is experiencing increasing geographical socioeconomic inequality and vulnerability to climate change impacts,[2] which will continue to exacerbate these inequalities. Extreme floods caused by climate change, unpredictable rainfall, and prolonged droughts affect food production and nutrition, especially for children and poor rural households. Heavy rain-induced flash floods have increased contaminants in drinking water sources and associated waterborne disease (WBD) outbreaks. High temperatures have led to the spread of vector-borne diseases (VBDs) to new areas of Tanzania's Northern highlands.[3] The growing disease burden is putting increased pressure on the country's already struggling health system.

2. **Tanzania is the largest country in East Africa; its country status rose from "low" to "lower-middle" income in July 2020.**[4] This achievement is primarily attributed to the country's two decades of economic reforms and commitment to poverty alleviation. One such reform is Tanzania's Development Vision 2025 — first formulated in 1995 and launched in 2000 to guide national-level economic and social development efforts up to 2025.[5] Tanzania, one of Africa's fastest-growing economies,[6] has seen a steady increase in its gross domestic product (GDP) from USD5.10 billion in 1988 to USD62.41 billion in 2020.[7] Agriculture, the backbone of Tanzania's economic system, contributes to 50 percent of the national income. Additional contributors to the county's economy are the energy, tourism, mining, and education sectors.[8]

3. **Tanzania is among the poorest countries in the world, with a GDP per capita of USD1,079.47 in 2020, despite the country's strong and stable economic growth.**[9] Although its GDP has increased steadily over the last decades, an estimated 29 million Tanzanians, out of a population of 59.15 million, lived in extreme poverty in 2021 (poverty line: USD1.90 per day).[10] While the *2019 Tanzania Mainland Poverty Assessment Report* shows that extreme poverty declined from 11.7 percent in 2007 to 8.0 percent in 2018,[11] inequality remains high (Gini: 40.5 in 2018), thereby highlighting income inequality gaps. Furthermore, in 2018, most of the population living below the poverty line resided in rural areas (31.3 percent of the country's population), compared with 15.8 percent in urban areas[12] (see Table 1 for a summary of development indicators).

TABLE 1.
Development Indicators for Tanzania

INDICATOR	CATEGORY	VALUE
Population	Population	59,734,213
	Annual population growth (%) (2020)	2.9
	Urban share of population (%) (2020)	35
	Employment in agriculture (% of total employment) (2019)	65
GDP	GDP (current USD, billions) (2020)	62.41
	Annual GDP growth (%) (2020)	2.0
	GDP per capita (current USD) (2020)	1,076.5
Pover	Poverty headcount ration at USD1.90 a day (2011 PPP) (% of population) (2018)	49.4
Climate and Disaster Risks	Rank (2019)	147
ND-GAIN[13]	Score (2019)	39.1

Sources: World Bank. Tanzania Mainland Poverty Assessment Report; https://www.statista.com/statistics/1230404/number-of-people-living-in-extreme-poverty-in-tanzania/; https://data.worldbank.org/indicator/NY.GDP.PCAP.CD?locations=TZ; https://worldpopulationreview.com/countries/tanzania-population

4. **Tanzania's population is quickly accelerating.** The country has the fifth-highest growth rate across Africa (2.98 percent).[14] In 2020, the population was 59.7 million — an exceptionally high increase from 25.2 million in 1990, and it is estimated to reach 129.4 million by 2050.[15] The fertility rate is 4.8 births per woman and a birth rate of 36.2 live births per 1,000 people.[16] As of 2022, 44.8 percent of Tanzania's population is under 15 years and 52 percent are between 15 and 64 years of age.[17] Most of the population resides in rural areas (64.77 percent in 2020) that are located in the highlands of northeastern Tanzania around Mt Kilimanjaro, Meru, and the Usambara mountains, along the shores of Lake Victoria, the coastal region, the southern highlands, and Zanzibar City.

5. **Tanzania has sought to address the impacts of climate change that threaten the country's socioeconomic and sustainable development, public health, and livelihoods, by embarking on various mitigation efforts and adaptation measures.** This includes developing policies and measures to boost the country's adaptive capacity to climate impacts. Tanzania has integrated climate into the country's existing policies and structures to support its climate change response, including the development of the National Climate Change Committee, the National Adaptation Programme of Action (2007), the National Climate Change Strategy (2012), and the integration of climate change into its Poverty Reduction Strategy Paper.[18] In July 2021, the country launched the 2021–2026 National Climate Change Response Strategy (NCCRS) to boost its overall resilience to the negative impacts of climate change and achieve sustainable development.[19] In addition, the Nationally Determined Contribution (NDC 2021) aimed for a greenhouse gas emissions (GHG) reduction of 10–20 percent by 2030.[20]

AIMS OF THIS ASSESSMENT AND CONCEPTUAL FRAMEWORK

6. **The objective of this Climate and Health Vulnerability Assessment (CHVA) is to support decision-makers in planning effective adaptation measures to deal with climate-related health risks.** Where available, these measures are also provided at a subnational level to assist regional health planners. The recommendations of this CHVA are primarily aimed at the health sector, as well as related sectors that affect climate-related health risks such as disaster risk management (DRM) or agriculture.

7. **Adaptation priorities need to be implemented alongside 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 the exact severity of the climate exposure facing populations in the future. There are many factors that could slightly slow or significantly speed up rates of change, including positive feedback effects, and most worrying of all, cascading climatological tipping points. For this reason, though not a focus of this assessment, mitigating existing greenhouse gas emissions (GHGs), as well as developing and implementing measures to protect human development from the changing climate, is of paramount importance.

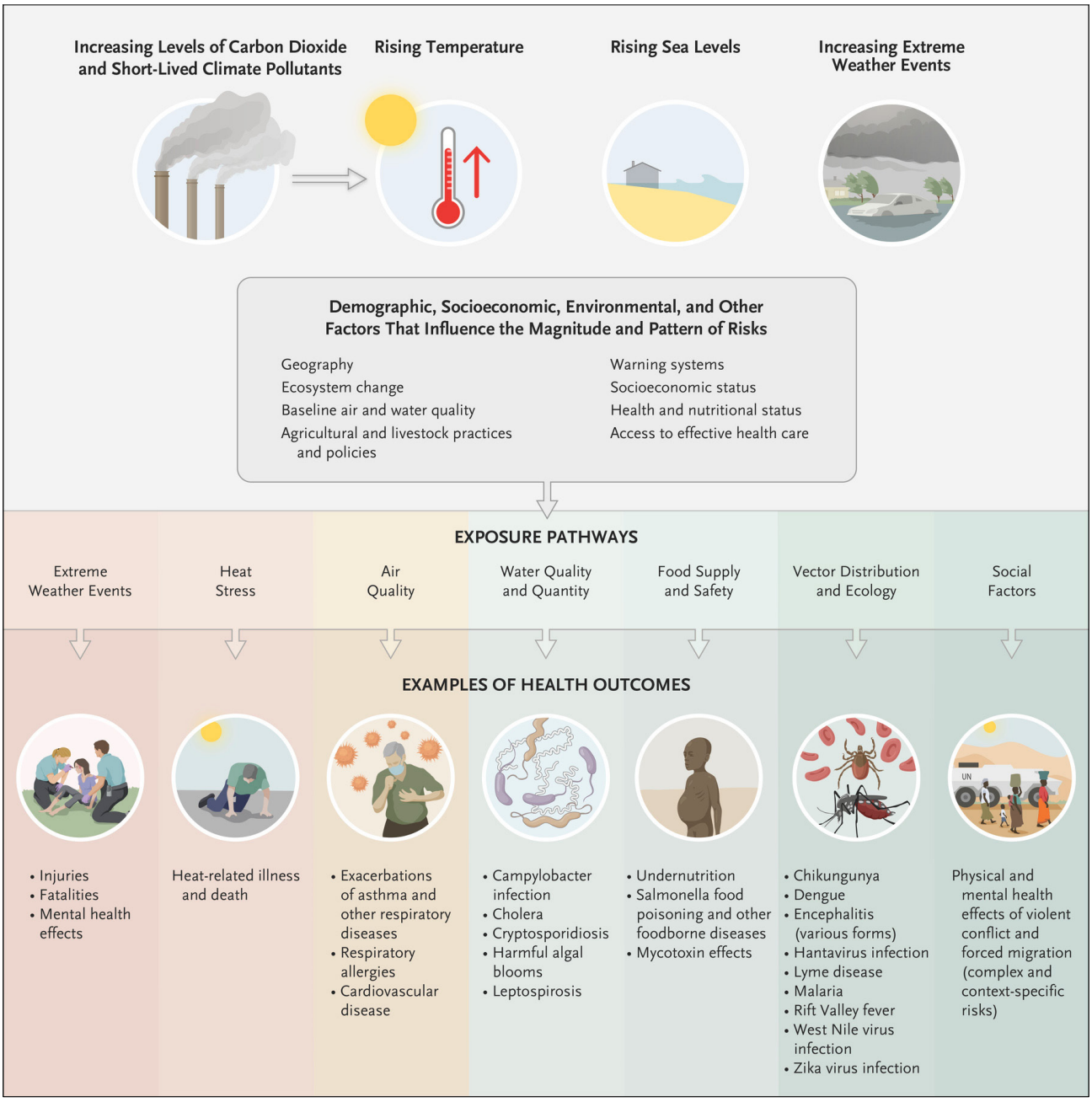
8. **Investment in adaptation strategies to proactively address the effects of climate change on health outcomes is critical.** This assessment is concerned with climate risks to health and health systems, the adaptive capacities that are in place to deal with these risks, and recommendations to meet identified gaps. The primary focus of this assessment is, therefore, on climate adaptation and resilience measures. However, as the Assessment Report Six (AR6)21 of the Intergovernmental Panel on Climate Change (IPCC) makes clear, "Global surface temperature will continue to increase until at least the mid-century under all emissions scenarios considered." Mitigation is no longer a sufficient strategy, regardless of the pace with which governments and communities around the world act. Adaptation is now as critical a part of climate action as mitigation. This report therefore focuses on adaptation measures, but, where possible, also includes recommendations for reducing GHGs or facilitating the decoupling of emissions from progress toward human development goals.

9. **The Haines and Ebi (2019) framework is adopted to guide the discussion on climate change-related health risks.** The framework (see Figure 1) shows the various exposure pathways through which climate change-related health hazards will affect human health.

10. **The World Health Organization's (WHO) operational framework (see Figure 2) for building climate-resilient health systems is adopted in this CHVA to analyze Tanzania's adaptive capacity to adequately deal with current and future identified risks.** The assessment is therefore structured around the six-health system strengthening (HSS) building blocks that lie at the core of this framework. These six categories are used to structure the assessment of the country's capacities and gaps — now and into the future. Subsequently, using the framework, the 10 components of health system climate resilience will be considered and presented in the Recommendations Section.

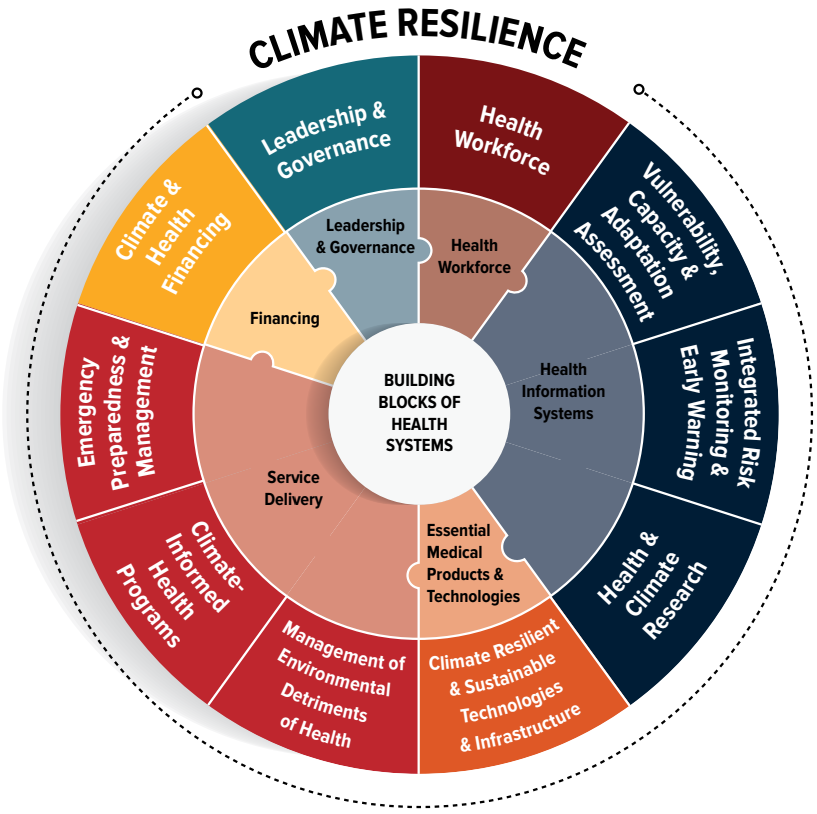
11. **This CHVA follows a stepwise linear approach (see CHVA Methodology for a detailed approach).** The first step presents the pertinent characteristics of the **climatology**

FIGURE 1.
Key Climate Change-Related Health Risks



Source: Andy Haines and Kristie Ebi, 2019, "The Imperative for Climate Action to Protect Health," New England Journal of Medicine 380 (3): 267.

FIGURE 2.
WHO's Operational Framework for Building Climate-Resilient Healthcare Systems

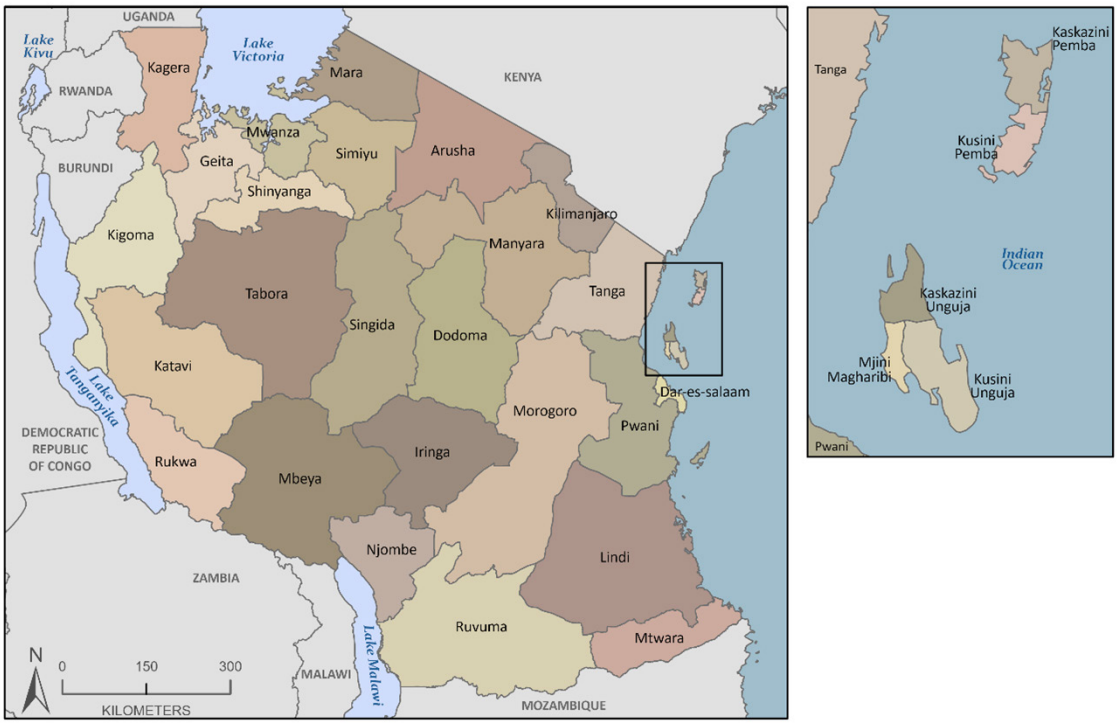


Source: World Health Organization, 2015, *Operational Framework for Building Climate Resilient Health Systems.*

in Tanzania, highlighting the observed and future climate exposures relevant to health. Using the Haines and Ebi (2019) framework, the second step examines **climate-related health risks (present and projected)**, including identifying vulnerable populations most at risk to the climate change-related health risks. Following WHO's six HSS building blocks and the 10 components of health system climate resilience, the final step assesses the **adaptive capacity of the health system**, identifying gaps to manage current and future climate-related health risks. Together, these steps inform a series of **recommendations** on reducing climate-related health vulnerability in Tanzania. The CHVA is based on a review of the published literature, national statistics, and consultations with key government counterparts including the Ministry of (MoHSW).

12. **The CHVA incorporates subnational considerations for health-related climate action.** Tanzania is divided into 31 administrative regions — 26 on the mainland and five in Zanzibar (see Figure 3). The regions are further divided into 169 districts and then into divisions and local wards. The capital, Dodoma, is located in the central area. Data for the analysis presented here reflect the administrative boundaries prior to the creation of the Songwe Region in 2016.

FIGURE 3.
Map of Tanzania and its Administrative Regions



Source: World Bank Cartography Unit

SECTION II.

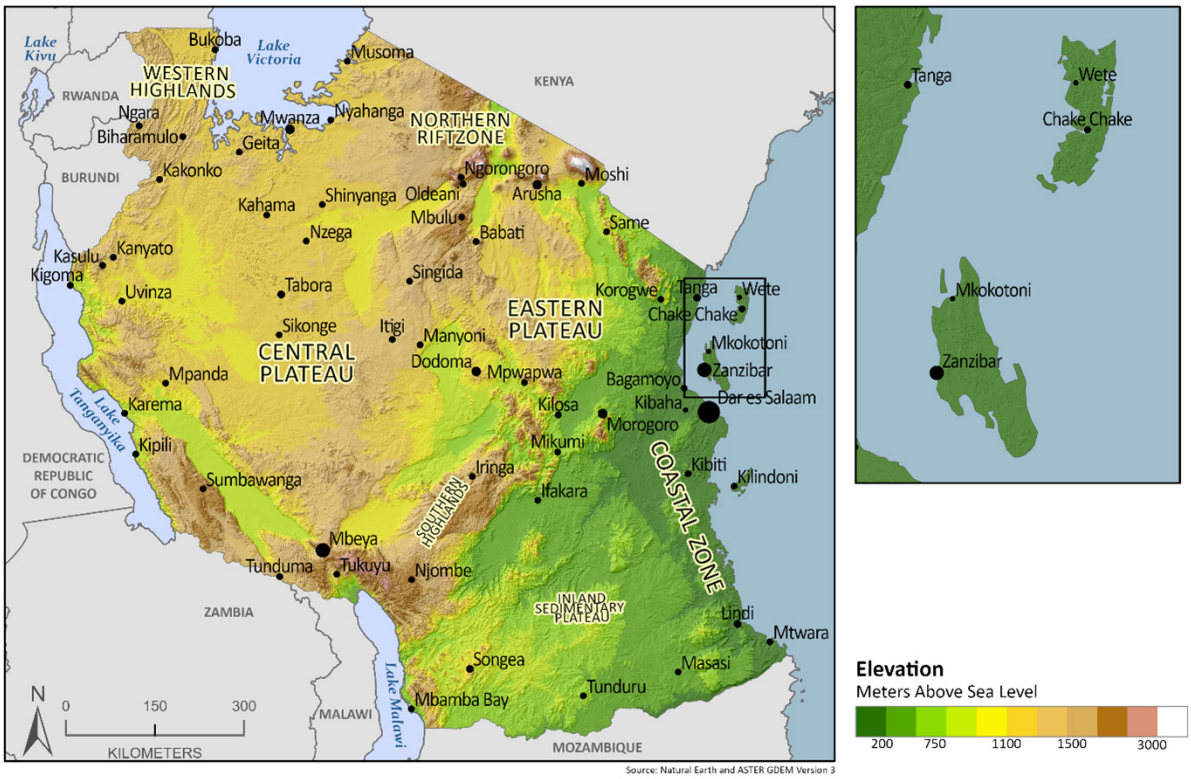
CLIMATE CHANGE: OBSERVED TRENDS AND PROJECTIONS

13. **This section describes observed climatic changes and projected climate trends, highlighting the priority climate-related hazards in relation to human health risks in Tanzania.** Climate information is taken from the World Bank Group's Climate Change Knowledge Portal (CCKP), where historical and observed data are derived from the Climatic Research Unit, University of East Anglia (CRU). Observed changes in the mean annual temperatures, mean maximum temperatures, mean minimum temperatures, and precipitation, presented on CCKP, uses the CRU TS version 4.05 gridded dataset for the 1901–2020 period. Model-based, climate projection data is derived from the Coupled Model Inter-Comparison Project Phase 6 (CMIP6). CMIP6 is a standard framework for the analysis of coupled atmosphere-ocean general circulation models (GCMs): it provides estimates of future temperature and precipitation scenarios. CMIP6 projections are shown through the five shared socioeconomic pathway (SSP) scenarios, as defined by their total radiative forcing (the cumulative measure of GHGs from all sources) pathways and levels by 2100. These projections represent possible future GHG concentration trajectories adopted by IPCC. This assessment explores projected climate changes under SSP3-7.0 for the short term (2030s; 2020–2039) and the medium term (2050s; 2040–2059).

TANZANIA'S GEOGRAPHY

14. **Tanzania, a country in East Africa, is located within the African Great Lakes region and situated south of the equator.** Tanzania, comprising mainland Tanzania and Zanzibar (the islands of Pemba, Unguja, and other small islands), covers a total area of 939,699 square kilometers (sq km). Mainland Tanzania is 740 miles long from North to South and 760 miles long, from East to West, with a coastline that stretches approximately 500 miles along the Indian Ocean.[22] It is bordered by Lake Victoria in the North, Lake Tanganyika in the West, Lake Nyasa in the Southwest, and the Indian Ocean in the East. Elevation ranges from 600 feet (ft) (coastal plains in the East) to 19,341 ft (Mount Kilimanjaro in the North), with much of the central mainland above 3,000 ft.[23] Tanzania's topography is highly diverse, dividing the country into several physiographic regions, including the Northern Rift Zone, the Eastern Plateau, the Coastal Zone, the Inland Sedimentary Plateau, the Southern Highlands, the Central Plateau, and the Western Highlands (see Figure 4).[24]

FIGURE 4.
Elevation Map of Tanzania and Major Cities



Source: Natural Earth and Aster GDEM Version 3

OBSERVED AND PROJECTED CLIMATOLOGY AND SEA-LEVEL RISE

15. **Mainland Tanzania has four distinct climate zones due to the country's highly diverse topography.** The highlands of the northeast and southwest are the coldest parts of the country, with average temperatures ranging from 20°C to 23°C. Annual precipitation is greatest in the southwestern highlands and the Lake Tanganyika basin, where rainfall can exceed 2,000 millimeters (mm) annually (see Figure 6). The northern and western high lakes region experiences cooler, semi-temperate conditions and approximately 750–1,250 mm of rainfall each year. The Central Plateau, situated between the two north-south branches of the East African Rift System, is hot and arid, with approximately 500 mm of annual precipitation. The coastal belt experiences the country's warmest temperatures that average 27–30°C, coupled with 750–1250 mm of annual precipitation.[25] In general, the mainland experiences cooler temperatures from May to August, with the highest temperatures occurring in March and October (see Table 2).

16. **Precipitation is highly seasonal and strongly influenced by the Intertropical Convergence Zone (ITCZ).** The south, west, and central regions experience long rains from October to May. In the north and east, there are two rainy seasons: the primary season is from March through May and the secondary from October to December.[26]

TABLE 2.

Seasonal Calendar of Temperature and Rainfall in Mainland Tanzania

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Temperature	Warm	Hot			Cooler Months					Hottest		Warm
Precipitation	Long Rains			Short Rains			Long Dry Season				Long Rains	

Source: World Bank Climate Change Knowledge Portal

TABLE 3.

CMIP6 Projections under SSP3-7.0 for Mainland Tanzania

CMIP6 ENSEMBLE PROJECTION	2020–2039	2040–2059
Annual Mean Temperature Anomaly (°C)	**+0.68°C** (0.36–0.96)	**+1.40°C** (1.03–1.87)
Annual Precipitation Anomaly (mm)	**+7.02 mm** (-427.07 - 488.56)	**+3.6 mm** (-434.79 - 537.54)

Notes: Bold value is the median (or 50th percentile); values in parenthesis indicate 10th–90th percentile range in mm.
Source: World Bank Climate Change Knowledge Portal

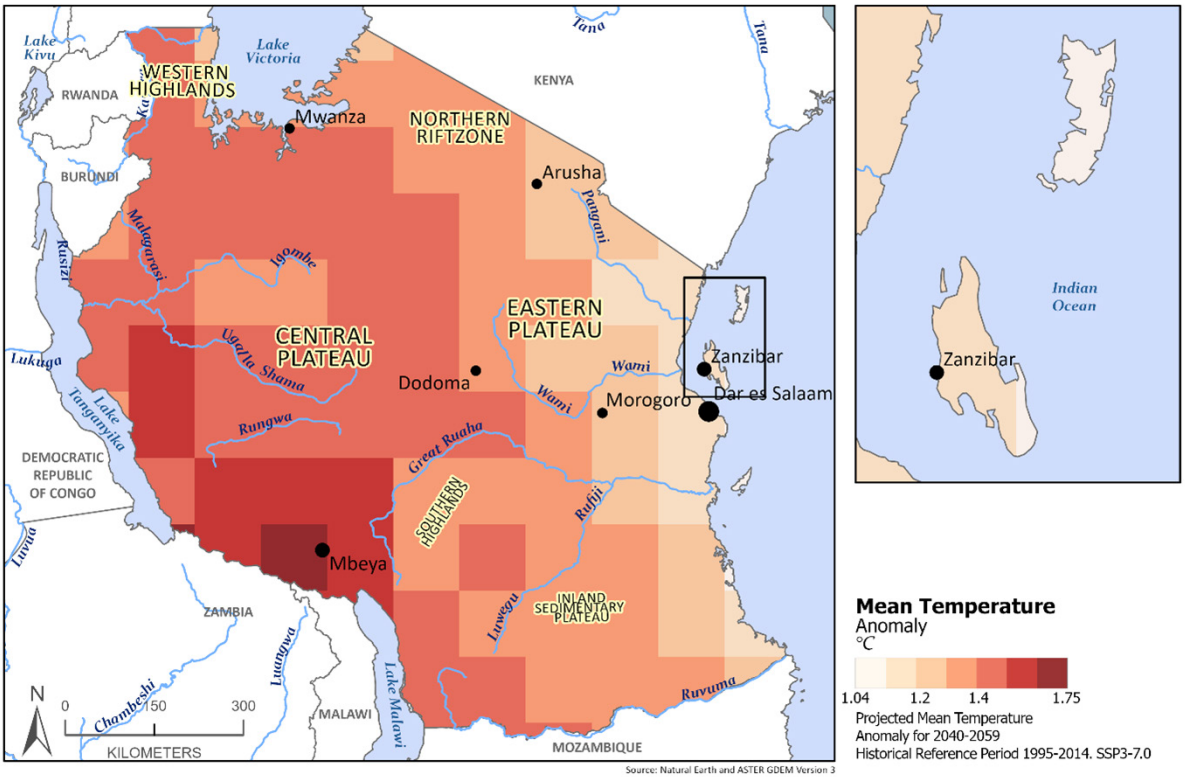
TEMPERATURE

17. **Mean annual temperatures, which have risen by 0.56°C over the past half century throughout the mainland of Tanzania, have occurred alongside increases in minimum (0.56°C) and maximum (0.55°C) temperatures.**[27] Warming has occurred throughout the year since 1960, with the highest increase in mean monthly temperature during August (+0.65°C). The shortening of the historical period for cooler temperatures, typically the June–August period, means that the country is experiencing warmer temperatures for longer periods throughout the year. October has historically had the highest average maximum temperatures: they range from 27.9°C in Njombe to 31.7°C in Pwani. In contrast, July is typically the coolest month of the year, with minimum temperatures ranging from 9.9°C to 19.6°C across the mainland. Annual mean temperatures range from 19.5°C in Njombe to 26.4°C in Dar es Salaam. From 1912 to 2009, rising temperatures have contributed to the loss of 85 percent of the ice cover on Mount Kilimanjaro.[28]

18. **Mean annual temperatures across mainland Tanzania are projected to increase by 0.68°C by the 2030s and 1.40°C by the 2050s** (see Table 3). As a result, monthly mean temperature increases are likely to range nationally from 21.4°C to 25.0°C in the 2030s and from 22.2°C to 25.8°C in the 2050s (see Figure 5). The largest increases in temperatures are projected to occur in August and September, thus signaling a continued lengthening of mainland Tanzania's historic warmer period. Western Tanzania, including the regions of Shinyanga, Tabora, Mbeya, Rukwa, and Singida, is projected to experience larger temperature increases than the eastern mainland. By the 2030s, extreme heat exposure[29] will threaten populations residing in 10 regions across the mainland,[30] with most regions experiencing such temperatures from September to December. See the following section on extreme heat for further discussions on population vulnerability to extreme temperatures.

FIGURE 5.

Projected Mean Temperature Increases for 2040–2059 throughout Tanzania under SSP3-7.0



Source: Natural Earth and Aster GDEM Version 3

PRECIPITATION

19. **Average annual precipitation across mainland Tanzania has declined by nearly 50 mm over the last half century, with the most substantial declines in the highlands of the Eastern Rift Valley.** Average precipitation during the rainy seasons across the mainland is 634 mm — more than two-thirds of the total annual rainfall. Generally, the southeastern mainland receives more precipitation than other areas of the country, except for the Kagera region in the northwest. Regions along the Eastern Rift Valley have experienced the largest declines in overall precipitation, most notably Njombe (-101 mm) and Kilimanjaro (-90.6 mm). The Mara region is the only region that has experienced a net gain (+10 mm) since the 1960s. Despite an overall net decline in annual rainfall, the country has, in recent decades, experienced heavy rainfall events in increasing frequency and intensity, which have led to widespread flooding throughout the mainland (see the section below on flooding). Notably, changes in the rainy season, including the unpredictability of onset and considerable shortening, have already led to shifts in the growing seasons,[31] with important implications for the cultivation of subsistence crops.

20. **Projections for precipitation in Tanzania include significant uncertainty however, median projections indicate that rainfall is expected to be heterogeneous throughout the mainland with an albeit slight, but increasing, trend through the mid-century.** Mean annual rainfall across the mainland is expected to

increase by a mere 1 mm through the 2050s, with the largest increases in monthly mean precipitation occurring in January and March (+12 mm in both months). Conversely, the long dry season is expected to become more arid, with monthly precipitation declines expected from May to October. Projected changes in rainfall are expected to follow a distinctly spatial pattern, with regions along the coastal belt experiencing declining mean annual precipitation, while regions further inland are likely to experience increases of more than 100 mm per year (see Figure 7). Moreover, heavy rainfall events are projected to intensify, with important implications for flooding across the mainland.

CLIMATE TRENDS AND PROJECTIONS IN ZANZIBAR

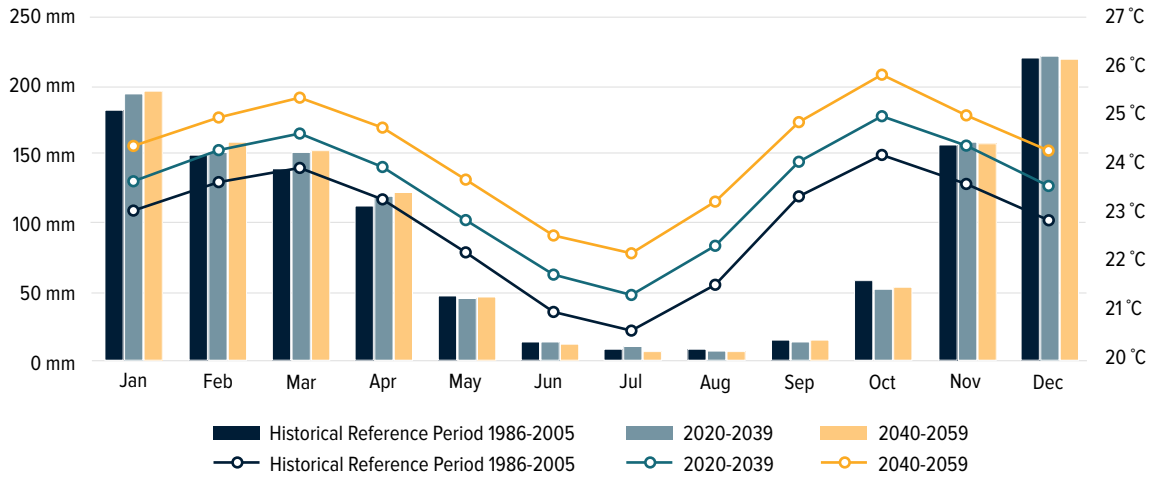
21. **Zanzibar has a tropical, hot climate year-round and two distinct rainy seasons — the more intense ("long rains") occur from March to May, while the less intense ("short rains") takes place from mid-October to December.**

TEMPERATURE

22. **Since 1960, annual minimum temperatures have increased more rapidly (+0.67°C) than the annual mean (+0.51°C) and maximum temperatures (0.36°C).** Warming has been the most pronounced in January, June, and September, with mean temperature increases of approximately 0.6°C. Mean monthly temperatures now range from 25.4°C in July and August to 28.8°C in January and February, while temperatures are fairly uniform across the five regions of Zanzibar. Northern and Southern Pemba typically experience lower temperatures than other regions.

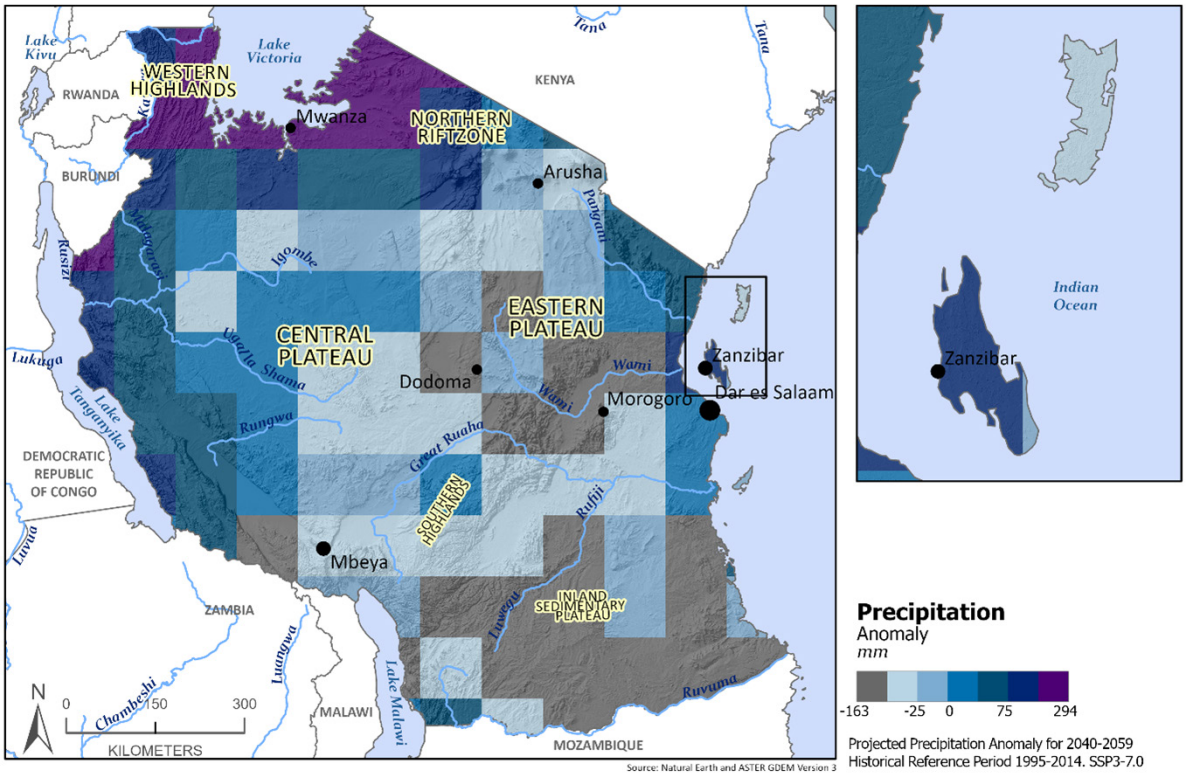
23. **Mean annual temperatures in Zanzibar will continue to accelerate through the mid-century, but at a lower rate than those projected for the mainland.** During the 2030s, mean annual temperatures are likely to increase by 0.57°C, followed by a projected increase of 1.13°C by the 2050s. The most pronounced increases are projected to occur in Mjini Magharibi and Kusini Unguja in May for both periods. Further, increases in mean

FIGURE 6.
Projected Average Monthly Temperature and Precipitation Patterns in Mainland Tanzania under SSP3-7.0



Source: World Bank Climate Change Knowledge Portal

FIGURE 7.
Projected Precipitation Anomalies for 2040–2059 (Annual) in Tanzania



Source: Natural Earth and Aster GDEM Version 3

maximum temperatures will push temperatures to at, or above, 33°C in February and March. Residents of Pemba are likely to be the most at risk of extreme heat exposure during these two months. This would be especially the case in March, when the heat index will exceed 35°C for approximately nine and 24 days by the 2030s and 2050s, respectively, in both regions of the island.

PRECIPITATION

24. Since mid-century[32], Zanzibar has experienced distinct inter-seasonal changes in the island's precipitation regime. Overall, annual precipitation has declined by approximately 40 mm, with the most pronounced decline during the dry season of June to September. The long dry season in Zanzibar is getting drier. Likewise, declines in monthly precipitation have also been observed from December (-1.5mm) to January (-19.7 mm) and in April (-15 mm), which is historically the rainiest month of the year. Nonetheless, despite monthly declines in April, rainfall during the long rainy season has increased by about 14 mm, due mainly to increases in precipitation (+26 mm) in March. Likewise, rainfall during the short rainy season has also increased slightly by 6 mm.

25. Median projections of annual net precipitation show an expected continued decline through the 2030s in Zanzibar (-3.5 mm), though it will increase by the 2050s (+52 mm). In both periods, the dry season from June through September is likely to continue

experiencing less overall rainfall, coupled with declines projected for mean monthly totals during the short rainy season, most notably in October (-7 mm: 2030s; -18 mm: 2050s). Monthly increases in precipitation are likely to occur from December to April, with more pronounced increases in January during the 2030s (+10 mm) and December during the 2050s (+15 mm).

SEA-LEVEL RISES

26. **Sea-level rises pose a significant threat to coastal communities along the Tanzanian coastline and to Zanzibar, including the five million residents of Tanzania's largest city — Dar es Salaam.**[33] Tanzania's mainland, with approximately 800 km of coastline, comprises five administrative regions and several major coastal cities that house approximately 25 percent of the total population, including the commercial and government center — Dar es Salaam.[34] The coastal zone, rich in natural resources, is characterized by mangrove forests and swamps, estuaries, coral reefs, intertidal flats, as well as sandy and muddy beaches.[35] These characteristics, along with other marine and coastal resources, contribute significantly to the overall social and economic development of the coastal communities and the country.

27. **Historical sea-level data for coastal Tanzania show an overall increasing trend, with an average annual anomaly of 115.78 mm in 2015.**[36] Potential impacts of ongoing sea-level rises, coupled with anthropogenic pressures (for example, the overexploitation of coastal resources and destructive fishing), include coastal erosion and damages to infrastructure, high storm surges, the destruction of coastal and marine habitats and resources, the inundation of low-lying areas, tourism-related economic losses, and population displacement.

KEY MESSAGES: OBSERVED AND PROJECTED CLIMATOLOGY AND SEA-LEVEL RISES

- Mean annual temperatures have increased by 0.56°C over the past half century and are projected to increase by 0.68°C by the 2030s and 1.40°C by the 2050s.
- Average annual precipitation across mainland Tanzania has declined by nearly 50 mm since the 1960s, with the most substantial declines in the highlands of the Eastern Rift Valley. While future precipitation projections are less certain, rainfall is likely to slightly increase through the 2050s.
- Ongoing sea-level rises pose a significant threat to coastal communities along Tanzania's coastline. Land and infrastructure damage associated with sea-level rises is expected to be approximately USD200 million annually by 2050, as a result of the projected rise of sea levels from 16 to 42 cm and projected increases in storm surges of nearly 2 m by 2050.[a,b]
- The escalating intensity of heavy rainfall events during the 2030s and 2050s is likely to exacerbate flooding risk, especially within the southeastern and northwestern regions of mainland Tanzania.
- Projected declines in overall precipitation are likely to increase the occurrences of dry spells through the mid-century, especially in regions such as Mbeya, Tabora, Geita, Kigoma, Katavi, Rukwa, Shinyanga, Singida, and Ruvuma.

a https://www.climatelinks.org/sites/default/files/asset/document/20180629_USAID-ATLAS_Climate-Risk-Profile-Tanzania.pdf.

b https://documents1.worldbank.org/curated/en/891701634533267413/pdf/Groundswell-Africa-A-Deep-Dive-on-Internal-Climate-Migration-in-Tanzania.pdf.

Land and infrastructure damage associated with sea-level rises is expected to be around USD200 million annually by 2050,[37] based on the projected rise of sea levels from 16 to 42 cm[38] and projected increases in storm surges of nearly 2 m by 2050.[39] In the nearer term, 0.3 to 1.6 million people are expected to be at risk of flooding associated with sea-level rises by 2030.[40]

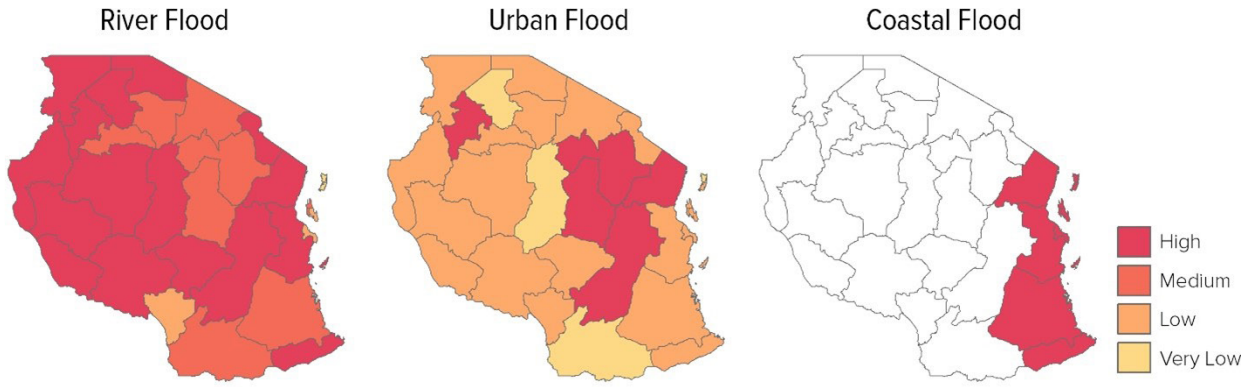
CLIMATE-RELATED HAZARDS

28. Tanzania is vulnerable to several climate-related hazards associated with ongoing climate change that can impact population health considerably. More than 70 percent of the natural disasters in the country are related to climate.[41] The most pressing ones are floods and droughts. Additional climate-related hazards include landslides, cyclones, heatwaves, and wildfires. The overall impacts of such events in Tanzania cannot merely be attributed to changing environmental conditions including changes to the climatology described in the previous section; they are also are compounded by anthropogenic causes including rapid deforestation, urbanization, rapid population growth, and inadequate housing.

FLOODS

29. Floods are among the most significant climate-related hazards in Tanzania. Heavy rainfall and sea- level rises contribute to regular riverine, urban, and coastal flooding across the country (see Figure 8), with the greatest risk of flooding occurring annually in March and April. Since 2000, 33 major floods have been recorded with nearly 400 deaths.[42] Riverine flooding poses the greatest risk, in terms of geographic extent, with most of Tanzania considered at medium to high risk (see Figure 8). However, urban and coastal flooding also pose a significant population risk: 35 percent of the total population reside in urban areas,[43] often in informal settlements that are ill-equipped to offer adequate safety during flooding events.[44] In 2018, heavy rains led to severe flooding in Dar es Salaam, affecting 1.7 million people, which resulted in economic losses equivalent to 4 percent of the city's GDP.[45]

FIGURE 8.
Riverine, Urban, and Coastal Flooding Risks in Tanzania



Source: World Bank, Think Hazard website.

30. **Extreme precipitation is projected to increase during the 2030s and 2050s, exacerbating flooding risks, especially within the south-eastern and northwestern regions of the mainland.** While projected annual mean precipitation across the mainland shows little change in rainfall totals, measurements of 5-day cumulative rainfall and 1-day intense precipitation signal an increasing likelihood of flooding events through the mid-century. Heavy cumulative rainfall over several days is associated with a higher likelihood of runoff entering river channels and subsequent flooding as soils reach their saturation point. Intense single-day events of heavy rainfall can have the same effect but in a shorter period and may result in flash flooding events and/or trigger landslide events.

31. **Projected figures for five-day cumulative rainfall show an average annual increase of approximately 9 mm in the 2030s and 17 mm in the 2050s, with the largest increases likely to occur in January.** The regions projected to see the greatest increases in cumulative 5-day rainfall totals are Mtwara (+21 mm) and Shinyanga (+21 mm) in the 2030s, and Tabora (+21 mm) and Singida (+ 21mm) in the 2050s.

32. **Nationally, there are expected increases in intense 1-day precipitation totals in the 2030s (+4 mm) and 2050s (+9 mm), which are more likely to occur in December in the 2030s and January in the 2050s.** Mtwara and Dar es Salaam are most likely to be vulnerable to flooding events triggered by heavy 1-day rainfall events during the 2030s, with Mtwara increasing in vulnerability through the 2050s.

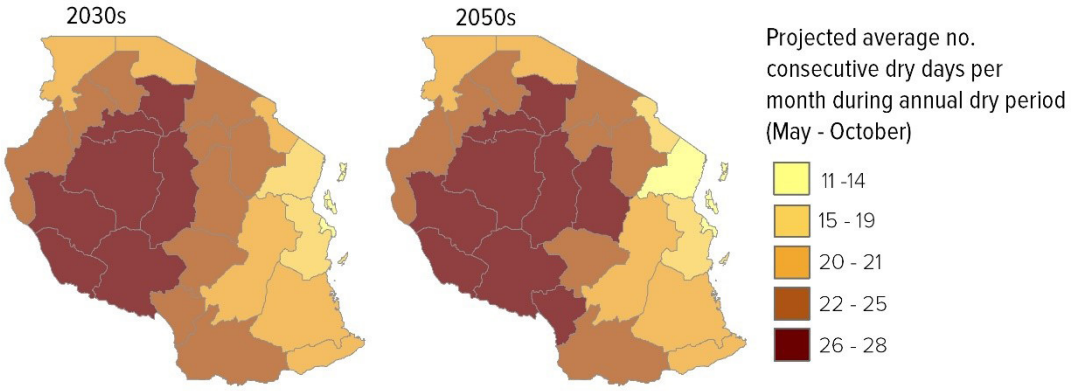
DROUGHTS

33. **Droughts and dry spells are frequent occurrences in Tanzania that undermine poverty alleviation, food security, and improved health outcomes.** The consequences of drought are far-reaching, with direct impacts on human health due to the effects on food availability and access, loss of biodiversity, and changes to migration patterns. Current estimates of agricultural productivity losses, primarily from droughts, are estimated at USD200 million.[46] Pastoralist communities in Tanzania have reported trekking three times the average distance to water sources during drought conditions,[47] placing additional pressure on community members and herds. Over the past three decades, Tanzania has experienced six major droughts.[48] The central regions of Shinyanga, Dodoma, and Singida have historically been the most vulnerable to drought conditions.[49] During October to December 2021, prolonged periods of dry spells have led to areas of the country experiencing the driest or second-driest conditions since 1981.[50] Herder communities in the northwest Manyara region, in particular, have experienced devastating losses (starvation of more than 62,000 livestock animals) due to drought conditions.[51]

34. **Drought projections for Tanzania are uncertain[52] however, though projected declines in precipitation are likely to increase the occurrences of dry spells through the mid-century.** By the 2050s, the lack of rainfall during the driest period of the year (May–October) will lead to 23 consecutive dry days each month, on average, during the 2030s and 2050s (see Figure 9). By the 2050s, Mbeya, Tabora, Geita, Kigoma, Katavi, Rukwa, Shinyanga, Singida, and Ruvuma are expected to be consecutively dry throughout July and August. Individuals whose livelihoods depend directly on climate-related sectors, such as pastoralists and farmers with rainfed crops, will be the most vulnerable to dry conditions.

FIGURE 9.

Projected Average Number of Consecutive Dry Days Per Month during Annual Dry Period (May–October)



Source: World Bank Climate Change Knowledge Portal

KEY MESSAGES: CLIMATE-RELATED HAZARDS

The most pressing climate-related hazards are floods and droughts. Additional climate-related hazards include landslides, cyclones, heatwaves, and wildfires.

Floods:

- Heavy rainfall and sea-level rises contribute to regular riverine, urban, and coastal flooding, with the greatest risks of flooding occurring annually in March and April.
- Northern, eastern, and southern coastal regions are at the highest risk of flooding.
- Extreme precipitation is projected to increase during the 2030s and 2050s, exacerbating flooding risks, especially in the southeastern and northwestern regions of the mainland.
- Projected figures for 5-day cumulative rainfall show average annual increases of approximately 9 mm in the 2030s and 17 mm in the 2050s, with the largest increases likely to occur in January.

Droughts:

- Droughts and dry spells are frequent occurrences in Tanzania; they undermine poverty alleviation, food security, and improved health outcomes.
- Drought projections for Tanzania are uncertain however, though projected declines in precipitation are likely to lead to increased occurrences of dry spells through the mid-century.
- By the 2050s, the lack of rainfall during the driest period of the year (May–October) will lead to 23 consecutive dry days each month, on average, during the 2030s and 2050s.
- By the 2050s, Mbeya, Tabora, Geita, Kigoma, Katavi, Rukwa, Shinyanga, Singida, and Ruvuma are expected to be consecutively dry throughout July and August.

SECTION III.

CLIMATE-RELATED HEALTH RISKS

35. **Tanzania faces significant health challenges from communicable diseases and noncommunicable diseases (NCDs), and climate change will worsen the severity of these health challenges.** In 2020, Tanzania had a crude death rate of 6.12 per 1,000 people, a neonatal mortality rate of 20.1 per 1000 live births, and an under-five mortality rate of 48.9 per 1,000 live births; though these figures have been decreasing, they remain high.[53,54] Although there had been a drastic decrease in Tanzania's maternal mortality ratio from 832 in 2012 to 642 per 100,000 live births in 2016, the country still has a very high maternal mortality ratio.[55] Tanzania's life expectancy increased from 50.81 in 2000 to 65.81 in 2020 and is higher than Sub-Saharan Africa's average life expectancy of 61.95.[56] Moreover, Tanzania's population of 59.7 million people (as of 2020) is projected to increase to 129.4 million at a population growth rate of 2.98 percent by 2050.[57]

36. **Climate change, coupled with high population rates, will continue to worsen the burden of disease, health, and income disparities, and negatively impact the country's economic development.** Communicable, nutritional, neonatal, and maternal diseases are the leading causes of morbidity and mortality combined in the country.[58] Of the 10 leading causes of death in Tanzania, lower respiratory infections, tuberculosis, malaria, nutritional diseases, ischemic heart disease, and diarrheal diseases are climate-sensitive diseases.[59]

37. **Risks to health outcomes from 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.[60] However, climate may exacerbate health inequalities, especially among certain vulnerable groups including the poor, rural populations, those living in informal urban settlements, women and young children, the elderly, those living with preexisting conditions and disabilities, and displaced populations. Therefore, investment in adaptation and mitigation measures must carefully consider groups who would directly benefit from or may be disadvantaged by adopted measures.

38. **Using the Haines and Ebi (2019) framework as a guide, Tanzania's Climate and Health Vulnerability Assessment (CHVA) assesses six climate-related health risk categories.** These include risks to (a) nutrition, (b) vector-borne diseases (VBDs), (c) waterborne diseases (WBDs), (d) heat-related conditions, (e) air

quality health, (f) direct injuries and mortality, along with (g) mental health and well-being. 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 seven health risk categories represent only the most pressing health risks to the population in Tanzania, as identified in the review of key country health reports. They include the Ministry of Health and Social Welfare (MoHSW) documents, WHO's Health and Climate Change Country Profile, the Climate Change Knowledge Portal (CCKP) of World Bank, nationally determined contributions (NDCs), and partner reports.

FOOD SECURITY AND NUTRITION RISKS

39. **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 include acute and chronic effects on agricultural production, storage, processing, distribution, and consumption. Nutritionally secure and stable diets depend on agricultural production and the complex interactions of demand, economics, legislation, conflict, food waste, nutrient losses, food safety, and access.[61] 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, as it relates to weather and climate impacts on agricultural productivity. Agricultural productivity is a key determinant of food availability; it is affected by weather and climate in a multitude of ways, from short-term shocks (for example, natural disasters) to long-term changes in agroecological conditions that can drastically reduce yields or redefine spatiotemporal patterns of crop suitability.

40. **Tanzania is challenged by acute food insecurity conditions, and climate change threatens to worsen the already dire situation.** In 2019, the prevalence of severe food insecurity among the Tanzanian population was 56.4 percent — an increase from 55 percent in 2018.[62] The results of the IPC (Integrated Food Security Phase Classification) Acute Food Insecurity Analysis in 16 districts of Tanzania reveal that an estimated one million people (20 percent of 4.8 million people) experienced severe acute food insecurity between November 2019 and April 2020, and about half a million people (10 percent of 4.8 million people) were projected to experience severe acute food insecurity between May and September 2020.[63] Approximately 4 million people (7.1 percent of the population) still lacked access to sufficient food as of November 2021, even though this figure constitutes a decrease from 4.9 million in January 2021.[64] Rural Tanzanians (84 percent) are more vulnerable to food insecurity than urban residents (64 percent),[65] with the northern and central regions experiencing the highest vulnerability to food insecurity.[66] The key drivers of food insecurity in Tanzania are

Approximately 4 million people (7.1 percent of the population) still lacked access to sufficient food as of November 2021, even though this figure constitutes a decrease from 4.9 million in January 2021.

prolonged dry episodes triggering drought conditions, unpredicted rains, and the 2017 fall armyworm infestation destroying mainly grains, especially maize — the main food crop in Tanzania.[67] These conditions have led to poor harvests, thereby limiting food availability, as well as increasing demand and in turn food prices, which have undermined the capacity of the majority of poor Tanzanians to afford food.

41. **Extreme hunger and malnutrition, coupled with pervasive poverty, are threatening Tanzania's economic, social, and human development progress.** Although Tanzania has registered substantial economic growth over the past two decades, this achievement has not been equally reflected in addressing food insecurity, ending poverty, and narrowing inequality. According to the World Food Programme (WFP), even though Tanzania produces enough food to feed the population, high levels of hunger persist, especially among the country's rural poor and marginalized households, largely due to limited access to food.[68] Tanzania's malnutrition rates remain high, with over 600,000 children reportedly suffering from acute malnutrition; as of 2015, about 32 percent of children under five were stunted, 5 percent were wasted, and 14 percent were underweight.[69] Results of the 2018 Standardized Monitoring and Assessment of Relief and Transitions (SMART) survey show that regions with the highest prevalence of stunting occurred in Njombe (54 percent), Rukwa (48 percent), Songwe (43 percent), Iringa (47 percent), Kigoma (42 percent), and Ruvuma (41 percent). Chronic malnutrition also causes nutritional challenges, including anemia among women, who account for over 60 percent of the agricultural labor force in Sub-Saharan Africa.[70] Give that women are both agricultural workers and caregivers, their struggles with hunger and malnutrition have an immense impact on the country's human capital and economic development.

42. **Projected increases in population growth, coupled with climate change impacts on the agricultural sector, will continue to worsen extreme hunger, food insecurity, and malnutrition in the Tanzanian population.** Agriculture — the main source of livelihood for over 75 percent of the rural population that accounts for nearly one-third of the country's GDP — is predominantly smallholder-based and relies primarily on rudimentary tools.[71] Climate change's impacts on the length of the growing season will disrupt food production by reducing food quantity and quality, thus limiting food availability, access, and affordability, and thereby worsening food insecurity and malnutrition. Projected temperature increases and increases in extreme precipitation triggering heavy rain, particularly the projected consecutive dry days from May to October (dry season), will lead to crop losses. The regions of Mbeya, Tabora, Geita, Kigoma, Katavi, Rukwa, Shinyanga, Singida, and Ruvuma would be the most affected by the prolongation of the dry season throughout July and August by the 2050s, which would affect crop yields. Warmer temperatures and unpredicted dry spells will likely increase the severity of insect pest populations, thus causing the crops to wither prematurely, thereby reducing harvesting with impacts on food security. The regions of northern and central Tanzania are already struggling with severe food insecurity and threatened livelihoods (the destruction of crops and deaths of livestock) triggered by prolonged droughts.[72] Under future climate scenarios, projected increases in temperature and precipitation in the 2050s will worsen food insecurity, hunger, and malnutrition in Tanzania.

VECTOR-BORNE DISEASE RISKS

43. **Climate is a key driver of spatiotemporal distributions and transmission dynamics of vector-borne diseases (VBDs) in Tanzania.** Climate variability causes vector and host ranges to expand or contract, shifting disease distribution, seasonality, and / or facilitating the emergence or reemergence of VBDs. Investigating the species distribution and seasonality of vectors is valuable for understanding plausible VBD distributions and planning efficient, spatially targeted methods of control. This assessment focuses on mosquito borne VBDs given their importance in Tanzania; while there are other VBDs present in Tanzania including filariasis, chikungunya, dengue, yellow fever, and zika, there is limited information and surveillance.[73] Spatial models (see Figures 10 and 11) were constructed to demonstrate the plausible spatial distributions of the vectors of malaria to assess the suitability and risk propensity of these diseases (see Annex A for information on model inputs and construction). The results of these analyses should be treated as a conservative estimation of the areas of Tanzania that exhibit suitable conditions for vector breeding and suitable conditions for vector breeding where humans are present (that is, populated areas).

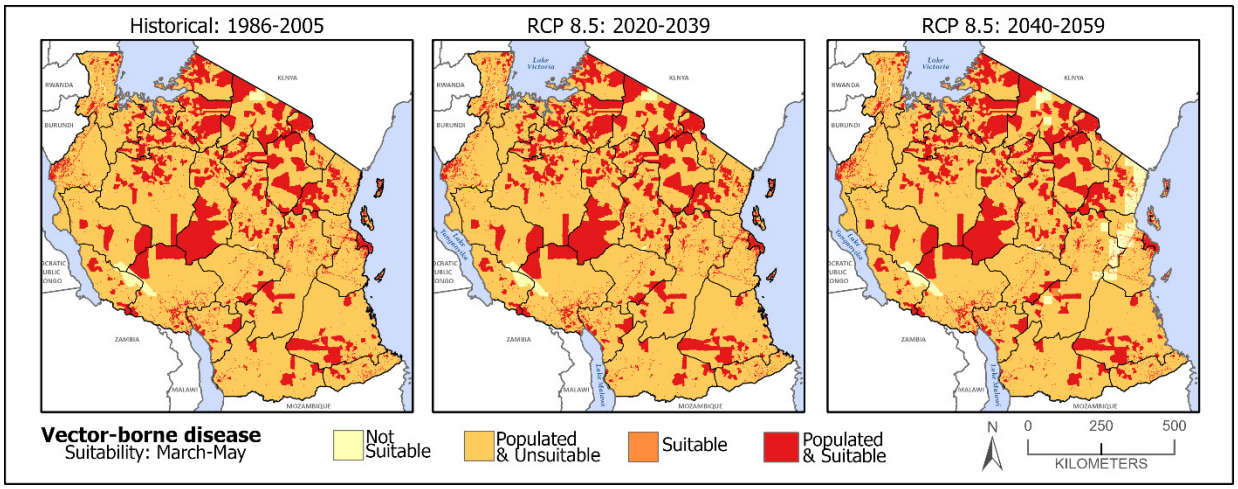
44. **Despite longstanding efforts by the country to control malaria, the disease continues to be a considerable public health threat.** Tanzania has one of the highest malaria prevalence rates (13.4 percent of malaria cases) in Eastern and Southern Africa, and malaria is a leading cause of death for children under five years of age in Tanzania.[74] An estimated 93 percent of the population of mainland Tanzania is at risk of being infected by malaria.[75] Communities around the shores of Lake Victoria have the highest malaria prevalence (41 percent).[76] *Plasmodium falciparum* — primarily transmitted by *anopheles gambiae* (*An. gambiae s.s.* and *An. arabiensis*) and *anopheles funestus* — is responsible for about 96 percent of all severe malaria cases in Tanzania.[77] Tanzania has two main malaria transmission seasons: the first season is between March and May following the long rains and the second season is from October to December.[78] Overall, for both seasons, the northern, northeast, eastern, central, and the Kilombero Valley of southern Tanzania have the highest suitability for malaria transmission; moreover, these areas are densely populated.

WATERBORNE DISEASE RISKS

45. **Tanzania experiences floods, extreme droughts, and heat waves, which affect the quality and quantity of safe water; this in turn has direct implications for the burden of waterborne diseases (WBDs).** Climate change, including rising temperatures and extreme precipitation, have increased the occurrences and severity of flash floods in Tanzania. Flash floods related to erratic rains (mostly in March and April) and decreased water levels are the leading causes of surface water and groundwater pollution. Increases in widespread WBD outbreaks, such as cholera and diarrheal diseases in Tanzania, have been attributed to poor sanitation, improper hygiene, and the consumption of contaminated drinking water in both urban and rural areas.[79] Between August 2015 and January 2018, there were an estimated 33,421 cholera cases and 542 deaths across Tanzania (86 percent) and Zanzibar, with the highest cases in the regions of Nyasa, Mbeya, Songwe, Manyara, Kigoma, Uvinza, Kigoma, Dar es Salaam, and Dodoma.[80]

FIGURE 10.

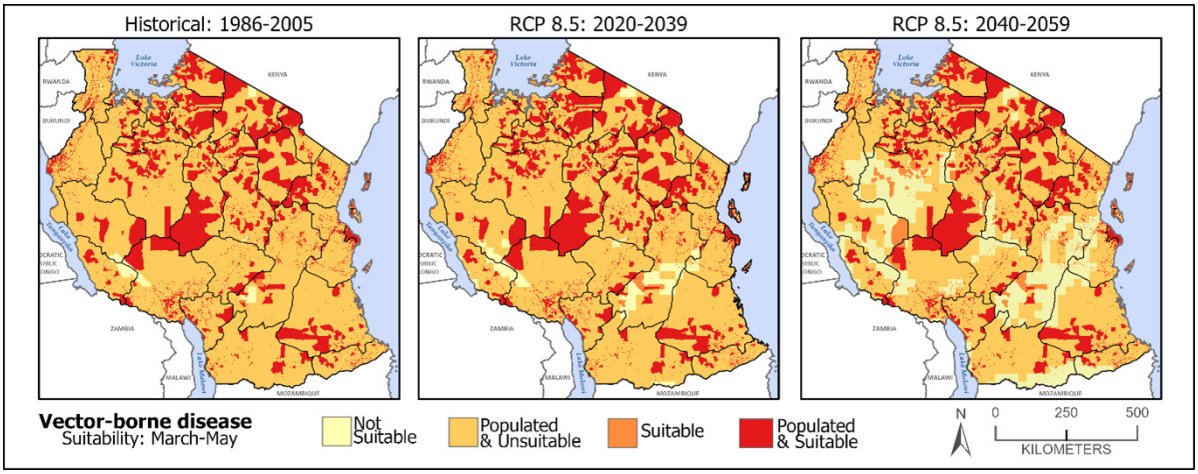
Vector-Borne Diseases — Suitability for Season 1: March–May



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 Accumulatio n(World Wide Fund for Nature, HydroSHEDS), Population (European Commission's Joint Research Centre, GHSL/P2016/POP_GPW_GLOBE_V

FIGURE 11.

Vector-Borne Diseases — Suitability for Season 2: October–December



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 Accumulatio n(World Wide Fund for Nature, HydroSHEDS), Population (European Commission's Joint Research Centre, GHSL/P2016/POP_GPW_GLOBE_V

46. Urban residents vulnerable to WBD outbreaks due to poor sanitation, the inadequate drainage systems that are unable to withstand the pressure of floods, and lack of wastewater and sewage treatment plants.[81] For example, Picarelli et al. (2017), in their paper on "weather shocks and health in Dar es Salaam," show a drastic increase in the incidence of cholera outbreaks, with increased rainfall, especially in flood-prone informal settlements.[82] Therefore, cholera is endemic in Tanzania, particularly in urban areas like Dar es Salaam. Climate change and associated flash floods will continue to worsen the situation.[83]

47. The burden of disease, attributed to inadequate safe water, improper sanitation, and poor hygiene in Tanzania, remains high. WBDs, due to the household use of unsafe and contaminated water, along with the improper disposal of excreta, account for nearly one-half of all the illnesses affecting children (see Table 4) and adult Tanzanians.[84] WBDs, responsible for 23,900 deaths per year among the under-fives, are one of the leading causes of ill health and deaths among Tanzanian children.[85] Nearly a third of Tanzania's population lives in arid to semi-arid areas, with limited access to clean and safe water.[86] Most of this population use groundwater (from wells and boreholes) as

TABLE 4.

Two-Week Prevalence of Diarrhea in Children under 5 years in Tanzania, 2015/2016

BACKGROUND CHARACTERISTICS		PERCENTAGE WITH DIARRHEA
Tanzania Mainland/Zanzibar	Mainland	11.8
	Urban	14.2
	Rural	11.0
	Zanzibar	10.5
	Unguja	10.2
	Pemba	10.9
Source of drinking water	Improved	12.2
	Not improved	11.3
Toilet facility type	Improved, not shared	12.2
	Shared	15.3
	Non-improved	11.1
Zone	Western	11.6
	Northern	8.0
	Central	10.2
	Southern Highlands	10.1
	Southern	16.3
	Southwest Highlands	15.5
	Lake	12.0
	Eastern	12.4
	Zanzibar	10.5

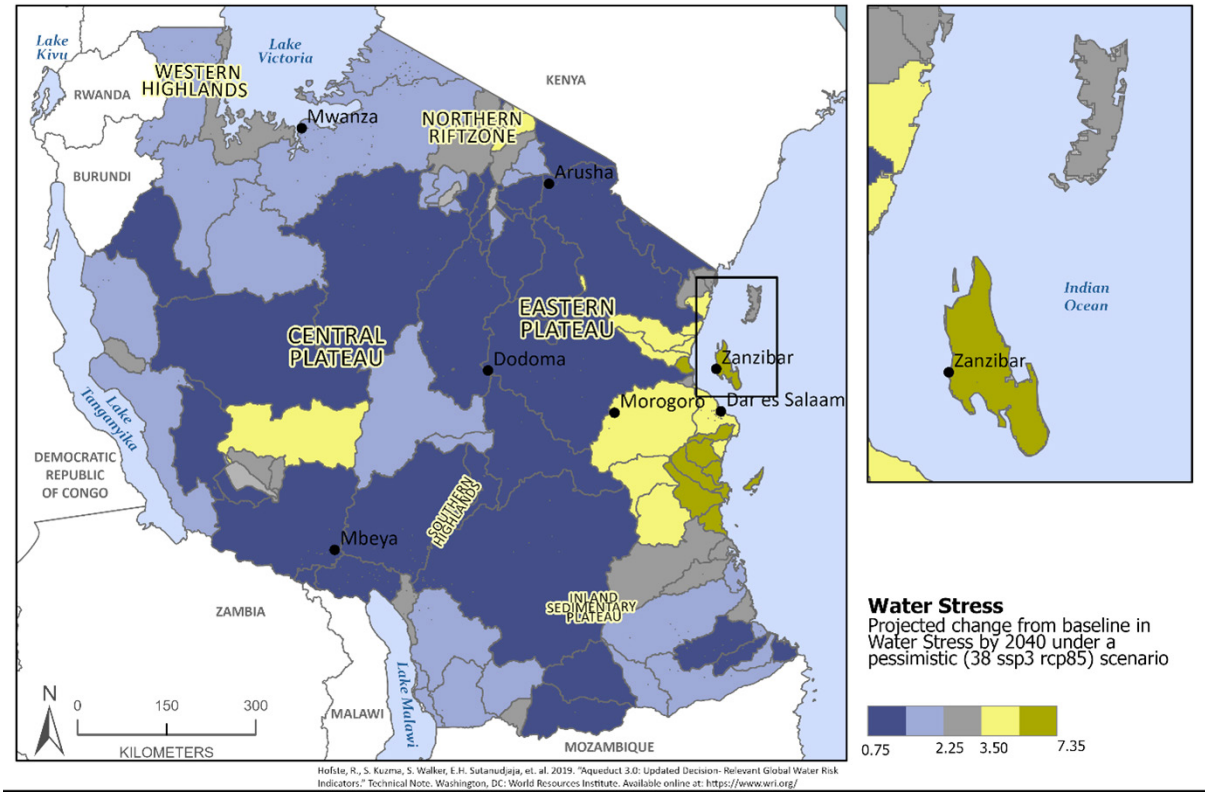
Source: Tanzania Demographic and Health Survey (DHS), 2015/2016.

the primary water source for the household, which is sometimes contaminated due to the proximity to drainage systems. Furthermore, because of water scarcity, communities are forced to bathe and wash their clothes close to these water sources, further contaminating them. This is the same contaminated water they carry home for household use, thereby increasing the occurrences of diseases. In addition, improper water handling, including collection, transportation, and storage, is also instrumental in the spread of WBDs in urban towns in Tanzania.[87]

48. Prolonged droughts seriously threaten water security, forcing communities to travel long distances in search of water for the household

(see Figure 12). Extreme droughts increase water temperatures and lead to reduced water levels, encouraging the growth of harmful algal blooms. This compromises water quality, making the water unsafe for household use for communities neighboring Lake Victoria, Lake Tanganyika, and the Upper Ngerengere Catchment in Morogoro. When there is drought-induced water scarcity, rural communities are often forced to resort to low-quality watering holes, thereby increasing their vulnerability to WBDs.[88] Furthermore, extreme droughts are often followed by water and food insecurity, malnutrition, the migration of populations (often rural to urban migration), and increased poverty. These trends further increase the occurrences of WBDs and the

FIGURE 12.
Map of Tanzania Showing Projected Water Stress (2040)



Source: Hofste, R., S. Kuzma, S. Walker, E.H. Sulanudaja, et al. 2019. "Aqueduct 3.0: Updated Decision-Relevant Global Water Risk Indicators." Technical Note. Washington, DC: World Resources Institute. Available online at: https://www.wri.org

communities' susceptibility to WBDs and the spread of WBD outbreaks. For girls and women, drought-induced water scarcity also means walking longer distances in search of water, which increases their vulnerability to rape, violence, missed school days, and the concomitant adverse impacts on their mental health and well-being.[89]

49. **Projected rises in temperature and precipitation will continue to increase the frequency and severity of flash floods and prolonged droughts, with immense impacts on human health.** These patterns are expected across many countries, with developing countries being hit the hardest. For countries like Tanzania, climate change impacts on health, due to increasing WBDs, will be worsened by a combination of factors, including high population rates, poor urban planning, informal settlements, and poverty. As shown in Section II of this report, Tanzania will continue to experience increases in the intensity of rainfall and flash floods, which are associated with water contamination and related increases in disease outbreaks. Projected increases in temperatures, especially in the regions of Western Tanzania, will increase the vulnerability of communities to WBDs such as cholera and other diarrheal disease outbreaks. Increased water temperatures and low water levels will increase the growth of harmful algal blooms and cases of food poisoning from affected aquatic foods, therefore resulting in outbreaks such as typhoid and campylobacter infections.

HEAT-RELATED MORBIDITY AND MORTALITY

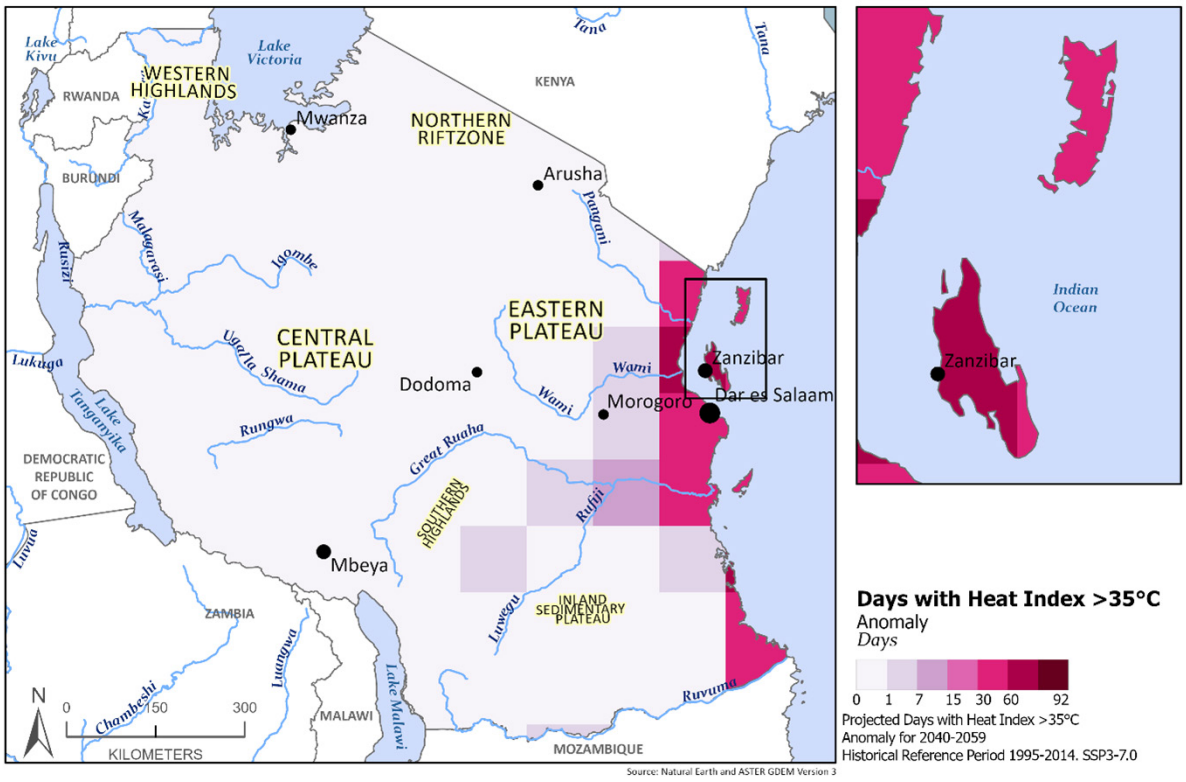
50. **The health risks of heat are wide-ranging, including effects on mortality, heat-related injuries, mental health, and well-being.** Health effects caused by heat include the direct effect of heat stress, heat rash, cramps, exhaustion, dehydration, and the acute exacerbation of pre-existing conditions including respiratory and cardiovascular diseases. Long-term mental health risks are also an important effect to consider. In addition to the impacts on individuals, the occurrence of the exposure of the whole population during an extreme heat event can lead to significant increases in hospitalizations, thereby imposing strains on health systems.[90] Extreme heat-related injuries and mortalities have commonly been registered in the Mara regions, especially among mine workers and in Dar es Salaam.[91]

51. **Extreme heat exposure will become more common throughout the mid-century, with populations in the Dar es Salaam region and the regions of Zanzibar at greatest risk (see Figure 13).** In particular, the increase in the number of days with temperatures above 35°C and the days when the heat index is above 35°C, that is, capturing the "feel like" experience, along with the number of tropical nights, will increase the risks of cardiovascular or respiratory morbidities. This is because the body will struggle to cope with high temperatures and have less time during the day to recover from the heat exposure.

AIR QUALITY RELATED HEALTH RISKS

52. **Ambient and household air pollution pose a considerable risk to the health of Tanzanians; however, the attribution of ongoing climate change and health outcomes to air pollution exposure in Tanzania is uncertain.** The government of Tanzania has made some efforts to address the impacts of air pollution on health. It has signed international and regional treaties, including the 2008 Libreville Declaration on Health and Environment in Africa and the Health and Pollution Action

FIGURE 13.
Map of Tanzania Showing Projected Number of Days with Heat Index >35°C

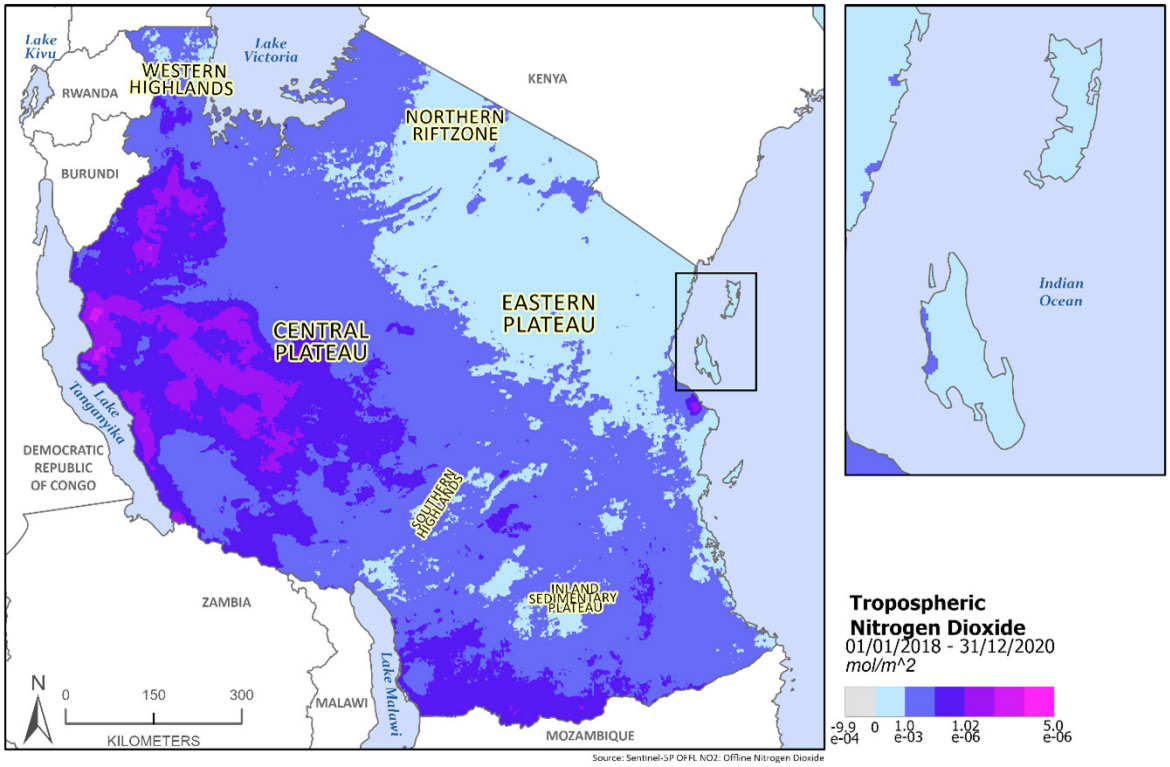


Source: Natural Earth and Aster GDEM Version 3

Plan (HPAP) in 2019.[92] Amidst Tanzania's efforts to address the health impacts of air pollution, indoor air pollution remains the single largest driver of poor health.[93,94] In 2019 alone, household air pollution was responsible for about 39,200 deaths.[95] Women and children are disproportionately affected due to their prolonged exposure to indoor air pollution during meal preparation, with domestic biomass combustion being the biggest contributor to household indoor air pollution. The main sources of outdoor pollution in Tanzania are vehicular traffic, industrial activities (steel and cement), agricultural activities, mining, improper waste disposal, and human activities (charcoal burning and forest fires).[96], Common diseases, associated with air pollution among the Tanzanian population, include respiratory tract infections, acute respiratory illnesses, chest pain, eye problems, cough, pneumonia, and tuberculosis.[97,98] According to the World Bank, Tanzania's annual mean exposure for fine particulate matter 2.5 ($PM_{2.5}$) was 29 micrograms per cubic meter (µg/m^3) in 2017,[99] higher than the WHO's recommended value of 5µg/m^3.[100]

53. **Projected increases in temperatures, coupled with longer and drier regimes, are likely to lead to the further deterioration of air quality in Tanzania.** Tanzania is already vulnerable to wildfires, and the projected increases in temperatures during the extended dry months of June to October will likely increase the

FIGURE 14.
Map of Tanzania Showing Tropospheric Nitrogen Dioxide (NO_2)



Source: Sentinel-SP OFFL NO2: Offline Nitrogen Dioxide

occurrences, intensity, and spread of these wildfires, thereby increasing air pollution.[101] In addition, rising temperatures and atmospheric carbon dioxide will likely extend the allergy season due to the impact on plant phonologies. Although not well-documented in Tanzania, recent research elsewhere has shown that prolonged exposure to air pollution increases the risks of some cancers, such as childhood leukemia and bladder cancer, dementia, and autoimmune disorders including rheumatoid arthritis.[102] Prolonged dry seasons and the lack of rainfall will likely increase exposure to particulate matter from industrial activities, construction, mining, vehicle fumes, dusty roads, and wildfires, due to a lack of rains to settle the fine and coarse particles to the ground.

DIRECT MORTALITY AND INJURIES

54. Flash floods, caused by heavy rains, mudslides, and landslides are associated with mortality and direct injuries (see Table 5). Globally, floods are one of the leading causes of natural disaster-related injuries and deaths, with over 6,000 deaths in 2020 alone. In Tanzania, there were more than 450 deaths and over 240 natural disaster-related injuries between 2000 and 2019.[103] In 2020, heavy rains and flooding caused 40 fatalities in the regions of Mwanza, Morogoro, Lindi, and Manyara.[104] On April 16, 2014, flooding, following three days of heavy rain, caused 41 deaths in Dar es Salaam. In particular, the coastal regions of northern, eastern, and southern Tanzania are particularly vulnerable to deaths caused by heavy rain-induced floods.

TABLE 5.
Extreme Weather Events Injuries and Mortality for Tanzania from 2000 to 2022

EXTREME EVENTS	SUBTYPE	EVENTS COUNT	TOTAL DEATHS	TOTAL AFFECTED
Flood	Flash flood	6	50	103,904
	Riverine flood	16	177	174,569
	Other	11	164	158,982
Drought	Drought	4	-	6,854,000
Landslide	Landslide	1	13	150
Storm	Convective storm	4	47	6,394
	Tropical cyclone	1	-	2,000,000
	Other	1	10	30,001

Source: https://public.emdat.be/data.

MENTAL HEALTH AND WELLBEING RISKS

55. Tanzania has limited research on the impacts of climate change on mental health. As such, to assess mental health in the context of climate change in this assessment, the full spectrum of mental health, including psychological, emotional, and social well-being, is considered. This allows for the incorporation of considerations of well-being and resilience; doing so is particularly relevant in Tanzania, where there is a background strain on the resilience of the population, as well as limited opportunities for psychological or psychiatric assessments and diagnoses to inform the analysis. The concept of mental health and well-being is thus framed as a spectrum of "psychosocial health." This incorporates the diverse psychological and social strains of climate change impacts, such as food and water insecurities, destruction of livelihoods and property, poverty, as well as living in very hot and humid conditions.

56. In Tanzania, mental health conditions are a growing concern, with the country's neuropsychiatric disorders accounting for an estimated 5.3 percent of the global disease burden. Tanzania is exposed to numerous natural hazards, including severe flooding, mudslides, landslides, sea-level rises, coastal storm surges, prolonged droughts, wildfires, and heat waves. These natural hazards, especially floods and prolonged droughts, exert significant impacts on people's socioeconomic activities and livelihoods, which also in turn produce adverse short- and long-term effects on their mental health and well-being. Socioeconomically disadvantaged communities, especially those in rural areas, including children, women, the sick, and the elderly, are disproportionately affected by the adverse effects of climate change due to their limited capacity to adapt. Confronted with climate change-related hazards and their impacts on livelihoods, coupled with the households' inability to adapt, people are likely to be more susceptible to anxiety, worry, distress, sleep disorders, mood disorders, depression, substance use disorders, and posttraumatic stress disorders.

57. Climate change and the resulting socioeconomic and livelihood insecurities have immensely affected the mental health of

low-income Tanzanians and created new vulnerabilities for those who are already experiencing mental health and substance use disorders. In Tanzania, there are various factors impact mental health, but here, we focus on climate-related factors. Climate change impacts on Tanzanians' mental health and well-being outcomes are mediated by severe socioeconomic and contextual factors, including the following:

- **Food insecurity:** Food insecurity, hunger, and malnutrition pose a big challenge in Tanzania. In a country where more than 67 percent of the population live in rural areas and rely solely on agriculture as the main source of food supply, adverse weather events due to climate change impacts, which lead to food insecurity, can trigger anxiety, stress, sleeplessness, and depression.[105]
- **Poverty:** In 2021, an estimated 29 million Tanzanians lived in extreme poverty;[106] most of them are rural residents. Agriculture is a source of livelihood and employment for over 70 percent of the Tanzanian population. The negative impacts of floods and prolonged droughts on agriculture, coupled with low adaptive capacity, have increased unemployment, poverty, substance use, domestic violence, and mental disorders, especially in regions prone to floods and droughts.
- **Migration:** The negative impacts of climate change on agriculture as the main source of livelihood have led to rural-urban migrations, with implications for physical and mental health. Once in urban areas, the new migrants, who are away from their social support networks, struggle to find a new source of livelihood, thus increasing their susceptibility to stress, anxiety, fear, depression, violence, crime, suicidal tendencies, and substance use.
- **Water and pasture scarcity:** Among the pastoral communities like the Maasai, the deaths of their cattle, goats, and sheep (main sources of livelihood), resulting from pasture and water scarcity following prolonged droughts, have increased levels of stress, depression, and anxiety.[107]
- **Loss of loved ones and property damage:** Flash floods can lead to mental health disorders, as this phenomenon can result in the loss of loved ones; physical injuries; property damage including housing, household items, and farm equipment; and the destruction of businesses (small income-generating activities).

TABLE 6.
Summary of Climate Change Impacts on Health Outcomes

	CURRENT RISK	PROJECTED RISK
Food Security and Nutrition 	• Tanzania is challenged by acute food insecurity. • The prevalence of severe food insecurity among the Tanzanian population was 56.4 percent in 2019 — an increase from 55 percent in 2018. • Rural Tanzanians (84 percent) are more vulnerable to food insecurity than urban residents (64 percent).	• Projected increases in population growth, coupled with climate change impacts on the agricultural sector, will continue to worsen extreme hunger, food insecurity, and malnutrition.
Vector-borne diseases 	• Tanzania has one of the highest malaria prevalence rates (13.4 percent of malaria cases) in Eastern and Southern Africa. • An estimated 93 percent of the population of mainland Tanzania (especially those in the northern and central parts) is at risk of contracting malaria. • Malaria is one of the leading causes of deaths among children under 5 years of age in Tanzania.	• Projected changes in rainfall patterns and intensity, as well as temperature increases, will likely increase the suitability for mosquito distribution and malaria transmission in Tanzania.
Waterborne diseases 	• Waterborne diseases (WBDs) are one of the leading causes of ill health and deaths among Tanzanian children: they are responsible for 23,900 deaths per year among the under-fives. • The growing occurrences of flash floods are associated with increased WBD outbreaks. • Decreased water levels, due to increased water temperatures, are a leading cause of surface water and groundwater contamination.	• Projected increases in temperatures will increase the vulnerability of communities, especially fishing and coastal communities, to WBD outbreaks. • Projected increases in extreme rainfall and associated floods will likely increase drinking water contamination and WBD outbreaks.
Heat-related morbidity and mortality 	• Populations in the Mara region and Dar es Salaam are highly vulnerable to extreme heat-related injuries and mortalities.	• Extreme heat exposure will become more common throughout the mid-century, with populations in the Dar es Salaam region and the regions of Zanzibar at the greatest risk.

	CURRENT RISK	PROJECTED RISK
Air quality and respiratory health 	• Indoor air pollution remains the single largest driver of poor health. • Domestic biomass combustion is the leading contributor to household indoor air pollution, with women and children disproportionately affected due to their prolonged exposure to indoor air pollution. • The leading causes of outdoor air pollution are vehicular traffic, industrial activities (steel and cement), agricultural activities, mining, improper waste disposal.	• Projected increases in temperatures, coupled with longer and drier regimes, are likely to lead to the further deterioration of air quality in Tanzania. • Rising temperatures and atmospheric carbon dioxide will likely extend the allergy season due to the impact on plant phonologies.
Direct injuries and mortalities 	• Floods are responsible for the most deaths and injuries in the country. • Flash floods caused by heavy rains, mudslides, and landslides threaten lives and livelihoods, with those living in southeastern and northeastern Tanzania at the greatest risk.	• Projected increases in flooding, associated with increasing temperatures and precipitation, will likely cause more deaths and direct injuries in the 2050s.
Mental health and well-being 	• Mental health conditions are a growing concern, with the country's neuropsychiatric disorders accounting for an estimated 5.3 percent of the global disease burden. • Climate change and the resulting socioeconomic and livelihood insecurities have affected the mental health of low-income Tanzanians immensely and created new vulnerabilities for those who are already experiencing mental health and substance use disorders.	• Increased temperatures are likely to continue to affect agricultural productivity, water availability, and livelihoods, thus increasing poverty, with implications for mental health outcomes.

SECTION IV.

CLIMATE ADAPTIVE CAPACITY OF THE HEALTH SYSTEM

HEALTH SYSTEM OVERVIEW

58. Tanzania's health system is hierarchical and aligned with political-administrative levels.[108] The government owns over 60 percent of the health facilities in the country at multiple levels,[109] including (a) the national hospital (highest level), (b) zone hospitals (tertiary level), (c) regional referral hospitals (regional level), (d) district hospitals (district level), (e) health centers (ward level, also the lowest level). The government — under the Ministry of Health (MoHSW) — also runs specialized hospitals that do not fall under any of the above categories. The health system is diverse: apart from public / government entities, the estimated 40 percent of the private health facilities are faith-based (majority), commercial, and not-for-profit (the majority being faith-based facilities), where health services are provided by traditional healers (THs), traditional herbalists, and traditional birth attendants (TBAs), and community health workers (CHWs).[110] THs, traditional herbalists, and TBAs remain popular in rural areas, where there are limited public and private health care providers.

59. The Tanzanian government has made commendable progress toward achieving Universal Health Coverage (UHC) through the introduction and implementation of public health insurance schemes. The introduction of the National Health Insurance Fund (NHIF), *Tiba Kwa Kadi* (TIKA[111]), the Community Health Fund (CHF), and the Social Health Insurance Benefit (SHIB) has increased access to health services for both the rural and urban populations. However, the successful implementation of health insurance schemes has faced major challenges. For example, the urban-based TIKA and the rural-based CHF insurance scheme have faced operational and structural challenges, thus undermining the acceptability, membership, and financial base of the schemes.[112] The low acceptability and uptake of the health insurance schemes have resulted in the provision of poor-quality health services to the members.

60. Tanzania's health insurance scheme covers a small percentage (15 percent) of the population. For example, TIKA covers only 7.3 percent of the urban population, followed by NHIF (approximately 6.6 percent), and other health insurance programs (collec-

tively 2 percent); this leaves an estimated 85 percent of the Tanzanian population without insurance coverage.[113] Low levels of health insurance coverage, coupled with low-quality health services, high costs of health care, and poverty, mean that the majority of poor rural and urban Tanzanians remain vulnerable to surging climate-related health risks.

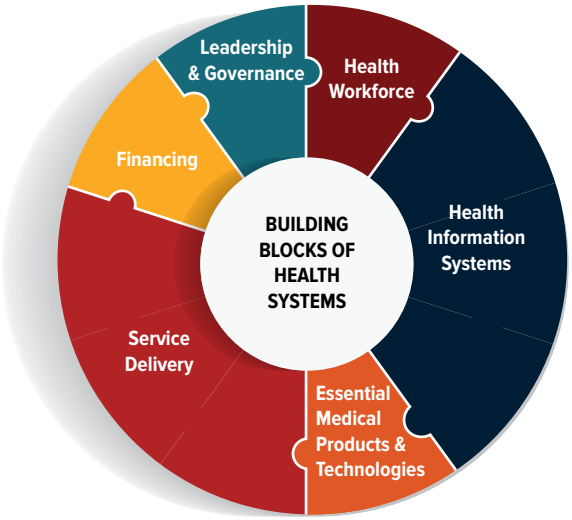
61. **Tanzania's fragile health system is challenged by a high disease burden that includes malaria, HIV/AIDS, pneumonia, along with maternal and child mortality.** The health system is further challenged by a shortage of human resources for health, constant stockouts of essential medicines, the lack of proper staff supervision, and inadequate health infrastructure, thus affecting the quality of health delivery, especially to the low-income rural majority of Tanzanians.[114],[115] In fact, the country has one of the lowest levels of access to skilled health workers in the world, with an estimated 0.31 doctors per 10,000 Tanzanians.[116]

62. **The government has made progress in improving the performance of the health system in areas of improved accountability, efficiency, and effectiveness.** In 2020/2021, USD387.9 million were allocated to the health sector, with a 40 percent contribution from donors.[117] However, challenges remain in the efficiency, operations, and financing of the different health system components. Healthcare access (accessibility, affordability, acceptability, availability) is characterized by geographical inequalities (rural vs. urban) and low insurance coverage. In 2019, only an estimated 32 percent had health insurance coverage.[118]

63. **The emergence and reemergence of pandemics, such as COVID-19 (coronavirus disease 2019) and Ebola, have highlighted gaps in the capacity of the health sector to manage emerging health risks effectively and efficiently.** In combination with high population growth rates and COVID-19, the climate crisis has the potential to overwhelm healthcare systems. This is especially true for already fragile health systems like that of Tanzania: it is characterized by a shortage of skilled health workers, insufficient resources, and poor management.[119] A study by Bajaria and Abdul (2020) revealed a low level of health system preparedness and inadequate capacity to detect, manage, and prevent the spread of COVID-19. Only 64 percent of the health facilities in the urban areas and 32.9 percent in the rural areas had adequate communication systems, thus highlighting spatial inequalities, in terms of the health facilities with COVID-19 preparedness measures.[120]

64. **The extent to which the health system in Tanzania has the capacity and the readiness to manage changes in hazards, exposure, and susceptibility will determine its resilience in the coming decades.** This assessment examines Tanzania's adaptive capacity[121] to prevent and manage climate-related health risks according to WHO's six health system building blocks (see Figure 15). It should be noted that several factors outside the scope of the health sector can also drive reductions in the adaptive capacity of Tanzania's institutions and people to manage the health risks of climate change. These include the country's economic challenges, changing demographic patterns, and slowly improving social conditions. The promotion of equity as a cross-cutting theme for enhancing adaptive capacity and 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.

FIGURE 15.
WHO's Health System Building Blocks.



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

LEADERSHIP AND GOVERNANCE

65. **The government of Tanzania recognizes climate change and its impacts on the country's development.** As a result, the government has already been developing strategies and policies to guide climate change mitigation and adaptation action. Although there was no single policy explicitly addressing climate change before the 2012 National Climate Change Strategy (2012), Tanzania's 1997 National Environmental Management Act highlights the negative impacts of climate change on the country's economic development and calls for action. Some other policies, strategies, and plans adopted by Tanzania in the effort to address climate include the following:

- Health Sector Strategic Plan II (HSSP II) (2003–2008),
- National Environment Management Act (EMA) (2004),
- Disaster Management Act (2005),
- HSSP III (2009–2015),
- Tanzania Emergency Preparedness and Response Plan (2012),
- Disaster Management Act (2014),
- National Operational Guidelines for Disaster Management (2014),
- National Environmental Action Plan (2012–2017),
- Disaster Management Act (2014 / 2015),
- Intended Nationally Determined Contributions (INDCs) (2015),
- HSSP IV (2015–2020),
- Tanzania's All Hazard Health Emergency Preparedness and Response Plan (2016),
- Nationally Determined Contributions (NDCs) (2021),
- National Environmental Policy (2021),
- Tanzania Disaster Communications Strategy (2012),
- Tanzania Health National Adaptation Plan (2018–2023),
- National Climate Change Response Strategy (2021), and
- HSSP V (2021–2026).

66. **Zanzibar works as a separate entity, although it is part of the same country.** Zanzibar has its own MoHSW and policy landscape. Its key policies on climate change and health are as follows:

    - Zanzibar Emergency Preparedness and Response Plan (2011),
    - Zanzibar Disaster management policy (2011),
    - Zanzibar Disaster Communication strategy (2011),
    - the Zanzibar Environmental Policy (2013),
    - the Zanzibar Climate Change Strategy (2014), and
    - Zanzibar HSSP III (2014–2018).

67. **The evolution of the climate change policy landscape in Tanzania since 1997 is summarized as follows:**

→ **1997 — In Tanzania, the National Environmental Policy (NEP) was adopted in 1997 and revised in 2021.** The development of the NEP resulted from a national analysis that illuminated the poor and deteriorating state of the environment, thereby leading to the call for immediate action. The environmental problems included the lack of access to safe water for urban and rural communities; habitat and biodiversity losses; land degradation; environmental pollution; deforestation; along with the deterioration and degradation of aquatic systems. The main objectives of the NEP are (a) develop a framework to guide the integration of environmental problems in decision-making; (b) provide policy guidelines and guidance on priority actions; as well as (c) build a system for monitoring the evaluation of environmental policies, plans, and programs. The NEP calls for regulation on the use of public lands, the rational exploitation of land and forest resources, waste management, reduced deforestation and the promotion of afforestation activities, the increased use of renewable energy, and increased climate change research.

→ **2004 — The 2004 Environment Management Act (EMA), which repealed the National Environment Management Act of 1983, was enacted to enforce the 1997 NEP.** The EMA provides a legal and institutional framework for the sustainable management of the environment. It outlines key principles for environmental management; pollution prevention and control; impact-risk assessments; environmental quality standards; waste management; public participation in environmental management; along with compliance, monitoring, and enforcement. The key stakeholders include the National Advisory Committee, the National Environment Management Council, the Minister for Environment, and the Director of Environment.

→ **2004 — The National Disaster Management Policy under the Disaster Management Department was approved in 2004.** The National Disaster Management Policy highlights the importance of environmental conservation as a strategy to control the negative impacts of natural disasters. The policy advocates for capacity building to raise the local community's awareness about the importance of environmental management. The policy developed a governance system with an implementation plan at different levels linking the national, regional, district, ward, and village levels. The governance system includes disaster management committees at different levels and outlines their respective roles and responsibilities as well as the responsibilities of other stakeholders — non-governmental organizations (NGOs), the media, and the civil society.

→ **2007 — The development of the National Adaptation Programme of Action (NAPA) fulfilled the requirement by the United Nations Framework Convention on Climate Change**

(UNFCCC) to address climate change. Overall, NAPA seeks to identify key climate change adaptation actions and activities sufficient for sustainable development amidst a changing climate. The main objectives of the NAPA are to identify and develop immediate and priority climate change and variability adaptation activities; protect people's livelihoods, the environment, biodiversity, and infrastructure; integrate climate change adaptation activities into national and subnational development strategies, policies and plans; increase communities' awareness of climate change, its impacts, and adaptation activities; support communities to improve human and technological capacities for sustainable environment and natural resource exploitation; support development activities hindered by climate change; as well as develop sustainable livelihood and development activities at the national, regional, and community levels.

→ **2012 — The main aim of the Tanzania Disaster Communication Strategy (TDCS) (2012) is to support and guide effective, timely, and reliable emergency communication among responders and the different levels of government and stakeholders.** The objectives of the TDCS are to ensure reliable and effective communication among emergency responders; support emergency communication to departments and communities at the different levels in the event of a disaster; guide the Tanzania Emergency Preparedness and Response Plan (TEPRP) by providing procedures to be followed in case of an emergency; and ensure that emergency responders communicate in a timely manner and as planned at all government levels. Although the TDCS does not mention climate-related hazards as disasters for an emergency response, the document outlines the Department of Public Health under MoHSW and the Tanzania Meteorological Agency as signatories.

Other documents guiding disaster management include the *Tanzania Emergency Preparedness and Response Plan (TEPRP – 2012), Disaster Management Act (2014/2015), the National Operational Guidelines for Disaster Management (2014), and Tanzania's All Hazard Health Emergency Preparedness and Response Plan (2016)*. The 2016 All Hazard Health Emergency Preparedness and Response Plan is a multisectoral plan spearheaded by the Tanzania Ministry of Health and Social Welfare MoHSW). It outlines guidelines for the health sector's emergency response to all hazards, including monitoring and evaluating disaster response activities, response planning, and decision-making in the face of an emergency, capacity building and resource mobilization for emergency response activities. The target audience for this emergency response plan is all health stakeholders in the government and private sectors.

→ **2012 — The overall goal of the National Climate Change Strategy (NCCS) is to enable Tanzania to effectively respond to climate change through adaptation and mitigation measures.** The NCCS seeks to place climate change on the policy agenda, reduce the country's vulnerability to climate change, build resilience to the negative effects of climate change, and achieve sustainable development, as stipulated in the National Development Vision 2025, Tanzania's 5-year National Development Plan, and different sectoral policies. The NCCS recognizes the need for the capacity building of key sectors to foster economic development and for related institutions to address climate mitigation and adaptation. The policy identifies the need for the public to learn about climate change, its harmful effects, as well as adaptation and

mitigation options; to this effect, it calls for the development and implementation of awareness programs. To further understand and address climate change, the NCCS stresses the need to establish adequate research capacity for research, build training institutions, increase the capacity of vulnerable and marginalized populations, promote local Indigenous knowledge in climate change responses, and purchase relevant technologies. Although not a climate change-health strategy, the 2012 NCCS clearly articulates the impacts of climate change on human health and identifies the need to build the capacity of facilities to address climate-related health risks.

- **2012 — The 2012–2017 National Climate Change Communication Strategy (NCCCS) (2012) aims to improve climate change awareness among stakeholders at different levels.** The 2012 NCCCS covers six thematic areas: climate change mitigation, adaptation, gender, awareness, research, and climate change financing. The document provides a strategic framework for guiding the effective implementation and delivery of climate change key messages / information to stakeholders, target audiences (international, national, regional, district, ward, and village levels), and responsible actors for each theme, in alignment with the media and national channels of communication and procedures.

  The 2012 NCCCS covers the impacts of climate change on the health sector under two of the six thematic themes. Under the themes of adaptation and climate change research, the strategy highlights key information on climate change impacts on human health, including climate-related health risks; the health systems' response to climate-related health risks; disease surveillance, control, and management; gender considerations; early warning systems (EWS); and the dissemination of best practices and key lessons. Although the 2012 NCCCS covers climate change, its impacts on the healthcare system, and climate health-related risks, the Ministry of Health and Social Welfare (MoHSW) was not on the National Task Force that prepared the 2012 NCCCS. This was thus a missed opportunity for the alignment of the NCCCS with the MoHSW's policies, plans, programs, and priorities.

- **2015 — Tanzania submitted its Intended Nationally Determined Contributions (INDCs) to the UNFCCC in 2015.** Tanzania's INDCs were developed in consultation with representatives from different sectors, including public and private sectors, government institutions, the civil society, along with academic and research institutions. Additional guidance was derived from international and national policies, strategies, action plans, and programs. Tanzania's INDCs aim to reduce GHGs, while achieving sustainable development, contributing to building adaptive capacity, enhancing actions to adapt to the impacts of climate change, and building long-term climate change resilience. Health is one of the identified adaptation priority sectors of the INDCs. The intended contributions for the health sector are integrating climate change adaptation into health policies and programs, conducting vulnerability assessments to guide the health sector adaptation action plan, and building a climate-sensitive health system and sanitation infrastructure.

- **2018 —Tanzania's 2018–2023 Health National Adaptation Plan (HNAP) to climate change is the country's first multisectoral exclusive document on health and climate change resilience.** Tanzania's HNAP aims to guide the country's health system to build resilience to climate change and a sustainable future for all Tanzanians. The HNAP seeks to (1) guide the integration of climate change in health sector policies, strategies, and programs; (2) highlight the need for an EWS for climate-sensitive

disease outbreaks and guide its operationalization; (3) support the implementation of the Nationally Determined Contributions (NDCs) and the integration of key health issues into the National Adaptation Plan; (4) advocate for the mobilization of resources and their allocation to support the adaptation of the health sector to climate change; and (5) guide the establishment of a climate change-resilient health sector.

- **2021 — Health Sector Strategic Plan V (HSSP V) (2021–2026), HSSP IV (2015–2020), HSSP III (2009–2015), HSSP II (2003–2008), and HSSP I (1999).** The Health Sector Strategic Plan V (HSSP V) (2021–2026) aims to achieve sustainable health coverage for all Tanzanians, irrespective of geographical location, age, social status, and gender by 2023. The HSSP V outlines guidelines for the health sector to achieve quality health services for all, by addressing the social determinants of health and improving the sector's emergency and disaster preparedness. In addition, the HSSP V aims to promote people-centered health services delivery. This will be attained through empowering and engaging communities in the planning, designing, and delivery of health services. The HSSP V recognizes the impacts of climate change on health and stresses the need for the health sector to adequately prepare to effectively tackle the health impacts related to change.
- **2021 — The NDC 2021 (which supersedes the INDC 2015).** Tanzania's NCD is guided by national policies, strategies, plans, programs, and international agreements, and calls for action on climate change and sustainable development, including the Paris Agreement, the New Urban Agenda (2016), and the Sustainable Development Goals (SDGs). The NDC was developed in consultation with multiple stakeholders from the government, local governments, the civil society, the private sector, as well as academic and research institutions. The guiding principles of the NDC includes increasing long-term resilience to climate change impacts and reducing climate vulnerability; enhancing transparency and stakeholder participation in the implementation of the NDCs per the provisions of the Paris Agreement; as well as contributing to the reduction of GHG efforts as stipulated in the UNFCCC and toward sustainable development as per the national development agenda. The NDC have also set out climate change adaptation strategies for the various sectors, including health; capacity building; gender mainstreaming; disaster risk reduction; infrastructure; agriculture; livestock; research and systematic observation; as well as water, sanitation, and hygiene (WASH).
- **2021 — Tanzania's National Climate Change Response Strategy (NCCRS) (2021–2026) was developed, based on the unaddressed gaps of prior regional and national climate change, environmental, and development policies, strategies, and plans.** The NCCRS 2021 was prepared by a multisectoral taskforce: it included representatives from the government ministries, the civil society, the local governments, the private sector, and development partners. The NCCRS aims to build Tanzania's resilience to climate change and guide the country to attain sustainable development through accelerating the transition to low-emission development pathways. The NCCRS has 10 specific aims, including strengthening and monitoring the implementation of the NDCs; ensuring the integration of climate change into national and subnational planning and programs; enhancing research and strengthening public awareness and education on climate change; and facilitating the mobilization of funds for the acquisition of technologies for climate change adaptation and mitigation programs.

Furthermore, the NCCRS 2021 aims to promote gender-response climate change adaptation and mitigation measures; enhance stakeholder engagement and inclusion in climate action; facilitate the transfer of climate-smart technologies in climate change adaptation and mitigation; and align climate change policies and programs with the national development agenda. Finally, the NCCRS 2021 highlights the impacts of climate change on the environment and human health and calls for the operationalization of a Health Sector National Adaptation Plan.

68. **Tanzania has made recommendable progress in the integration of climate change and health efforts; however, gaps remain.** Capacity building to strengthen health and climate mainstreaming is weak. In addition, there is weak accountability within MoHSW at the regional and local levels on health and climate change. Furthermore, communication and collaboration between the relevant sectors and departments are weak, and at times, non-existent.

HEALTH WORKFORCE

69. **The healthcare staff shortage is a persistent challenge in Tanzania, thus limiting health service delivery and undermining the overall resilience of the health system.** The lack of human resources for health (HRH) positions Tanzania among the 36 African countries in crisis. Additionally, Tanzania faces numerous health workforce challenges, including urban-rural maldistribution, a lack of proper skill mix, low quality of education, poor absorption capacity, rural retention issues, international outmigration, along with insufficient and irregular salary payments.[122] Simultaneously, climate change impacts the health workforce through mechanisms related to changes in the frequency and intensity of extreme weather events that may affect a facility or the workers' ability to reach the facility, as well as through altered patterns of climate-sensitive diseases to which health professionals may not be able to respond in a timely manner (WHO 2020).

70. **HRH in Tanzania are below the WHO minimum threshold for achieving universal health coverage (UHC) — 44.5 per 10,000.**[123] In 2018, the country had an estimated 0.5 medical doctors and 5.67 nurses and midwives per 10,000 population. Overall, there are an estimated 2,885 registered doctors and 31,940 nurses in total. Moreover, there is a shortage of allied health professionals.[124] For example, in 2018, there were only 4,361 medical pathologists and laboratory scientists and 929 environmental health officers (0.21 per 10,000), and in this survey no reported community health workers (CHWs) – who play a vital role in increasing resilience in the health system. Regarding mental health, there are no reports on the number of psychiatrists, psychologists, or nurses with mental health training. Although there are 2,946 workers registered as support staff, it is unclear what role and training they possess.[125],[126]

71. **There are limitations in the health workforce, both in terms of professional expertise and distribution, as well as an overarching lack of information on the awareness of climate change and health risks among health workers.** The health workforce, particularly doctors, is concentrated in urban areas, with almost 70 percent of medical doctors located in urban health facilities, leaving around 30 percent of medical doctors in rural areas where 65 percent of the population lives.[127] This gap increases in the case of medical specialists or consultants: 90 percent is found

in in urban areas. On the contrary, nurses and midwives (approximately 64 percent) are mostly located in rural areas, with only 36 percent in urban areas. There is an uneven distribution of the health workforce across provinces, with the majority of highly skilled professionals stationed in Dar es Salaam. There is no data on the quantity or the level of expertise on climate-related health risks among the health workforce.[128]

72. **Labor conditions for health workers restrict health workforce capacity.** The current salaries of health workers are low and labor conditions are inadequate, especially in rural areas where roads, communications, electricity, and other basic services are limited or lacking. Poor working conditions have triggered the outmigration of skilled health workers. Efforts to retain health personnel have focused on providing health insurance, a contributory social security scheme, housing or housing allowance, and in-service training. However, most of these incentives are still insufficient or have been removed, such as the housing or housing allowances. Official documents state that incentives have been a key topic of discussion; however, the current status of incentive packages or labor conditions is unclear.[129]

73. **The health sector's educational institutions tend to be underfunded, characterized by insufficient qualified educators, materials, and infrastructure.** By 2013, the country reported having 10 training institutions for medical doctors and 68 for nurses and midwives nationwide. These degree-level institutions are under the responsibility of the Ministry of Education and Vocational Training. Students attending medical colleges are fully sponsored, while other degrees are provided with soft loans to cover tuition fees and living expenses. However, these subsidies are dependent on funds availability and the performance of students. On the other hand, non-degree training programs are coordinated by MOHSW, with in-service training targeted at career advancement, for example, from clinical assistant to clinical officer. Other training programs are organized in terms of specific topics or diseases, such as HIV, malaria, or healthcare quality; however, these programs are not very well-coordinated.[130] It is unclear whether any training workshops or modules on climate change's impact on health and health service delivery have been conducted.

HEALTH INFORMATION SYSTEMS

74. **Tanzania has an Integrated Disease Surveillance and Response (IDSR) system that is currently monitoring 34 priority diseases and conditions; yet challenges remain in data collection, entry, management, and use.** The IDSR is coordinated by the Epidemiology Unit within MoHSW: it identifies, reports, and provides guidelines for responses on (a) diseases that are epidemic-prone, (b) key NCDs, (c) public health emergencies of international concern, (d) diseases of public health importance such as diarrhea, pneumonia, and malaria, as well as (e) diseases targeted for eradication / elimination. In the case of malaria, the country has a National Malaria Control Program in place, which integrates data on cases, mortality, and patients in all health facilities with the IDSR.[131]

75. **The country also has a Health Management Information System (HMIS).** This system collects data from health-related administrative and operational activities, such as information from over 7,000 health facilities, collecting morbidity and mortality rates of the population, health service delivery, essential

medical products, quality of services, along with financial and administrative operations.[132] However, the IDSR and other health information systems face challenges with data incompleteness, delays in reporting, poor data integration, as well as data storage and management challenges.[133],[134] Council health management teams (CHMTs) and other staff handling health data lack adequate training in data collection, analysis, and interpretation.[135]

76. **Tanzania has a multihazard early warning service (MHEWS) for coastal areas that is coordinated by the Tanzania Meteorological Agency in collaboration with the DRM department.** This system is aimed at delivering a five-day weather forecast service for climate-related hazards, such as heavy rain, flooding, landslides, strong winds, high waves, and extreme temperatures. It is focused mostly on the impact of these hazards on fishing communities along the coast of the country, and particularly for Zanzibar. However, it is not clear if the MHEWS is being integrated in the Health Management Information System (HIS) and contributing to understanding how climate-related hazards would change health emergencies. Dissemination of information to other areas in the country and along other climate-related risks, has lagged.[136],[137]

77. **Though there are other programs that are aimed at strengthening early warning systems (EWS) and responding to climate-related hazards, the extent to which health impacts are monitored or the health department uses EWS data is unknown.** The Tanzania Urban Resilience Programme (TURP), created in 2016 (with the collaboration of the World Bank), integrates weather and climate information for all decision-making levels in order to have improved responses to climate-related emergencies in urban areas.[138] The TURP system also collects data on vulnerable and at-risk households, while identifying their coping strategies. Households receive warning messages when extreme weather events are forecasted.

78. **Furthermore, the United Nations Development Programme Global Environmental Finance (UNDP-GEF) project is strengthening climate information and the EWS by transferring technologies and infrastructure for climate monitoring and setting up weather stations.** This project also integrates weather information with agrometeorological information for activities such as crop farming and livestock.[139] It uses text messages that are sent to smallholder farmers who are registered within the short message service (SMS) system. However, there are no details on the implementation of the program and its effectiveness in reducing climate-related risks.

ESSENTIAL MEDICAL PRODUCTS AND TECHNOLOGIES

79. **Tanzania has made progress in the supply of essential medicines and quality medical products, largely due to improved communication between the Medical Stores Department (MSD) and rural health facilities.** Yet there are still constant drug stock-outs as well as delays in the delivery of essential medicines and medical products — a situation that will be worsened by the climate change impacts on transport — and will increase the disease burden. Improved regulatory capacity has led to improved quality, safe and effective medical equipment, along with diagnostics and treatments, even in rural health facilities.[140] Tanzania has a National Essential Medicines List — first published in 1991 and revised in 2018 — and undated Standard Treatment

Guidelines.[141] However, gaps remain. The health sector in Tanzania is heavily dependent on donor funds and donor health priorities, including maternal, reproductive and child health programs as well as some communicable diseases like HIV/AIDS. This has led to the neglect of other current and emerging health issues, such as nutrition, malaria, injuries, and noncommunicable diseases (NCDs), which are becoming health burdens among the Tanzanian population; most of them are climate-related. There are insufficient funds to purchase basic essential medical products including gloves and gauze, along with the equipment needed for the diagnosis and treatment of NCDs. Health facilities are faced with drug stockouts, especially in the case of medicines for cancer, diabetes, high blood pressure, cardiovascular and chronic respiratory diseases, which are likely to be leading disease burdens among the Tanzanian population in the 2050s, due to climate change impacts.

80. **The Health Technology Assessment (HTA) was introduced in Tanzania in 2014 to improve universal health coverage (UHC).** However, there is inadequate funding and a lack of sufficient human resources for HTA. Following the introduction of the HTA, an HTA committee was formed. Nonetheless, the committee members lack adequate training to implement the HTA efficiently and effectively. Furthermore, there is still a lack of sufficient human resources for HTA and technical capacity.[142] There is also a lack of funds to purchase medical equipment and testing kits for the diagnosis and treatment of increasing premature deaths and cardiovascular and respiratory diseases related to climate change. In addition, Tanzania faces a severe shortage of laboratories, especially in rural areas,[143] which are, in most cases, also prone to climate change impacts, as they have the greatest vulnerability to climate change-related health risks. Because of delays in the delivery of test results from laboratories outside the district, disease detection, diagnosis, and treatment are delayed.

HEALTH SERVICE DELIVERY

81. **The introduction of the public-private partnerships (PPPs) in the health sector in Tanzania has led to an improvement in healthcare service delivery.** However, gaps and inefficiencies in the management of PPPs, as well as inadequate funding, have hindered timely and quality service delivery which is critical, given the increasing climate change impacts on health. The introduction of PPPs in the health sector is aimed at improving the quality of health services, increasing access to affordable and equitable health care services to all Tanzanians, and improving effectiveness and efficiency of health service delivery, among other things.[144] Overall, the implementation of the PPPs has improved the quality, affordability, and access to healthcare services.

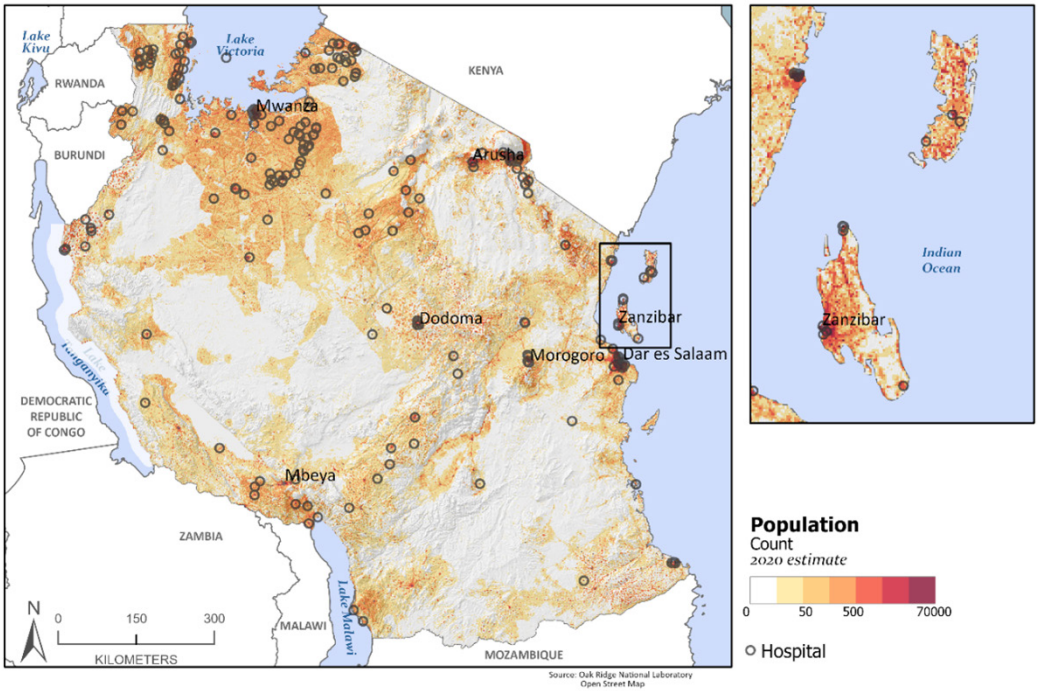
82. **However, challenges remain in realizing the core aims of the PPP.** Inadequate resources, due to the untimely or the lack of disbursement of financial resources by the government to the private health sector, have hindered effective health service delivery.[145] In addition, inadequate financial support undermines the timely monitoring and evaluation of PPP activities, which is key to compliance with the PPP agreements for the efficient and effective delivery of health services. Limited government capacity to monitor the private sector, poor communication and lack of transparency, the limited power of the private sector to contribute to decision-making, and poor governance

mechanisms have combined to undermine the efficiency of the PPP performance in the delivery of health services to all Tanzanians.

83. Tanzania has health facilities that are mostly concentrated in urban areas, leaving those living in rural areas to travel bigger distances to receive health care; this is a situation that is worsened by floods and severe droughts (see Figure 16 for the locations of health facilities). The country has a total of 6,881 public health facilities (see Table 7) that have a great majority of the dispensaries. The private sector has an important presence as well, with 1,333 health facilities. Overall, primary care services are the basis of healthcare in Tanzania: both public and private providers have a total of 6,942 dispensaries that provide preventive and curative outpatient services.[146] At the local level, the Council Health Management Teams (CHMTs), as the frontline of health care and social welfare services management, have an essential role in referring patients to hospitals and primary health care facilities.[147] Despite the increase in the number of health facilities between 2009 and 2014, the utilization of outpatient services had not increased concomitantly (about 0.7 per capita in 2013). Low utilization has been highlighted as a consequence of low quality and limited access to essential medicines and products.

84. Key health services in Tanzania are aligned with the needs on the current burden of disease; however, there are no considerations for the increase in the burden of disease due to climate change. The main services contemplated in the National Health Sector Strategy are (a) nutritional services; (b) reproductive, maternal, newborn, child & adolescent health (which include services for family planning); (c) communicable diseases such as malaria and other neglected tropical

FIGURE 16.
Location of Hospitals and Population Distribution in Tanzania



Source: Oak Ridge National Laboratory Open Street Map

TABLE 7.

Public Sector Facilities in Tanzania, Including Faith-Based Organizations (FBOs) (2014)

PUBLIC SECTOR FACILITIES	NUMBER	# BEDS
National general hospitals	1	1,362
National specialized hospitals	4	1,497
Regional referral hospitals (Gov)	14	3,449
Regional referral hospitals (FBO)	12	4,581
Zonal hospitals	5	2,327
Council hospitals	63	7,267
Council designated hospital	37	6,742
Voluntary Agency Hospital	103	5,595
Parastatal hospitals and health centers	29	1,214
Health centers	614	14,959
Dispensaries	5,819	
Parastatal dispensaries	168	
Specialized clinics	12	
Total	**6881**	**48,993**

Source: Tanzania Ministry of Health and Social Welfare (2015). Health Sector Strategic Plan July 2015 – June 2020. – HSSP IV. https://www.prb.org/wp-content/uploads/2020/06/Tanzania-Health-Sector-Strategic-Plan-IV-2015-2020-1-4.pdf

diseases, which are affected by temperature increases and changes in rainfall patterns; and (d) NCDs including mental health.[148]

85. In terms of the emergency preparedness of the health system and the continuation of health services, Tanzania has made some efforts in having an adequate policy and planning framework.[149,150] However, there is still room to prepare healthcare facilities to better cope with climate-related hazards and respond accordingly. Research shows that around 60 percent of health facilities have disaster committees and about 20 percent have developed disaster plans. Nonetheless, most hospitals (88 percent) lack backup communication systems.[151]

HEALTH FINANCING

86. There have been improvements in national investments in health; however, Tanzania is still highly dependent on foreign donors. Government expenditure in health, as a percentage of GDP, has kept stable for the last years, which was at 3.83 percent as of 2019.[152] Although overall health expenditure has increased, the amount stills falls behind the threshold of the recommended 5 percent spending in order to progress toward UHC. This figure also does not meet the Abuja Declaration target for African states to allocate 15 percent of its total budget to the health sector. The percentage of total government expenditure accounts for approximately 40 percent of the total budget for the health sector.[153,154]

87. **Overall health expenditure in absolute numbers has increased; however, it lags behind the country's overall economic growth (GDP increase of 7 percent).** From 2010 to 2017, the total health budget doubled, while government allocations to health declined by 3 percent.[155] On the other hand, per capita expenditure on health increased by approximately 20 percent from USD23.6 in 2010 to USD28.5 in 2017. This increase in per capita expenditure helped to reduce the gap between high- spending districts and low-spending districts from a sixfold difference in 2013 to a fivefold difference in 2017. For example, health expenditure as a share of total spending was 19 percent in the district of Njombe, but only 4 percent in Rukwa. Nonetheless, the existence of these gaps could still exacerbate vulnerabilities, as climate shocks would impact health service delivery across districts differently.[156]

88. **User fees have increased and become an important source of funding, constituting between 40 and 50 percent of all revenue from complementary financing sources, which will escalate inaccessibility to health services, considering the increased burden of climate change health impacts.** This affects mostly poorer households by hindering their access to care, as these fees are being collected at primary levels of care. This situation may be further aggravated because of climate change putting more strain on individuals and households in Tanzania, especially those most vulnerable to climate impacts. While fees are increasing, the government is implementing measures to remove these financial barriers. Efforts such as the Community Health Fund (CHF) and TIKA (a scheme for urban and peri-urban areas) are aimed at reducing costs in primary care.[157] Around 16 million Tanzanians (28 percent of the population) are currently covered by either the CHF or the National Health Insurance Fund (NHIF).[158]

89. **Building resilient health systems for climate change requires budget allocation to be an integrated component in the overall planning of a national health plan; this is still lacking.** Although there is a multisectoral approach and an integration of climate change and health in the Health National Adaptation Plan (HNAP) and overall health strategic planning, there is a lack of guidelines on integrating a climate-resilient approach for specific climate-related health risks, such as food insecurity and malnutrition, as well as heat-related morbidity and mortality, which are necessary for informing rationalized resource allocation. Moreover, while Tanzania adopts risk-pooling mechanisms, it is not clear whether it has accounted for climate-related risks.[159]

90. **Climate change mitigation and adaptation options in the health sector have not been adequately promoted as cost-effective options.** Arguments for implementing climate change mitigation policies often focus on the perceived short-term financial costs. However, cost assessments are lacking and rarely account for the health co-benefits of these policies — strengthening the resilience and 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 Tanzania.

TABLE 8.

Summary of Health System Adaptive Capacity Gaps for Tanzania

BUILDING BLOCK	SUMMARY OF GAPS IN ADAPTIVE CAPACITY
Leadership and Governance	• The country has developed a policy landscape that adequately integrates climate change into adaptation planning. However, there is a need for coordination mechanisms that promote synergies among ministries in order to improve resilience and health outcomes.
Health Workforce	• HRH in Tanzania are below the WHO's minimum threshold to achieve UHC. • There are limitations in the health workforce, both in professional expertise and distribution, as well as an overarching lack of information on the awareness of climate change and health risks among health workers. • Healthcare staff shortages are a persistent challenge in Tanzania, curtailing health service delivery and overall resilience of the health system. • The health sector's educational institutions tend to be underfunded, characterized by insufficient qualified educators, materials, and infrastructure.
Health Information Systems and Response	• It is not clear if the MHEWS is being integrated in the HMIS and contributing to the understanding of how climate-related hazards would change health emergencies. • The scaling up of current EWS to other areas in the country and along other climate-related risks has been delayed. • The IDSR system does not incorporate meteorological information to offer a better understanding of climate-related health risks.
Essential Medical Products and Technologies	• There are insufficient funds to purchase basic essential medical products including gloves and gauze, as well as equipment needed for the diagnosis and treatment of NCDs. • Health facilities face drug stockouts, especially in terms of medicines for cancer, diabetes, high blood pressure, cardiovascular and chronic respiratory diseases, which are likely to be leading burdens among the Tanzanian population in the 2050s. • There are insufficient human resources for HTAs and technical capacity. • Tanzania faces severe shortages of laboratories, especially in the rural areas.
Health Service Delivery	• Overall poor governance mechanisms have curtailed the functioning of PPPs in the health sector, and therefore, decreased the efficiency of health service delivery. Additionally, there is a lack of governmental capacity to oversee the private sector. • Health services are of low quality and there is limited access to essential medicines and products. • There are no considerations for the increase of burden of disease due to climate change, and therefore, for medical services that address the increased climate-related health risks.

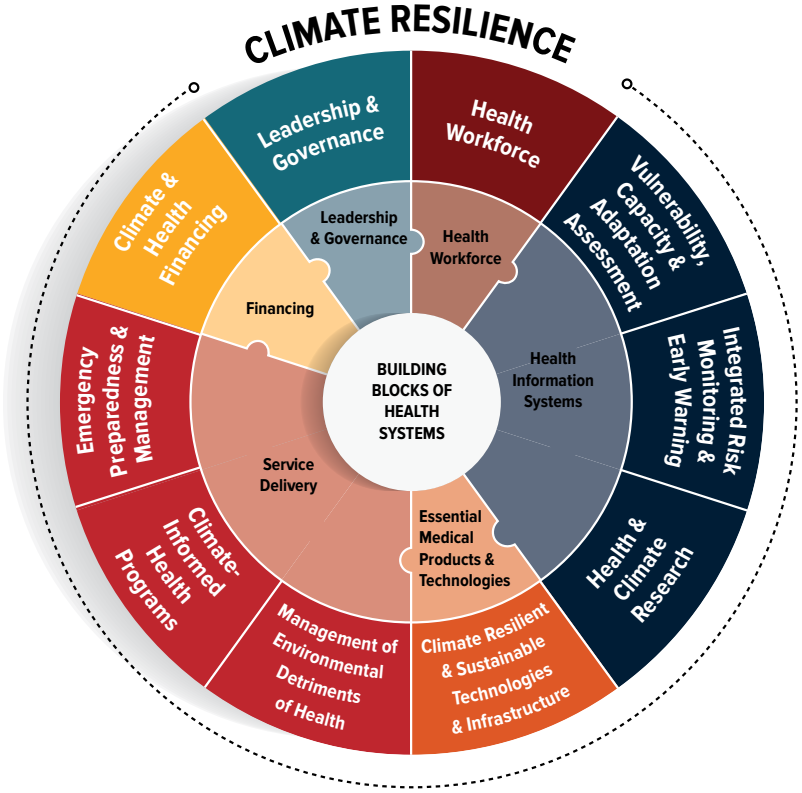
BUILDING BLOCK	SUMMARY OF GAPS IN ADAPTIVE CAPACITY
Health Financing	• Regarding health expenditure as a percentage of GDP, the country falls behind the Abuja Declaration and the target to achieve UHC. • The country has seen an increase in economic growth; however, health expenditure has not increased in terms of percentage of GDP. • User fees have increased and become an important source of funding, constituting between 40 and 50 percent of all revenue from complementary financing sources. • Climate change mitigation and adaptation options in the health sector have not been adequately promoted as cost-effective options. • Climate change and climate-related health morbidities and mortalities do not have budget allocations.

SECTION V.

RECOMMENDATIONS TO ENHANCE HEALTH SYSTEM RESILIENCE TO CLIMATE CHANGE

91. This section outlines a set of recommendations to enhance Tanzania's health system resilience and adaptation to climate change, including 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 as well as the existing gaps in adaptive capacity to manage and / or prevent these risks. This section is organized, using the 10 components of climate-resilient health systems (see Figure 17) and drawing from the consultations and reviews of all relevant governmental policies, as well as the World Bank's Health, Nutrition, and Population (HNP) Climate and Health Guidance Note.

FIGURE 17.
Who's Operational Framework for Building Climate-Resilient Health Systems



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

COMPONENT 1: LEADERSHIP AND GOVERNANCE

- On the one hand, health should adequately be integrated into national climate change policies, strategies, and programs. On the other hand, climate change should also be taken into consideration, when national health policies, strategies, and programs are developed. The integration of health and climate change should be strengthened at all levels from the national level to the local government level.
- There is a need for a coordination mechanism. A National Climate Change and Health Task Force should be established with expert representatives from different ministries and departments including MOHSW the Division of Environment (the department under Vice President's Office responsible for climate change), and other key departments. Focal persons should be appointed to represent the national, regional, and local levels in the National Climate Change and Health Task Force.
  - This group would further health adaptation efforts within the Division of Environment by taking part in strategic planning and activities, while also conducting and promoting work meetings to advocate for and raise awareness on climate-related health risks.
  - The National Climate Change and Health Task Force should ensure the dissemination of climate and health strategies and activities and monitor their implementation at the subnational and local levels regularly.

COMPONENT 2: HEALTH WORKFORCE

- Integrate climate change and health into the national education curriculum for health training at all levels, including lower secondary, upper secondary, and tertiary.
- Establish refresher courses and continuing education programs that focus on climate-related health risks.
- Develop climate and health training materials for health workers to raise the awareness of health workers regarding the health impacts of climate change.
- Enhance the provision of benefits on housing or housing allowances for health workers in order to improve retention. Other retention strategies include providing better salaries in rural areas and areas prone to climate change hazards (floods, droughts, and heat waves), including those of northern, central, and coastal Tanzania, in order to increase the number of medical doctors and specialists in those areas. The distribution of health workforce should consider the geographic distribution of climate-related hazards: for example, areas that are prone to VBDs would require better capacities in laboratories for processing samples and keeping a better surveillance mechanism.

COMPONENT 3: VULNERABILITY, CAPACITY, AND ADAPTATION ASSESSMENT

- Conduct routine national climate health impact assessments to guide policy-making decisions.
- Make routine projections of the climate-related disease burden and the geographical distribution of climate-related health risks (under different scenarios).

- Update the Human Resources for Health (HRH) country profile to help in the identification of gaps and need for training.

COMPONENT 4: INTEGRATED RISK MONITORING AND EARLY WARNING

- The Health Management Information System (HMIS) and the monitoring / surveillance should account for climate-related health risks and indicators. This would require cross-sectoral work that will involve the Tanzania Meteorological Agency, water & sanitation, DRM, agriculture, environment responsible entities, among others, integrating climate and environment data with disease surveillance and early warning mechanisms (climate-informed disease surveillance).
- Promote a comprehensive risk assessment framework involving different-level stakeholders (researchers, health policy makers, communities, and donors) and approaches.
- Enhance early warning mechanisms and communication on climate change hazards among the different-level stakeholders.
- Map climate-related health risks to facilitate the identification of vulnerable populations and their exposure to climate-related hazards.
- Develop a list of key climate-related health risks (present and projected) and indicators for targeted monitoring and surveillance that should take into consideration geographical differences.

COMPONENT 5: HEALTH AND CLIMATE RESEARCH

- Create awareness and advocate for the importance of conducting climate and health research to attract policy makers and international donors. This campaign should be spearheaded by MoHSW.
- Improve institutional capacity to conduct more climate-related health research.
- Strengthen communication channels between climate and health researchers and policy makers.
- Create mechanisms for disseminating climate and health findings and translating them into policies.

COMPONENT 6: CLIMATE-RESILIENT AND SUSTAINABLE TECHNOLOGIES AND INFRASTRUCTURE

- Map health facilities including laboratories and assess their resilience to climate change.
- Advocate for the strengthening of climate-resilient health as well as water sanitation and hygiene (WASH) infrastructure and technologies to attract more funding for supporting the capacity development, planning, monitoring and evaluation of health facilities for WASH provisions.
- Develop climate-resilient infrastructure design guidelines and ensure adherence to these guidelines.
- Develop a WASH and climate change adaptation strategy.

COMPONENT 7: MANAGEMENT OF ENVIRONMENTAL DETERMINANTS OF HEALTH

- Strengthen collaboration among different sectors, in terms of the monitoring and management of climate-related health and environmental risks. Environmental efforts have not included health-related risks.

- MoHSW should establish coordination mechanisms to integrate health risks that are linked to environmental efforts and policies, that is, air quality efforts should incorporate interventions aimed at improving health outcomes, such as respiratory diseases. Another example involves the Ministry of Water and the consideration of how their policies and programs would benefit health outcomes by strengthening water treatment facilities, for instance, which would reduce WBDs.
- Include health in environmental impact assessments and enforce requirements stipulated in the health impact assessments.
- Reinforce the awareness of the health implications of poor sanitary and improper waste disposal practices, including open defecation, amidst a changing climate (that is, the connection between flash floods and diarrheal disease outbreaks).

COMPONENT 8: CLIMATE-INFORMED HEALTH PROGRAMS

- Develop and disseminate awareness campaigns on climate-related health risks, by using radio, television, and push notifications, as well as engaging with community leaders to ensure better communication channels in the most vulnerable and remote communities. Campaigns should focus on preventive measures and the management of environmental determinants of health, such as the use of water and how to treat it to reduce pollutants and bacteria.
- Need for bottom-up climate change and health initiatives to ensure sustainability of programs and local impact.
- Strengthen and conduct routine health programs by taking into consideration the past and current climate conditions and projected climate change. These health programs should account for geographical differences in climate change exposure and climate-related health risks.

COMPONENT 9: EMERGENCY PREPAREDNESS AND MANAGEMENT

- Enhance health system resilience to climate-related hazards. For example, the health impacts of climate change should be integrated into emergency preparedness and the routine climate resilience assessment of health facilities and infrastructure.

COMPONENT 10: CLIMATE AND HEALTH FINANCING

- Ensure that strategic purchasing includes climate-related health risk considerations. It is recommended that this involves a move toward a provider payment mechanism that incentivizes healthcare providers to focus on climate-related health outcomes, particularly in relation to those most vulnerable to climate-related health risks. The mechanism should be guided by detailed, subnational climate information on population needs related to ongoing climate exposures.
- Put in place a detailed resource mobilization plan for resources to support climate-related emergency responses and climate and health research.
- Advocate for the allocation of funds to strengthen the health sector's resilience to climate-related hazards.
- Ensure that climate-related health risks are integrated into national, regional, and local programs and associated budgets.

SUMMARY OF RECOMMENDATIONS TO ENHANCE HEALTH SYSTEM RESILIENCE TO CLIMATE CHANGE IN TANZANIA

BUILDING BLOCK	RECOMMENDATIONS
Leadership and Governance	• Adequately integrate health into national climate change policies, strategies, and programs. • Strengthen the coordination mechanism by establishing a National Climate Change and Health Task Force with expert representatives from different ministries and departments.
Health Workforce	• Integrate climate change and health into the national education curriculum for health training at all levels. • Establish refresher courses and continuing education programs that focus on climate-related health risks. • Develop climate and health training materials for health workers to raise awareness on the health impacts of climate change among health workers. • Enhance the provision of benefits on housing or housing allowances for health workers in order to improve retention.
Vulnerability, Capacity, and Adaptation Assessment	• Develop a Climate Change Health Risk Assessment model to guide planning, decision-making, and resource allocation. • Conduct routine national climate health impact assessments to guide policy-making decisions. • Conduct routine projections of climate-related disease burden and geographical distribution of climate-related health risks. • Update the HRH country profile to help in the identification of gaps and need for training.
Integrated Risk Monitoring and Early Warning	• The HMIS and the monitoring / surveillance should account for climate-related health risks and indicators. • Integrate climate and environment information with disease surveillance and early warning mechanisms. • Enhance early warning mechanisms and communication on climate change hazards among the different-level stakeholders. • Map climate-related health risks to facilitate the identification of vulnerable populations and their exposure to climate-related hazards. • Promote a comprehensive risk assessment framework involving different-level stakeholders (researchers, health policy makers, communities, and donors) and approaches. • Develop a list of key climate-related health risks and indicators for targeted monitoring and surveillance.

BUILDING BLOCK	RECOMMENDATIONS
Health and Climate Research	• Create awareness and advocate for the importance of conducting climate and health research to attract policy makers and international donors. • Improve institutional capacity to conduct more climate-related health research. • Strengthen communication channels between climate and health researchers and policy makers. • Create mechanisms for the dissemination of climate and health findings and their translation into policies.
Climate Resilient and Sustainable Technologies and Infrastructure	• Map health facilities and assess their resilience to climate change. • Advocate for climate-resilient health and WASH infrastructure and technologies. • Develop a WASH and climate change adaptation strategy. • Develop climate-resilient infrastructure design guidelines and implement them.
Management of Environmental Determinants of Health	• Strengthen collaboration among different sectors, in terms of monitoring and managing climate-related health and environmental risks. • MoHSW should establish coordination mechanisms in order to integrate health risks that are linked to environmental efforts and policies. • Include health in environmental impact assessments and enforce assessments. • Reinforce awareness on the health implications of poor sanitary and improper waste disposal practices, including open defecation, amidst a changing climate.
Climate-informed Health Programs	• Develop and disseminate awareness campaigns on climate-related health risks. • Need for bottom-up climate change and health initiatives to ensure sustainability of programs and local impact. • Strengthen and conduct routine health programs that take into consideration past and current climate conditions, along with projected climate change.
Emergency Preparedness and Management	• Enhance health system resilience to climate-related hazards.
Climate and Health Financing	• Ensure that strategic purchasing includes climate-related health risk considerations. • Put in place a detailed mobilization plan for resources to support climate-related emergency responses climate and health research. • Advocate for the allocation of funds to strengthen the health sector's resilience to climate-related hazards. • Ensure that climate-related health risks are integrated into national, regional, and local programs and associated budgets.

ANNEXES

ANNEX A. METHODS FOR THE ESTIMATION OF MOSQUITO SUITABILITY UNDER REPRESENTATIVE CONCENTRATION PATHWAY (RCP) 8.5 IN TANZANIA

METHODS FOR THE ESTIMATION OF MOSQUITO SUITABILITY UNDER RCP 8.5 IN TANZANIA

Model Construction

Spatiotemporal distributions of *Anopheles (An.) gambiae s.s., Anopheles funestus*, and *Anopheles arabiensis* mosquitoes was determined, using a raster-based suitability model constructed with the Google Earth Engine by adapting methodology presented by Frake et al. (2020).[160] This methodology uses abiotic variables specific to the thermal tolerances of vector species and biotic variables that consider 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, landcover, 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, using Boolean logic to produce suitability maps across three epochs — historical reference period (1986–2005), 2030–2049, and 2040–2059 — during Tanzania's two historic malaria transmission periods: March–May and October–December.[161]
- Population vulnerability was demonstrated by spatially overlaying suitability maps for malaria mosquitoes in Tanzania with population data from the Global Human Settlement Layers (2015) to calculate the number of Tanzanians residing in suitable areas, by region. Population data were held constant in all models, in the absence of spatial population projection data.

Output spatial resolution of products is 1000 meters: this analysis was performed at the landscape, not microscale level. Microscale variations in climatological and land use and land cover can and do affect 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	*An. gambiae s.s.* Min: 18°C Max: 34°C *An. arabiensis* Min: 13°C Max: 35°C *An. funestus* Min: 14°C Max: 35°C
Land Cover	Copernicus Global Land Service	Proba-V-C3	100 m	See Annex Table 2*
Water Resources	Joint Research Centre (JRC)	GSW1_0	30 m	>0 percent 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 to mosquito development and life history. Temperatures that are either too low or too high can increase mortality during aquatic or adult stages. Bayoh and Lindsay (2003) demonstrated that the upper and lower thresholds for *An. gambiae* s.s. aquatic development were 18°C and 34°C, respectively.[162] The lower development thresholds for *An. arabiensis* and *An. funestus* have been demonstrated at 13°C and 14°C, respectively, while the upper limits for survival for both species are 35°C.[163] Data were acquired from the NASA NEX-GDDP at a 0.25-degree spatial resolution.

Land Use and Land Cover

There is a significant relationship between land use and land cover (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" (Tablea 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 *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 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 *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.	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 areas likely to become inundated, the annual average precipitation was calculated from the Climate Hazards Group InfraRed Precipitation and Station Data (CHIRPS v2.0). Likewise, flow accumulation was derived from the HydroSHEDS Flow Accumulation product to determine the natural drainage from a given pixel to an 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 by buffering the water bodies by 250 m to approximate water-rich soils that would support larval development.

ANNEX B. VECTOR-BORNE DISEASE SUITABILITY PER REGION — SEASON 1: MARCH–MAY

TABLE B1.

Vector-Borne Disease Suitability Per Region and Vulnerable Population in the Past, Present, and Future — Season 1: March–May

	PERCENT AREA								
	POPULATED, SUITABLE			OVERALL SUITABILITY			VULNERABLE POPULATION		
REGION	HISTORIC	2030S	2050S	HISTORIC	2030S	2050S	HISTORIC	2030S	2050S
Mainland Tanzania									
Arusha	44.95	44.95	44.32	95.33	95.33	91.42	1985570	1985570	1967922
Dar-es-salaam	89.68	89.68	89.68	98.79	98.79	98.79	563584	5635844	5635844
Dodoma	21.74	21.74	21.74	99.34	99.34	99.34	2430118	2430118	2430118
Geita	14.35	14.35	14.35	93.54	93.54	93.54	2179487	2179487	2179487
Iringa	9.45	9.45	9.45	99.80	99.80	99.80	1069239	1069239	1069239
Kagera	10.86	10.86	10.86	70.82	70.82	70.82	2796196	2796196	2796196
Katavi	16.35	16.35	16.35	95.00	95.00	95.00	683211	683211	683211
Kigoma	8.94	8.94	8.94	80.49	80.49	80.49	2500794	2500794	2500794
Kilimanjaro	36.75	36.75	36.75	99.43	99.43	99.43	1883654	1883654	1883654
Lindi	19.03	19.03	19.03	99.89	99.89	99.78	959000	959000	958896
Manyara	36.77	36.77	36.77	99.89	99.89	99.89	1688364	1688364	1688364
Mara	30.74	30.74	30.74	70.00	70.00	70.00	2028963	2028963	2028963
Mbeya	21.45	21.45	21.45	96.96	96.96	96.96	3285500	3285500	3285500
Morogoro	13.09	13.09	11.28	99.94	99.94	90.78	2593247	2593247	2461616
Mtwara	13.54	13.54	13.54	99.71	99.71	99.71	1404733	1404733	1404733
Mwanza	15.72	15.72	15.72	46.89	46.89	46.89	3194439	3194439	3194439
Njombe	21.70	21.70	21.70	99.86	99.86	99.86	790434	790434	790434
Pwani	10.51	10.51	7.22	99.63	99.63	79.47	1244935	1244935	968116
Rukwa	11.61	11.61	11.61	76.81	76.81	76.81	1178359	1178359	1178359
Ruvuma	9.0	9.00	9.00	99.96	99.96	99.96	1596947	1596947	1596947
Shinyanga	37.12	37.12	37.12	99.98	99.98	99.98	1791925	1791925	1791925
Simiyu	54.84	54.84	54.84	97.28	97.28	97.28	1906861	1906861	1906861
Singida	55.25	55.25	55.25	99.90	99.90	99.90	1582819	1582819	1582819
Tabora	15.91	15.91	15.91	99.96	99.96	99.96	2740514	2740514	2740514
Tanga	35.95	35.95	32.02	99.92	99.92	70.57	2391781	2344306	1642764
Zanzibar									
Kaskazini Pemba	62.55	62.55	52.12	92.86	92.86	73.17	227618	227618	172365
Kaskazini Unguja	46.57	46.57	40.34	96.78	96.78	78.54	217573	217573	173696
Kusini Pemba	48.03	48.03	46.49	95.61	95.61	92.11	208270	208270	201998
Kusini Unguja	31.38	31.38	31.38	97.41	97.41	97.41	129564	129564	129564
Mjini Magharibi	58.62	58.62	58.62	98.28	98.28	98.28	730476	730476	730476
						Total	**52995468**	**53008974**	**51775830**

Source: Buchhorn, M. ; Lesiv, M. ; Tsendbazar, N. - E. ; Herold, M. ; Bertels, L. ; Smets, B. Copernicus Global Land Cover Layers—Collection 2. Remote Sensing 2020, 12Volume 108, 1044. DOI 10.3390/rs12061044

ANNEX C. VECTOR-BORNE DISEASE SUITABILITY PER REGION — SEASON 2: OCTOBER–DECEMBER

TABLE C1.

Vector-Borne Disease Suitability Per Region and Vulnerable Population in the Past, Present, and Future — Season 2: October–December

	PERCENT AREA								
	POPULATED, SUITABLE			OVERALL SUITABILITY			VULNERABLE POPULATION		
REGION	HISTORIC	2030S	2050S	HISTORIC	2030S	2050S	HISTORIC	2030S	2050S
Mainland Tanzania									
Arusha	45.04	44.97	44.39	97.19	95.21	91.31	1985570	1985570	1967922
Dar-es-salaam	89.94	89.94	89.94	99.20	99.20	99.20	563584	5635844	5635844
Dodoma	21.74	21.70	19.78	99.31	99.05	83.83	2430118	2430118	2430118
Geita	14.24	14.24	14.24	93.56	93.56	90.69	2179487	2179487	2179487
Iringa	9.45	8.82	7.93	99.80	97.07	81.96	1069239	1069239	1069239
Kagera	10.94	10.94	10.94	70.76	70.76	70.76	2796196	2796196	2796196
Katavi	16.41	15.99	5.69	95.00	90.14	56.60	683211	683211	683211
Kigoma	8.91	8.91	8.73	80.44	80.44	69.24	2500794	2500794	2500794
Kilimanjaro	36.89	36.89	36.89	99.49	99.49	99.49	1883654	1883654	1883654
Lindi	19.02	19.02	18.99	99.87	98.99	89.41	959000	959000	958896
Manyara	36.86	36.86	36.86	99.89	99.89	99.89	1688364	1688364	1688364
Mara	30.58	30.58	30.58	69.71	69.71	69.71	2028963	2028963	2028963
Mbeya	21.51	20.89	17.81	96.95	95.10	83.10	3285500	3285500	3285500
Morogoro	11.64	8.31	6.01	95.59	76.37	41.81	2593247	2593247	2461616
Mtwara	13.64	13.64	12.65	99.76	99.76	74.92	1404733	1404733	1404733
Mwanza	15.83	15.83	15.83	46.89	46.89	46.89	3194439	3194439	3194439
Njombe	21.69	21.69	21.36	99.89	99.89	97.02	790434	790434	790434
Pwani	10.71	9.93	6.71	99.66	94.34	61.92	1244935	1244935	968116
Rukwa	11.70	11.55	11.51	76.89	69.51	61.17	1178359	1178359	1178359
Ruvuma	8.94	8.89	7.77	99.96	97.42	76.14	1596947	1596947	1596947
Shinyanga	37.51	37.51	37.51	99.99	99.99	99.99	1791925	1791925	1791925
Simiyu	54.53	54.53	54.53	97.28	97.28	97.28	1906861	1906861	1906861
Singida	55.24	55.24	51.98	99.90	99.90	91.08	1582819	1582819	1582819
Tabora	15.80	15.80	8.73	99.95	99.95	52.45	2740514	2740514	2740514
Tanga	36.14	36.14	35.70	99.93	99.93	97.23	2391781	2344306	1642764
ZANZIBAR									
Kaskazini Pemba	61.91	61.91	61.91	93.36	93.36	93.36	227618	227618	172365
Kaskazini Unguja	45.00	45.00	45.00	95.65	95.65	95.65	217573	217573	173696
Kusini Pemba	49.34	49.34	49.34	94.98	94.98	94.98	208270	208270	201998
Kusini Unguja	32.11	32.11	32.11	97.94	97.94	97.94	129564	129564	129564
Mjini Magharibi	60.34	60.34	60.34	97.41	97.41	97.41	730476	730476	730476
						Total	52995468	53008974	51775830

Source: Buchhorn, M. ; Lesiv, M. ; Tsendbazar, N. - E. ; Herold, M. ; Bertels, L. ; Smets, B. Copernicus Global Land Cover Layers—Collection 2. Remote Sensing 2020, 12Volume 108, 1044. DOI 10.3390/rs12061044

ANNEX D: KEY RECOMMENDATIONS AND RELEVANT LINE MINISTRIES IN TANZANIA

HIGH-LEVEL RECOMMENDATIONS	RELEVANT LINE MINISTRIES	WHO'S CLIMATE AND HEALTH OPERATIONAL COMPONENT
• Adequately integrate health into climate change policies, strategies, and programs at both the national and subnational levels. • Strengthen climate-health coordination through the establishment and financing of a National Climate Change and Health Task Force.	Ministry of Health, and Social Welafre) MoHSW); Regional Medical Officers; District Medical Officers (DMOs); Vice President's Office (Division of Environment)	Leadership and Governance
• Develop health workforce capacity to manage climate-related health risks. • Enhance health workforce retention packages in areas prone to climate change-related hazards.	MoHSW; Ministry of Education, Science and Technology (Division of Higher Education); Medical Association of Tanzania (MAT); Tanzania Medical Student's Association (TAMSA)	Health Workforce
• Integrate climate and environment information with disease surveillance and early warning mechanisms.	MoHSW; Epidemiology Unit; Public Health Emergency Operations Center, Disease Control Section; President's Office, Regional Administrative and Local Government (PO-RALG); Regional and Council Medical Offices; Tanzania Meteorological Agency	Integrated Risk Monitoring and Early Warning
• Advocate for climate and health research.	MoHSW; MAT; TAMSA; Tanzania National Institute for Medical Research (NIMR); Ministry of Education, Science and Technology (Division of Higher Education); Higher Institutions of Learning	Health and Climate Research
• Advocate for strengthening climate-resilient health and WASH infrastructure and technologies. • Develop a WASH and climate change adaptation Strategy.	MoHSW (Directorate of Preventative Health Services); PO-RALG; Ministry of Water (MoW); Rural Water Supply and Sanitation Agency (RUWASA)	Climate Resilient and Sustainable Technologies and Infrastructure
• Reinforce public awareness on the health implications of poor sanitary and waste disposal practices, including open defecation, amidst a changing climate.	MoHSW; Regional and Council Medical Offices; PO-RALG, RUWASA	Management of Environmental Determinants of Health
• Strengthen and conduct routine health programs, taking into consideration past and current climate conditions, and projected climate change.	MoHSW (Directorate of Preventative Health Services); Epidemiology Unit; Public Health Emergency Operations Center, Disease Control Section; Tanzania Food and Nutrition Center (TFNC); PO-RALG	Climate-informed Health Programs
• Integrate climate-related health risks into national, regional, and local health budgets.	MoHSW, Ministry of Finance and Planning	Climate and Health Financing

ANNEX E: CATEGORIZATION OF RECOMMENDATIONS

(SHORT — LESS THAN 2 YEARS; MEDIUM — 2–5 YEARS; AND LONG TERM — MORE THAN 5 YEARS)

COMPONENTS	SUMMARY OF RECOMMENDATIONS
Leadership and Governance	**Medium Term:** Adequately integrate health into national climate change policies, strategies, and programs. Strengthen the coordination mechanism by establishing a National Climate Change and Health Task Force with expert representatives from different ministries and departments.
Health Workforce	**Short Term:** Develop climate and health training materials for health workers to raise awareness on the health impacts of climate change among health workers. Enhance the provision of benefits on housing or housing allowances for health workers to improve retention.
	Medium Term: Establish refresher courses and continuing education programs that focus on climate-related health risks.
	Long Term: Integrate climate change and health into the national education curriculum for health training at all levels.
Vulnerability, Capacity, and Adaptation Assessment	**Short Term:** Develop a climate change health risk assessment model to guide planning, decision-making, and resource allocations.
	Medium Term: Conduct routine national climate health impact assessments to guide policy-making decisions. Update the Human Resources for Health (HRH) country profile to help in the identification of the gaps and needs for training.
	Long Term: Conduct routine projections of climate-related disease burden and geographical distribution of climate-related health risks.
Integrated Risk Monitoring and Early Warning	**Short Term:** The Health Management Information System (HMIS) and the monitoring / surveillance should account for climate-related health risks and indicators. Integrate climate and environment information with disease surveillance and early warning mechanisms. Enhance early warning mechanisms and communication on climate change hazards among the different-level stakeholders. Map climate-related health risks to facilitate the identification of vulnerable populations and their exposure to climate-related hazards. Promote a comprehensive risk assessment framework involving different-level stakeholders (researchers, health policy makers, communities, and donors) and approaches. Develop a list of key climate-related health risks and indicators for targeted monitoring and surveillance.

COMPONENTS	SUMMARY OF RECOMMENDATIONS
Health and Climate Research	**Short Term:** Create awareness and advocate for the importance of conducting climate and health research to attract policy makers and international donors. Strengthen communication channels between climate and health researchers and policymakers. Create mechanisms for disseminating climate and health findings and translating them into policies.
	Medium Term: Develop a resource mobilization strategy / plan for funds to support climate and health research.
	Long Term: Improve institutional capacity to conduct more climate-related health research.
Climate-Resilient and Sustainable Technologies and Infrastructure	**Short Term:** Map health facilities and assess their resilience to climate change. Advocate for climate-resilient health and WASH infrastructure and technologies.
	Medium Term: Develop a WASH and climate change adaptation strategy. Develop climate-resilient infrastructure design guidelines and implement them.
Management of Environmental Determinants of Health	**Short Term:** Reinforce awareness on the health implications of poor sanitary and improper waste disposal practices, including open defecation, amidst a changing climate.
	Medium Term: Strengthen collaboration between different sectors, in terms of monitoring and managing climate-related health and environmental risks. MoHSW should establish coordination mechanisms to integrate health risks that are linked to environmental efforts and policies. Include health in environmental impact assessments and assessments should be enforced.
Climate-informed Health Programs	**Short Term:** Develop and disseminate awareness campaigns on climate-related health risks. Strengthen and conduct routine health programs by taking into consideration past and current climate conditions, and projected climate change.
	Medium Term: Need for bottom-up climate change and health initiatives to ensure the sustainability of programs and local impact.
Emergency Preparedness and Management	**Long Term:** Enhance health system resilience to climate-related hazards.
Climate and Health Financing	**Short Term:** Ensure that strategic purchasing includes climate-related health risk considerations.
	Medium Term: Set up a detailed mobilization plan for resources to support climate-related emergency responses. Advocate for the allocation of funds to strengthen the health sector's resilience to climate-related hazards. Ensure that climate-related health risks are integrated into national, regional, and local programs, along with associated budgets.

ANNEX F: MENU OF ADAPTATION RECOMMENDATIONS

	FOOD SECURITY AND NUTRITION	VECTOR-BORNE DISEASES (VBDS)	WATERBORNE DISEASES (WBDS)	HEAT-RELATED MORBIDITY AND MORTALITY	AIR QUALITY	DIRECT INJURIES AND MORTALITY	MENTAL HEALTH AND WELL-BEING
Leadership and Governance	• Enhance coordination among subnational, district, and community levels for the improved implementation of climate change, agriculture, food security, and nutrition policies and programs.	• Need for collaborative efforts in the development and adaptation of control and prevention mechanisms to address climate change impacts on VBDs.	• Promote coordination efforts in the development and adaptation of control and prevention mechanisms to address climate change impacts on WBDs.	• Integrate heat adaptation strategies into national and subnational health policies.	• Strengthen the enforcement of air quality standards. • Coordinate climate and air quality policies.	•	• Integrate climate change impacts on mental health and wellbeing into health policies and strategies.
Health workforce	• Integrate climate change impacts on food security and nutrition into health workforce training.	• Enhance health workforce training on the increased risk of VBD burden in new regions due to climate change.	• Improve the training of the health workforce on the impacts of climate change on WBDs, including water sanitation and hygiene (WASH).	• Enhance the health workforce training on the management of heat-related illnesses.	• Develop on-the-job training materials and refresher courses to facilitate the improved management of air quality-related illnesses.	• Improve the capacity of community health workers (CHWs) to better manage direct injuries, including training, facilitation, and the provision of sufficient first aid kits.	• Training of more health workers to manage mental health and wellbeing issues.
Vulnerability, capacity, and adaptation assessment	• Enhance the vulnerability and adaptation assessment to evaluate the extent of climate change impacts on food security and nutrition.	• Support community-based adaptation measures to address VBDs.	• Enhance assessments to quantify the magnitude of climate change impacts on WBDs.	• Improve community capacity and resilience to hot conditions by conducting routine adaptation assessments and disseminating findings.	• Strengthen assessments to quantify the magnitude of climate change impacts on air quality deterioration and health risks.	• Improve assessments to quantify the magnitude of the impacts of climate hazards on direct injuries and mortalities, as well as vulnerable populations.	• Develop assessments to quantify climate change impacts on mental health and wellbeing, as well as the most at-risk populations.

	FOOD SECURITY AND NUTRITION	VECTOR-BORNE DISEASES (VBDS)	WATERBORNE DISEASES (WBDS)	HEAT-RELATED MORBIDITY AND MORTALITY	AIR QUALITY	DIRECT INJURIES AND MORTALITY	MENTAL HEALTH AND WELL-BEING
Integrated risk monitoring and early warning	• Ensure the timely dissemination and communication of early warning information to facilitate a timely and effective food security response.	• Promote a holistic approach to the climate risk management of VBDs that involves health policy makers, researchers, and communities.	• Integrate climate data into WBD surveillance and monitoring to inform policy and practice.	• Improve heat and heat wave recording / data to support robust heat early warning systems (EWS) for regions most at risk of heat waves now and in the future.	• Enhance the integration of climate data considerations into air quality monitoring and management.	• Improve climate change EWS and the timely communication of weather information to facilitate community and household preparedness and response to prevent direct injuries and mortalities.	• Enhance climate change EWS to facilitate community and household preparedness and response, including the effective dissemination of climate change information on extreme events.
Health and climate research	• Strengthen the financial mobilization plan for funds to support climate change, agriculture, food security, and nutrition research in order to inform policies and programs at the national, subnational, and local levels.	• Enhance research initiatives (both applied and targeted) for VBDs and communities with the highest risk of VBDs.	• Support research (both applied and targeted) for WBDs and population groups / communities most at risk of WBDs.	• Promote research initiatives (both applied and targeted) for heat risk in communities experiencing heat waves now and in the future.	• Advocate for research to advance the understanding of the impacts of climate change on air quality (both indoor and ambient).		• Enhance research on mental health and wellbeing, especially in climate change prone regions and communities.
Climate-resilient and sustainable technologies and infrastructure		• Improve laboratory capabilities • (laboratory equipment and supplies) to facilitate the detection, diagnosis, and treatment of VBDs.	• Improve laboratory capabilities (laboratory equipment and supplies) to facilitate the detection, diagnosis, and treatment of WBDs.	• Integrate heat adaptation strategies into infrastructure (including health facilities), urban planning, and landscape.	• Support clean and sustainable energy like clean cooking and lighting options in health facilities, households, and schools (use of solar for lighting and energy saving stoves).	• Implement climate change infrastructure planning, roads with proper drainage, and strict building standards.	

	FOOD SECURITY AND NUTRITION	VECTOR-BORNE DISEASES (VBDS)	WATERBORNE DISEASES (WBDS)	HEAT-RELATED MORBIDITY AND MORTALITY	AIR QUALITY	DIRECT INJURIES AND MORTALITY	MENTAL HEALTH AND WELL-BEING
Management of environmental determinants of health	• Strengthen community-led sustainable food security options and food insecurity mapping, especially in regions prone to climate change now and in the future.	• Strengthen community awareness on climate change impacts on VBDs and prevention action options, including the disposal of empty containers near homes and the clearing of vegetation close to homes.	• Enhance WASH facilities in health facilities and communities, especially in flood-prone areas.	• Inclusion of heat adaptation in communal building plans • Planting of drought-tolerant trees.	• Promote planting of trees to collect dust and smoke particles • Promote the use of clean and sustainable energy, such as clean cooking and lighting options in health. facilities, households, and schools (use of solar for lighting and energy saving stoves.	• Plant trees and grass to hold the soil during heavy rains to prevent mudslides and flooding.	• Plant drought tolerant trees for shade during hot days.
Climateinformed health program	• Need for bottomup climate change, agriculture, food security and nutrition initiatives to ensure the sustainability of programs and local impact. • Improve the awareness of communities and extension workers on climate change and food security and nutrition policies.	• Strengthen community awareness on climate change impacts on VBDs and prevention action options, including the disposal of empty containers and the clearing of bushes near homes, as well as sleeping under treated mosquito nets.	• Strengthen health promotion campaigns on the construction of pit latrines, the proper disposal of wastes, hand washing, along with the boiling and storage of drinking water.	• Integrate heat data into health programs, including reproductive and maternal health, mental health, along with food security and nutrition.			• Diversify livelihoods to reduce dependency on agriculture. • Enhance climatesmart agriculture, especially in rural areas prone to prolonged droughts.

	FOOD SECURITY AND NUTRITION	VECTOR-BORNE DISEASES (VBDS)	WATERBORNE DISEASES (WBDS)	HEAT-RELATED MORBIDITY AND MORTALITY	AIR QUALITY	DIRECT INJURIES AND MORTALITY	MENTAL HEALTH AND WELL-BEING
Emergency preparedness and management	Promote communityled programs on food storage systems for improved food security.	Enhance knowledge on climate change impacts on VBDs. Incorporate climate change information into VBD control plans.	Strengthen WASH emergency preparedness and response plans and strategies.	Enhance heat illness prevention programs to support the adaptation and resilience of communities to extreme heat.		Implement community awareness campaigns on preparedness and response before floods to reduce mortalities and injuries.	Incorporate climate change impacts on mental health into community programs.
Climate and health financing	Strengthen the resource mobilization plan for funds to support food insecurity, emergency responses, as well as agriculture, food security, and nutrition initiatives.	Enhance government and partner funding for prevention, control, surveillance, treatment programs, and research to reduce VBDs burden.	Strengthen funding to support WBD programs, including water testing, WBD surveillance, and WASH programs.	Promote funding and the need for the inclusion of heat risk programs in national and subnational budgets.	Advocate for funding and budgeting for air quality initiatives, including research, control, and adaptation mechanisms.	Increase funding to support disaster response and preparedness efforts.	Explore funding opportunities for mental health research and programs.

REFERENCES

1 https://www.climatelinks.org/sites/default/files/asset/document/20180629_USAID-ATLAS_Climate-Risk-Profile-Tanzania.pdf.

2 https://www.usaid.gov/sites/default/files/documents/1860/CDCS Tanzania FINAL.pdf.

3 Manisha A. Kulkarni, Rachelle E. Desrochers, Debora C. Kajeguka, Robert Diotrephes Kaaya, Andrew Tomayer, Eliningaya Kweka, Natacha Protopopoff, and Franklin W. Mosha, 2016, "10 Years of Environmental Change on the Slopes of Mount Kilimanjaro and Its Associated Shift in Malaria Vector Distributions," Frontiers in Public Health 4: 281, doi: 10.3389/fpubh.2016.00281.

4 https://www.worldbank.org/en/country/tanzania/overview#1.

5 https://knowledge.uclga.org/IMG/pdf/_del-tanzanie_-web.pdf.

6 https://www.usaid.gov/tanzania/economic-growth-and-trade.

7 https://www.macrotrends.net/countries/TZA/tanzania/gdp-gross-domestic-product.

8 https://www.flandersinvestmentandtrade.com/export/sites/trade/files/attachments/Economies%20of%20teh%20Eastern%20African%20Communities.pdf.

9 https://data.worldbank.org/indicator/NY.GDP.PCAP.CD?locations=TZ.

10 https://www.statista.com/statistics/1230404/number-of-people-living-in-extreme-poverty-in-tanzania/.

11 https://www.nbs.go.tz/nbs/takwimu/hbs/Tanzania_Mainland_Poverty_Assessment_Report.pdf.

12 https://www.nbs.go.tz/nbs/takwimu/hbs/Tanzania_Mainland_Poverty_Assessment_Report.pdf.

13 ND-GAIN Notre Dame Global Adaptation Initiative, available at: https://gain.nd.edu/about/

14 https://data.worldbank.org/indicator/SP.POP.TOTL?locations=TZ.

15 https://data.worldbank.org/indicator/SP.POP.TOTL?locations=TZ.

16 https://worldpopulationreview.com/countries/tanzania-population.

17 https://worldpopulationreview.com/countries/tanzania-population.

18 https://www.iisd.org/system/files/publications/idl-55870-tanzania.pdf.

19 https://www.taees.org/national-climate-change-response-strategy-2021-2026/.

20 https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/United%20Republic%20of%20Tanzania%20First%20NDC/TANZANIA_NDC_SUBMISSION_30%20JULY%202021.pdf.

21 Valérie Masson-Delmotte, Panmao Zhai, Anna Pirani, Sarah L. Connors, Clotilde Péan, Yang Chen, Leah Goldfarb, et al., eds., 2021. Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change, Cambridge, UK and New York, NY, USA: Cambridge University Press, https://www.ipcc.ch/report/ar6/wg1/.

22 https://www.countryreports.org/country/Tanzania/geography.htm.

23 https://www.nationsencyclopedia.com/geography/Slovenia-to-Zimbabwe-Cumulative-Index/Tanzania.html.

24 Casper Szilas, Johnson Semoka, and Ole Borggaard, 2007, "Can Local Minjingu Phosphate Rock Replace Superphosphate on Acid Soils in Tanzania?" Nutrient Cycling in Agroecosystems 77 (3): 257–68, doi:10.1007/s10705-006-9064-4.

25 https://www.climatelinks.org/sites/default/files/asset/document/20180629_USAID-ATLAS_Climate-Risk-Profile-Tanzania.pdf.

26 https://www.climatelinks.org/sites/default/files/asset/document/20180629_USAID-ATLAS_Climate-Risk-Profile-Tanzania.pdf.

27 https://climateknowledgeportal.worldbank.org/country/tanzania/trends-variability-historical.

28 Lonnie G. Thompson, Henry H. Brecher, Ellen Mosley-Thompson, Douglas R. Hardy, and Bryan G. Mark, 2009, "Glacier Loss on Kilimanjaro Continues Unabated," Proceedings of the National Academy of Sciences 106 (47): 19770–5, doi: 10.1073/ pnas.0906029106.

29 As defined by maximum temperatures in excess of 35°C.

30 Mtwara, Morogoro, Tabora, Lindi, Dar-es-Salaam, Katavi, Rukwa, Shinkyanga, Ruvuma, and Pwani.

31 https://documents1.worldbank.org/curated/en/891701634533267413/pdf/Groundswell-Africa-A-Deep-Dive-on-Internal-Climate-Migration-in-Tanzania.pdf.

32 Refers to mid-20th Century

33 https://www.preventionweb.net/news/tanzania-rising-sea-levels-how-stop-city-sinking#:~:text=The%20coastal%20metropolis%20of%20Dar,flooding%20entire%20neighborhoods%20each%20year.

34 https://www.climatelinks.org/sites/default/files/asset/document/20180629_USAID-ATLAS_Climate-Risk-Profile-Tanzania.pdf.

35 http://economics-of-cc-in-tanzania.org/images/Tanzania_coastal_report_draft_vs_2_1_.pdf.

36 https://climateknowledgeportal.worldbank.org/country/tanzania/impacts-sea-level-rise.

37 https://www.climatelinks.org/sites/default/files/asset/document/20180629_USAID-ATLAS_Climate-Risk-Profile-Tanzania.pdf.

38 https://www.climatelinks.org/sites/default/files/asset/document/20180629_USAID-ATLAS_Climate-Risk-Profile-Tanzania.pdf.

39 https://documents1.worldbank.org/curated/en/891701634533267413/pdf/Groundswell-Africa-A-Deep-Dive-on-Internal-Climate-Migration-in-Tanzania.pdf.

40 Paul Watkiss, Tom Downing, Jillian Dyszynski, and Steve Pye, 2011, "The Economics of Climate Change in the United Republic of Tanzania," Development Partners Group on Environment and Climate Change, Dar es Salaam, Tanzania, http://www.economics-of-cc-in-tanzania.org/images/Final_report_ launch_vs_3.pdf.

41 https://www.irishaid.ie/media/irishaid/allwebsitemedia/30whatwedo/climatechange/Tanzania-Country-Climate-Action-Report-2016.pdf.

42 Em-Dat.

43 https://data.worldbank.org/indicator/SP.URB.TOTL.IN.ZS?locations=TZ.

44 https://www.jstor.org/stable/pdf/resrep29563.6.pdf?refreqid=excelsior%3A105f798f1310c68e2e99b61b1bce29d2&ab_segments=&origin=

45 https://blogs.worldbank.org/developmenttalk/staying-afloat-new-evidence-how-firms-tanzania-cope-flooding#:~:text=In%20April%202018%2C%20cities%20across,percent%20of%20the%20city's%20GDP.

46 Carlos E. Arce and Jorge Caballero, 2015, Tanzania: Agricultural Sector Risk Assessment, Washington, DC: World Bank, https://openknowledge.worldbank.org/handle/10986/22277.

47 https://documents1.worldbank.org/curated/en/891701634533267413/pdf/Groundswell-Africa-A-Deep-Dive-on-Internal-Climate-Migration-in-Tanzania.pdf.

48 https://www.climatelinks.org/sites/default/files/asset/document/tanzania_climate_vulnerability_profile_jan2013.pdf.

49 https://unfccc.int/files/adaptation/napas/application/pdf/34_tanz_pp.pdf.

50 https://reliefweb.int/sites/reliefweb.int/files/resources/WFP-0000135990.pdf.

51 https://www.aa.com.tr/en/africa/fighting-drought-tanzania-faces-loss-of-62-000-livestock/2482330.

52 Paul Watkiss, Tom Downing, Jillian Dyszynski, and Steve Pye, 2011, "The

Economics of Climate Change in the United Republic of Tanzania," Development Partners Group on Environment and Climate Change, Dar es Salaam, Tanzania, http://www.economics-of-cc-in-tanzania.org/images/Final_report_ launch_vs_3.pdf.

53 https://data.unicef.org/country/tza/.

54 https://data.worldbank.org/country/tanzania.

55 https://data.worldbank.org/indicator/SH.STA.MMRT.NE?end=2016&locations=TZ-ZG&start=2004&view=chart.

56 https://data.worldbank.org/indicator/SP.DYN.LE00.IN?locations=TZ-ZG.

57 https://data.worldbank.org/indicator/SP.POP.TOTL?locations=TZ.

58 https://www.healthdata.org/tanzania.

59 https://www.cdc.gov/globalhealth/countries/tanzania/default.htm.

60 https://www.emdat.be/.

61 FAO (Food and Agriculture Organization of the United Nations), IFAD (International Fund for Agricultural Development), UNICEF (United Nations Children's Fund), WFP (World Food Programme), and World Health Organization (WHO), 2021, The State of Food Security and Nutrition in the World — Transforming Food Systems for Food Security, Improved Nutrition and Affordable Healthy Diets for All, Rome: FAO, doi: 10.4060/cb4474en.

62 https://data.worldbank.org/indicator/SN.ITK.MSFI.ZS?locations=TZ.

63 https://www.kilimo.go.tz/uploads/dasip/Tanzania_IPC_Food_and_Nutrition_Security_Situation_Report_201.pdf.

64 https://www.statista.com/statistics/1236193/number-of-people-facing-food-insecurity-in-tanzania/.

65 https://www.reuters.com/article/tanzania-hunger/survey-finds-most-tanzanians-go-hungry-despite-government-denials-idUSL5N1GJ5CP.

66 https://reliefweb.int/report/united-republic-tanzania/alert-drought-and-food-insecurity-central-and-northern-regions.

67 https://www.kilimo.go.tz/uploads/dasip/Tanzania_IPC_Food_and_Nutrition_Security_Situation_Report_201.pdf.

68 https://www.wfp.org/countries/tanzania.

69 https://scms.usaid.gov/sites/default/files/documents/tagged_Tanzania-Nutrition-Profile.pdf.

70 https://www.project-syndicate.org/commentary/women-farmers-africa-gender-equality-agriculture-by-ruth-meinzen-dick-2019-10.

71 https://www.usaid.gov/documents/1860/tanzania-2014-feed-future-fact-sheet.

72 https://reliefweb.int/report/united-republic-tanzania/tanzania-food-insecurity-drought-emergency-plan-action-epoa-dref.

73 Eliningaya J. Kweka, Epiphania E. Kimaro, Esther G. Kimaro, Yakob P. Nagagi, and Imna I. Malele, 2017, "Major Disease Vectors in Tanzania: Distribution, Control and Challenges," in Biological Control of Pest and Vector Insects, edited by Vonnie D. C. Shields, 257–84, Rijeka, Croatia: Intech, doi:10.1007/s10705-006-9064-4.

74 Rodrick R. Kisenge, Chris A. Rees, Jacqueline M. Lauer, Enju Liu, Wafaie W. Fawzi, Karim P. Manji, K. P., and Christopher P. Duggan, 2020, "Risk Factors for Mortality among Tanzanian Infants and Children," Tropical Medicine and Health 48 (1): 1–10, doi: 10.1186/s41182-020-00233-8.

75 https://d1u4sg1s9ptc4z.cloudfront.net/uploads/2021/03/fy-2015-tanzania-malaria-operational-plan.pdf.

76 Joseph N. Aikambe and Ladslaus L. Mnyone, 2020, "Retrospective Analysis of Malaria Cases in a Potentially High Endemic Area of Morogoro Rural District, Eastern Tanzania," Research and Reports in Tropical Medicine 11: 37–44, doi: 10.2147/RRTM.S254577.

77 https://www.severemalaria.org/countries/tanzania.

78 Katharina Kreppel, Cyril Caminade, Nicodem Govella, Andrew P. Morse, Heather M. Ferguson, and Matthew Baylis, 2019, "Impact of ENSO 2016–17 on Regional Climate and Malaria Vector Dynamics in Tanzania," Environmental Research Letters 14 (7): 075009, doi: 10.1088/1748-9326/ab26c7.

79 https://healthpolicy-watch.news/as-climate-change-tightens-grip-tanzania-braces-for-more-cholera-outbreaks/.

80 https://www.who.int/emergencies/disease-outbreak-news/item/12-january-2018-cholera-tanzania-en.

81 https://www.theigc.org/wp-content/uploads/2017/08/Picarelli-et-al-2017-working-paper.pdf.

82 Nathalie Picarelli, Pascal Jaupart, and Ying Chen, 2017, "Cholera in Times of Floods: Weather Shocks & Health in Dar es Salaam," Working Paper C-40404-TZA-1, International Growth Centre, London, July 2017, https://www.theigc.org/wp-content/uploads/2017/08/Picarelli-et-al-2017-working-paper.pdf.

83 Yaovi Mahuton Gildas Hounmanou, Kåre Mølbak, Jonas Kähler, Robinson Hammerthon Mdegela, John Elmerdahl Olsen, and Anders Dalsgaard, 2019, "Cholera Hotspots and Surveillance Constraints Contributing to Recurrent Epidemics in Tanzania," BMC Research Notes 12 (1): 1–6, doi: 10.1186/s1310401947310.

84 https://dhsprogram.com/pubs/pdf/FR321/FR321.pdf.

85 Eliapenda Elisante and Alfred N. N. Muzuka, 2016, "Sources and Seasonal Variation of Coliform Bacteria Abundance in Groundwater around the Slopes of Mount Meru, Arusha, Tanzania," Environmental Monitoring and Assessment 188 (7): 395, doi: 10.1007/s10661-016-5384-2

86 https://thewaterproject.org/water-crisis/water-in-crisis-tanzania.

87 Irene Tesha, Revocatus L. Machunda, Karoli N. Njau, and Emmanuel A. Mpolya, 2019, "Water-Handling Patterns and Associated Microbial Profiles in Relation to Hygiene in Babati Town, Tanzania," Journal of Environmental and Public Health, 7: 1–11, doi: 10.1155/2019/5298247.

88 Makarius V. Mdemu, 2021, "Community's Vulnerability to Drought-Driven Water Scarcity and Food Insecurity in Central and Northern Semi-Arid Areas of Tanzania," Frontiers in Climate 122, doi: 10.3389/fclim.2021.737655.

89 https://thewaterproject.org/water-crisis/water-in-crisis-tanzania.

90 R. Sari Kovats and Shakoor Hajat, 2008, "Heat Stress and Public Health: A Critical Review," Annual Review of Public Health 29: 41–55, doi: 10.1146/annurev.publhealth.29.020907.090843.

91 Amatus Gyilbag, Martial Amou, Roberto Xavier Supe Tulcan, Lei Zhang, Tsedale Demelash, and Yinlong Xu, 2021, "Characteristics of Enhanced Heatwaves over Tanzania and Scenario Projection in the 21st Century," Atmosphere 12 (8): 1026, doi: 10.3390/atmos12081026.

92 https://www.unido.org/sites/default/files/files/2019-10/Tanzania%20HPAP.English_2.pdf.

93 https://wedocs.unep.org/bitstream/handle/20.500.11822/17122/Tanzania.pdf?sequence=1&isAllowed=y.

94 https://tunza.eco-generation.org/ambassadorReportView.jsp?viewID=13303.

95 https://www.stateofglobalair.org/health/hap.

96 https://openknowledge.worldbank.org/handle/10986/33445.

97 Thomas Zoller, Elirehema H. Mfinanga, Tresphory B. Zumba, Peter J. Asilia, Edwin M. Mutabazi, David Wimmersberger, Francis Mhimbira, Fredrick Haraka, and Klaus Reither, 2022, "Symptoms and Functional Limitations Related to Respiratory Health and Carbon Monoxide Poisoning in Tanzania: A Cross Sectional Study," Environmental Health 21 (1): 1–12, doi: 10.1186/s12940-022-00847-x/.

98 James H. Kilabuko, Hidieki Matsuki, and Satoshi Nakai, 2007, "Air Quality and Acute Respiratory Illness in Biomass Fuel Using Homes in Bagamoyo, Tanzania," International Journal of Environmental Research and Public Health 4 (1): 39–44, doi: 10.3390/ijerph2007010007.

99 https://data.worldbank.org/indicator/EN.ATM.PM25.MC.M3.

100 https://www.who.int/news-room/fact-sheets/detail/ambient-(outdoor)-air-quality-and-health.

101 https://www.cbd.int/doc/world/tz/tz-nbsap-v2-en.pdf.

102 Dean E. Schraufnagel, John R. Balmes, Clayton T. Cowl, Sara De Matteis, Soon-Hee Jung, Kevin Mortimer, Rogelio Perez-Padilla, et al., 2019, "Air Pollution and Noncommunicable Diseases: A Review by the Forum of International Respiratory Societies' Environmental Committee, Part 2: Air Pollution and Organ systems," Chest 155 (2): 417–26, doi:

10.1016/j.chest.2018.10.041.

103 Helen Msemo, Andrea Taylor, Cathryn Birch, Andrew J. Dougill, Andrew Hartley, and Beth J. Woodhams, 2021, "What do Weather Disasters Cost? An Analysis of Weather Impacts in Tanzania," Frontiers in Climate 3: 32, doi: 10.3389/fclim.2021.567162.

104 https://floodlist.com/africa/tanzania-floods-lindi-mwanza-morogoro-manyara-february-2020.

105 Kenneth Ayuurebobi Ae-Ngibise, Winifred Asare-Doku, Jennifer Peprah, Mohammed Nuhu Mujtaba, Diane Nifasha, and Gordon Maanianu Donnir, 2021, "The Mental Health Outcomes of Food Insecurity and Insufficiency in West Africa: A Systematic Narrative Review," Behavioral Sciences 11 (11): 146, doi: 10.3390/bs11110146.

106 https://www.statista.com/statistics/1230404/number-of-people-living-in-extreme-poverty-in-tanzania/.

107 Carrie Ripkey, Peter D. Little, Paula Dominguez-Salas, Joyce Kinabo, Akwilina Mwanri, and Amy Webb Girard, 2021, "Increased Climate Variability and Sedentarization in Tanzania: Health and Nutrition Implications on Pastoral Communities of Mvomero and Handeni Districts, Tanzania," Global Food Security, 29: 100516, doi: 10.1016/j.gfs.2021.100516.

108 Fatuma Manzi, Joanna Armstrong Schellenberg, Guy Hutton, Kaspar Wyss, Conrad Mbuya, Kizito Shirima, Hassan Msinda, Marcel Tanner, and David Schellenberg, 2012, "Human Resources for Health Care Delivery in Tanzania: A Multifaceted Problem," Human Resources for Health 10: 1–10, doi: 10.1186/1478-4491-10-3.

109 https://www.trade.gov/country-commercial-guides/tanzania-healthcare.

110 https://documents.worldbank.org/curated/en/888021468132272587/pdf/Private-health-sector-assessment-in-Tanzania.pdf.

111 Tiba Kwa Kadi (TIKA) is also a Community Based Health Insurance scheme (CBHI)

112 Ramadhani Kigume and Stephen Maluka, 2021, "The Failure of Community-Based Health Insurance Schemes in Tanzania: Opening the Black Box of the Implementation Process," BMC Health Services Research 21: 1–8, doi: /10.1186/s12913-021-06643-6.

113 https://medium.com/health-for-all/towards-universal-health-coverage-in-tanzania-a-call-to-leave-no-one-behind-52d193a0d881.

114 https://www.usaid.gov/tanzania/global-health.

115 https://www.researchgate.net/publication/305487245_Challenges_Hindering_the_Accessibility_of_Tanzania's_Health_Service_A_Literature_Review.

116 Alex J. Goodell, James G. Kahn, Sidney S. Ndeki, Eliangiringa Kaale, Ephata E. Kaaya, and Sarah B. J. Macfarlane, 2016, "Modeling Solutions to Tanzania's Physician Workforce Challenge," Global Health Action 9: 31597, doi: 10.3402/gha.v9.31597.

117 https://www.trade.gov/country-commercial-guides/tanzania-healthcare.

118 https://www.trade.gov/country-commercial-guides/tanzania-healthcare.

119 https://openknowledge.worldbank.org/handle/10986/24796?locale-attribute=en.

120 Sharaddha Bajaria and Ramadhani Abdul, 2020, "Preparedness of Health Facilities Providing HIV Services during COVID-19 Pandemic and Assessment of Their Compliance to COVID-19 Prevention Measures: Findings from the Tanzania Service Provision Assessment (SPA) Survey," The Pan African Medical Journal 37 (Suppl 1): 18, doi: 10.11604/pamj.supp.2020.37.1.25443.

121 Adaptive capacity is defined by IPCC as "the ability of a system to adjust to climate change, moderate potential damages, take advantage of opportunities, and cope with the consequences" (IPCC AR5). The related term, "resilience," is the ability to prepare and plan for, absorb, recover from, and more successfully adapt to adverse events. People and communities with strong adaptive capacity have greater resilience. This assessment makes use of the term adaptation and adaptive capacity to encompass both terms. – it is not clear what the "term" and "terms" are referring to in this sentence.

122 https://www.who.int/data/gho/data/themes/topics/health-workforce.

123 https://apps.who.int/iris/bitstream/handle/10665/250330/9789241511407-eng.pdf.

124 https://www.sartorius.com/en/company/newsroom/blog/tanzania-has-a-severe-shortage-of-well-trained-healthcare-staff-674006.

125 https://www.jica.go.jp/project/tanzania/006/materials/ku57pq00001x-6jyl-att/country_profile_2013.pdf.

126 https://www.who.int/data/gho/data/themes/topics/health-workforce.

127 https://www.jica.go.jp/project/tanzania/006/materials/ku57pq00001x-6jyl-att/country_profile_2013.pdf.

128 https://www.jica.go.jp/project/tanzania/006/materials/ku57pq00001x-6jyl-att/country_profile_2013.pdf.

129 https://www.jica.go.jp/project/tanzania/006/materials/ku57pq00001x-6jyl-att/country_profile_2013.pdf.

130 https://www.jica.go.jp/project/tanzania/006/materials/ku57pq00001x-6jyl-att/country_profile_2013.pdf.

131 https://pdf.usaid.gov/pdf_docs/PA00TKWC.pdf.

132 https://pdf.usaid.gov/pdf_docs/PA00TKWC.pdf.

133 Irene R. Mremi, Janeth George, Susan F. Rumisha, Calvin Sindato, Sharadhuli I. Kimera, and Leonard E. G. Mboera, 2021, "Twenty Years of Integrated Disease Surveillance and Response in Sub-Saharan Africa: Challenges and Opportunities for Effective Management of Infectious Disease Epidemics," One Health Outlook 3: 22, doi: 10.1186/s42522-021-00052-9.

134 Irene R. Mremi, Janeth George, Susan F. Rumisha, Calvin Sindato, Sharadhuli I. Kimera, and Leonard E. G. Mboera, 2022, "Improving Disease Surveillance Data Analysis, Interpretation, and Use at the District Level in Tanzania," Global Health Action 15 (1): 2090100, doi: 10.1080/16549716.2022.2090100.

135 Irene R. Mremi, Janeth George, Susan F. Rumisha, Calvin Sindato, Sharadhuli I. Kimera, and Leonard E. G. Mboera, 2022, "Improving Disease Surveillance Data Analysis, Interpretation, and Use at the District Level in Tanzania," Global Health Action 15 (1): 2090100, doi: 10.1080/16549716.2022.2090100.

136 https://cdn.odi.org/media/documents/202006_odi_triple_dividend_wp_final.pdf.

137 https://public.wmo.int/en/resources/bulletin/Products_and_services/MHEWS_for_Ocean_Prediction#:~:text=The%20United%20Republic%20of%20Tanzania,on%20land%20or%20at%20sea.

138 https://cdn.odi.org/media/documents/202006_odi_triple_dividend_wp_final.pdf.

139 https://cdn.odi.org/media/documents/202006_odi_triple_dividend_wp_final.pdf.

140 https://www.who.int/news-room/feature-stories/detail/tanzania-making-steady-progress-in-access-to-essential-medicines-and-health-products-as-new-challenges-emerge.

141 Karin Wiedenmayer, Eva Ombaka, Baraka Kabudi, Robert Canavan, Sarah Rajkumar, Fiona Chilunda, Selemani Sungi, and Manfred Stoermer, 2021, "Adherence to Standard Treatment Guidelines among Prescribers in Primary Healthcare Facilities in the Dodoma Region of Tanzania," BMC Health Services Research 21 (1): 272, doi: 10.1186/s12913-021-06257-y.

142 Gavin Surgey, Kalipso Chalkidou, William Reuben, Fatima Suleman, Jacqui Miot, and Karen Hofman, 2020, "Introducing Health Technology Assessment in Tanzania," International Journal of Technology Assessment in Health Care 36 (2): 80–6, doi: 10.1017/S0266462319000588.

143 https://www.thecitizen.co.tz/tanzania/news/national/rural-tz-to-get-medical-labs-2536964.

144 Said Nuhu, Chakupewa Joseph Mpambije, and Kinamhala Ngussa, 2020, "Challenges in Health Service Delivery under Public-Private Partnership in Tanzania: Stakeholders' Views from Dar es Salaam Region," BMC Health Services Research 20: 765, doi: 10.1186/s12913-020-05638-z.

145 Delphine Boulenger and Bart Criel, 2012, The Difficult Relationship between Faith-Based Health Care Organisations and the Public Sector in Sub-Saharan Africa: The Case of Contracting Experiences in

Cameroon, Tanzania, Chad and Uganda, Antwerp, Belgium: ITGPress.

146 https://www.prb.org/wp-content/uploads/2020/06/Tanzania-Health-Sector-Strategic-Plan-IV-2015-2020-1-4.pdf.

147 https://www.prb.org/wp-content/uploads/2020/06/Tanzania-Health-Sector-Strategic-Plan-IV-2015-2020-1-4.pdf.

148 https://www.prb.org/wp-content/uploads/2020/06/Tanzania-Health-Sector-Strategic-Plan-IV-2015-2020-1-4.pdf.

149 https://drmims.sadc.int/sites/default/files/document/2020-03/Tanzania Emergence Preparedness and Response Plan.pdf.

150 https://drmims.sadc.int/sites/default/files/document/2020-03/All%20 hazard%20%20ERP%282%29_0.pdf.

151 https://bmchealthservres.biomedcentral.com/articles/10.1186/s12913-018-3609-5.

152 https://datos.bancomundial.org/indicador/SH.XPD.EHEX.CH.ZS?locations=TZ.

153 https://www.prb.org/wp-content/uploads/2020/06/Tanzania-Health-Sector-Strategic-Plan-IV-2015-2020-1-4.pdf.

154 https://openknowledge.worldbank.org/bitstream/handle/10986/34620/Tanzania-Health-Sector-Public-Expenditure-Review-2020.pdf?sequence=5&isAllowed=y.

155 https://openknowledge.worldbank.org/bitstream/handle/10986/35036/Tanzania-Health-Policy-Note-Opportunities-for-Prioritizing-Health-in-the-Budget.pdf?sequence=1&isAllowed=y.

156 https://openknowledge.worldbank.org/bitstream/handle/10986/34620/Tanzania-Health-Sector-Public-Expenditure-Review-2020.pdf?sequence=5&isAllowed=y.

157 https://www.prb.org/wp-content/uploads/2020/06/Tanzania-Health-Sector-Strategic-Plan-IV-2015-2020-1-4.pdf.

158 https://openknowledge.worldbank.org/bitstream/handle/10986/34620/Tanzania-Health-Sector-Public-Expenditure-Review-2020.pdf?sequence=5&isAllowed=y.

159 https://openknowledge.worldbank.org/bitstream/handle/10986/34620/Tanzania-Health-Sector-Public-Expenditure-Review-2020.pdf?sequence=5&isAllowed=y.

160 April N. Frake, Brad G. Peter, Edward D. Walker, and Joseph P. Messina, 2020, “Leveraging Big Data for Public Health: Mapping Malaria Vector Suitability in Malawi with Google Earth Engine,” Plos One 15 (8): e0235697, doi: 10.1371/journal.pone.0235697.

161 Katharina Kreppel, Cyril Caminade, Nicodem Govella, Andrew P. Morse, Heather M. Ferguson, and Matthew Baylis, 2019, “Impact of ENSO 2016–17 on Regional Climate and Malaria Vector Dynamics in Tanzania,” Environmental Research Letters 14 (7): 07500, doi: 10.1088/1748-9326/ab26c7.

162 Nabie Bayoh and Steve Lindsay, 2003, “Effect of Temperature on the Development of the Aquatic Stages of Anopheles Gambiae Sensu Stricto (Diptera: Culicidae),” Bulletin of Entomological Research 93 (5): 375–81, doi: 10.1079/BER2003259.

163 Candice L. Lyons, Maureen Coetzee, and Steven L. Chown, 2013, “Stable and Fluctuating Temperature Effects on the Development Rate and Survival of Two Malaria Vectors, Anopheles Arabiensis and Anopheles Funestus,” Parasites & Vectors 6: 104, doi: 10.1186/1756-3305-6-104.

SEPTEMBER 2023

CIF CLIMATE INVESTMENT FUNDS

THE WORLD BANK
IBRD • IDA | WORLD BANK GROUP