

Climate and Health Vulnerability Assessment

MADAGASCAR



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Cover image: Morondava-Madagascar-October-7-2017: Unidentified Malagasy worker harvests rice in the countryside of Madagascar.

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LIST OF ABBREVIATIONS

AAP	Ambient Air Pollution
AQI	Air Quality Index
AR6	Sixth Assessment Report
BNGRC	Bureau National de Gestion des Risques et des Catastrophes
BRIO	Building Resilience in the Indian Ocean
CKKP	Climate Change Knowledge Portal
CHVA	Climate Health Vulnerability Assessment
CMIP	Couple Model Inter-Comparison Project
COUSP	Emergency Response Committee
CSB	Centre Santé Basic (Primary Healthcare Center)
CSO	Community Supported Organization
DALYs	Disability-Adjusted Life Years
DHS	Demographic Health Survey
DJF	December, January, February
GDP	Gross Domestic Product
GFATM	Global Fund to Fight AIDS, Tuberculosis and Malaria
GFDRR	Global Facility for Disaster Reduction and Recovery
GFF	Global Financing Facility
GHG	Greenhouse Gas
GIZ	German Cooperation Office
HAP	Household Air Pollution
HNP	Health, Nutrition, and Population
HSS	Health System Strengthening
IDA	International Development Association
IOC	Indian Ocean Commission
IPCC	Intergovernmental Panel on Climate Change
ITNs	Insecticide-Treated Nets
MoH	Ministry of Health
MPA2	Phase 2 of the Multiphase Programmatic Approach on Improving Nutrition Outcomes
NAP	National Adaptation Plan
NDC	Nationally Determined Contribution
NDVI	Normalized Difference Vegetation Index
NGO	Non-Governmental Organization
NOAA	National Oceanic and Atmospheric Administration
ONN	Office of National Nutrition
OOP	Out-Of-Pocket (Expenditure)

PAD	Project Appraisal Document
PET	Potential Evapotranspiration
PFM	Public Financial Management
PhaGeCOM	Community Managed Pharmacies
PhaGeCOM	District Pharmacies
PHC	Primary Health Care
PIU	Project Implementation Unit
PM	Particulate Matter
PNASS	Plan D'Action National D'Adaptation Du Secteur Santé Au Changement Climatique (National Adaptation Action Plan for the Health Sector to Climate Change)
PPSB	Pandemic Preparedness and Basic Health Service Delivery Project
RBF	Results-Based Financing
SLR	Sea-Level Rise
SMS	Short Message Service
SON	September, October, November
SPEI	Standardized Precipitation Evapotranspiration Index
SSP	Shared Socioeconomic Pathway
TB	Tuberculosis
UN	United Nations
UNDRR	United Nations Office for Disaster Risk Reduction
UNFCCC	United Nations Framework Convention on Climate Change
UNICEF	United Nations Children's Fund
USAID	United States Agency for International Development
WASH	Water, Sanitation, and Hygiene
WHO	World Health Organization
WMO	World Meteorological Organization

EXECUTIVE SUMMARY

Madagascar's location and distinctive topography makes it vulnerable to climate-related hazards, such as cyclones, floods, droughts, landslides, and sea-level rise (SLR). Current and projected changes in climate patterns increase the likelihood of health risks that are sensitive to temperature and precipitation changes. This Climate and Health Vulnerability Assessment (CHVA) has been prepared to contribute to developing and implementing adaptation and mitigation measures that address climate-related health challenges. It aims to assist decision-makers by identifying the climate hazards, the health risks, and the adaptive capacity of the health system, as well as formulating recommendations to strengthen the health system's resiliency to climate change.

Several climate-related hazards that affect population health in Madagascar are linked to changes in baseline temperatures and precipitation, and their impacts are expected to change in the near- and mid-terms.

- **Cyclones** are the main climate-related hazard in the country: Madagascar experiences an average of 3–4 cyclones a year. With damaging winds of above 200 km/h, these cyclones affect mostly the coastal regions in the northern and eastern parts of the island country. More significantly, they are expected to increase in severity, especially in the 2070s.
- Apart from cyclones, Madagascar is also impacted by storm-triggered rainfall, which increases the exposure to **floods** and **landslides**. The eastern coast, comprising elevated areas, tends to experience most of the landslides.
- At the same time, the country has also been afflicted steadily by **droughts** over the past five years, with the southern region being the most impacted. It has been experiencing limited precipitation rainfall and the greatest number of consecutive dry days, which are projected to increase in the 2030s and the 2050s.
- In addition, **wildfires** have been triggered by deforestation rates, increased temperatures, and a lack of rainfall. Since 1953, the country has lost around 44 percent of its forest due to anthropogenic activity. With a lack of rainfall, it is projected that wildfires may increase concomitantly.

Changes in climate affect health risks in Madagascar. Notably, food security and nutrition, waterborne diseases, vector-borne diseases, air quality risks, and zoonotic diseases are sensitive to climatic patterns, as explained below:

- **Nutrition risks:** Stunting and malnutrition are major health challenges in Madagascar: 40 percent of the children in the country experience stunting, 8 percent suffer from wasting, and 23 percent are underweight. Around 1.6 million people are in need of humanitarian assistance — mostly those in the southern region due to the impact of droughts on crops and food availability. It is expected that climate change will worsen the situation by impacting agricultural production.
- **Waterborne diseases:** The prevalence of diarrheal diseases in the country has remained at approximately 10 percent since 2003. In general, the lack of access to improved drinking water and improved sanitation facilities increases the vulnerability of the population, especially children, to waterborne diseases. Moreover, floods, landslides, and droughts can hinder the availability of safely managed water sources, thereby increasing the risks of waterborne diseases.
- **Vector-borne diseases:** Changes in precipitation and temperature patterns are expanding vector's spatio-temporal suitability. Notably, more than 25 million people (out of 28.9 million) is at high-risk of Malaria. It is projected that by 2070, this figure will increase to 46 million people as population grows, risk of Malaria will grow concomitantly.
- **Air quality risks:** Indoor air pollution is a major concern in Madagascar. Changes in rainfall and temperatures, which alter cooking habits, lead to increased cooking inside the house, where 98 percent of the households use solid fuel for cooking (i.e. coal, charcoal) increasing risks for respiratory diseases. Ambient air pollution (AAP) due to wildfires and brick production also increases the risk of respiratory illnesses that are widely prevalent in the country.
- **Zoonotic diseases:** Because Madagascar is a country characterized by high biodiversity, there is an increased risk of zoonotic diseases, such as plague, which is endemic in the country. With wildfires and deforestation rates changing the habitats of rodents, many are being driven to inhabited areas, thus increasing the risks of infection.

In the face of climate-related hazards and health risks, Madagascar is developing policies and plans to strengthen mitigation and adaptation actions and increase its adaptive capacity. The government's National Adaptation Action Plan for the Health Sector to Climate Change (PNASS by its French acronym) guides the efforts of the Ministry of Health (MoH) in addressing climate-related shocks. The activities to be carried out to increase the health sector's resilience to climate change are grouped into seven components: (1) risk and capacity assessment, (2) capacity building, (3) integrated monitoring of the environment and health, (4) response, (5) research, (6) monitoring and evaluation, along with (7) program coordination and management. However, the implementation of these activities is hindered by a lack of financing, limited capacities at the district and fokontany (commune)¹ levels, a limited health workforce, and cross-sectoral collaboration challenges for health concerns such as food security and nutrition.

Currently, the country is developing tools to enhance its information systems: climate and health bulletin and an early warning system using SMS services, building codes, and emergency response mechanisms. These efforts highlight the commitment of the country to improve its health system resiliency in the face of climate change. However, there are still additional priorities that need to be addressed. First, the country's health workforce needs improved incentives to increase distribution to climate-vulnerable areas. Second, information systems are lacking in proposing specific actions and recommendations for the population to adopt. Third, contingency and emergency plans are lagging. Finally, the monitoring of the progress and enforcement of climate and health activities — such as the enforcement of building codes in water, sanitation, and hygiene (WASH) and health facilities — needs to be improved.

Madagascar's endeavor to achieve universal health coverage for its health system and increase its adaptive capacity to a changing climate has been primarily undermined by a lack of financing resources. The central MoH does not have a budget line for climate-related activities, including emergency preparedness and other adaptation measures; climate change work seems to be limited to its Environmental Health department. According to estimates by the PNASS, it would cost USD3.7 million to implement key strategies for the health sector to deal with climate change. However, the strategies and activities outlined in the Action Plan will depend on the financing of development partners for implementation.

Moving forward, Madagascar needs to expand its climate and health strategic priorities by incorporating preparedness mechanisms, enhancing its current efforts, improving the monitoring of its progress, strengthening communication between the district and fokontany levels, and promoting coordination with development partners to ensure the availability of financing sources for implementing its PNASS.



INTRODUCTION

COUNTRY CONTEXT

- 1. Madagascar experienced modest economic growth of 4.4 percent in 2021 as the Covid-19 pandemic receded². Nonetheless, the country's economic and social development remains constrained by low economic growth, inadequate human capital infrastructure, and governance and institutional weakness.** In 2021, the country reported a gross domestic product (GDP) of USD14.47 billion and a GDP per capita of USD500.50; with a Human Development Index of 0.501, it ranked 173 out of 191 countries.³ Economic growth averaged 3.5 percent from 2013 until the beginning of the COVID-19 pandemic in 2020. The ensuing recession was three times more severe than most of Sub-Saharan Africa, with its economy contracting by 7.1 percent.
- 2. Two factors had adversely impacted Madagascar's economy: (a) the COVID-19 pandemic and (b) its exposure to historic droughts and crop failure in the southern region.** The COVID-19 pandemic led to the closure of the mining, tourism, transport, and service sectors — key sources of the country's GDP. Additionally, exposure to droughts, notably in the southern region, has led to livestock diseases and agricultural setbacks. This critical context led to growing food insecurity, internal migration, and increased poverty that rose from 69 percent in 1999 — the lowest point over the last 30 years — to 81 percent in 2012 (measured by the poverty line of USD2.15/capita/day) and staying at 75 percent in 2022.⁴ Recent economic growth in 2021 was again interrupted in 2022 by the adverse effect of the war in Ukraine on the European Union — Madagascar's main trading partner, coupled with an increase in fuel prices of 34 percent (as of July 2022). Nevertheless, modest annual economic growth of more than 4 percent is projected for both 2023 and 2024.⁵
- 3. Madagascar's population has steadily increased since the mid-century.** The population grew from slightly over 5 million in 1960 to more than 28.9 million in 2021, reflecting an annual growth rate of 2.4 percent in 2021.⁶ As of 2021, there was an even proportion of women and men.⁷ The population is relatively young: those aged 0–14 represented 39 percent of the total population, while those above 65 years constituted only 3 percent.⁸ The country's urban population has been growing: the proportion increased from 11 percent in 1960 to 39 percent in 2021. However, 67 percent of the urban population lived in slums, with the majority living in Antananarivo — the country's capital and largest city.⁹
- 4. Madagascar's location and distinctive topography make it vulnerable to climate-related hazards.** Madagascar is among the most cyclone-prone countries in Africa, with an average of 3–4 cyclones yearly. Its cyclone season runs from November to March. Furthermore, intense rainfall caused

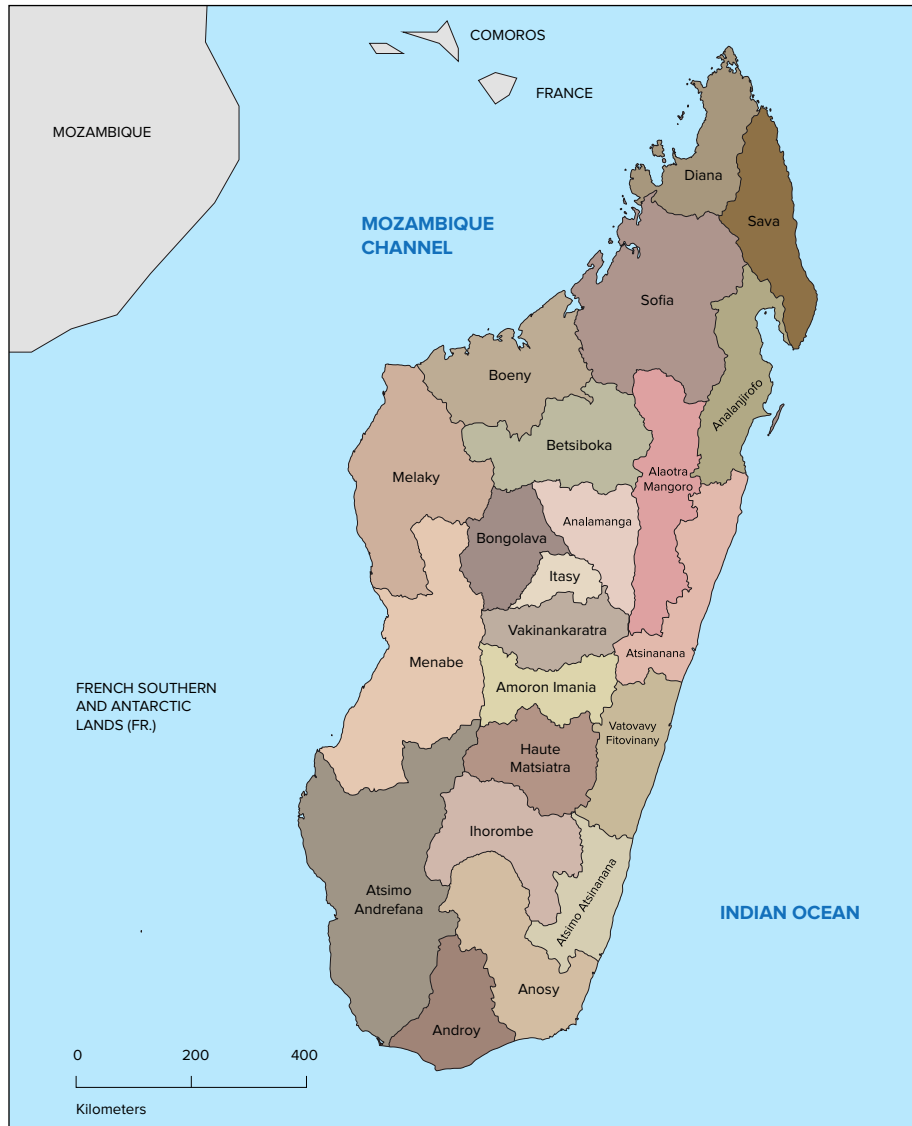
by strong storms and tropical cyclones also affects the country, leading to significant and damaging floods. Shoreline erosion, caused by sea-level rises (SLRs), is also a major problem for Madagascar's coastal ports and beaches. Finally, droughts are common in the south — the hottest and driest part of the island, with some areas receiving less than 400 millimeters (mm) of rainfall each year, due to large-scale disruptions in the atmospheric circulation and exacerbated by poor land use practices.

- 5. Madagascar — one of the few countries in the world that absorbs more carbon than it emits — is committed to tackling climate change.** It signed the Paris Agreement of the United Nations Framework Convention on Climate Change (UNFCCC) on April 22, 2016,¹⁰ which aims to limit the global mean temperature increase to well below 2°C compared with pre-industrial levels. Madagascar ratified its commitment and submitted nationally determined contributions (NDCs) to the UNFCCC on September 21, 2016.¹¹ The NDCs set out Madagascar's commitment and identified priority sectors for mitigation and adaptation strategies to reduce the country's vulnerability to the adverse impacts of climate change.

- 6. Adaptation measures covering a 10-year period are detailed in Madagascar's National Adaptation Plan (NAP) that was published in December 2021.** The NAP has three main strategic axes: (a) strengthening governance and adaptation integration, (b) implementing a priority sectoral action program, and (c) financing adaptation to climate change. Priority sectors for the implementation of adaptation actions include the following: (a) agriculture, farming, and fisheries; (b) water resources; (c) public health; (d) biodiversity and forestry; (e) coastal zones; (f) the management of territory and infrastructure; (g) the management of climate-related risks and hazards; and (h) habitats and new cities. The NAP outlines two strategic public health priorities: (a) improving the health sector's capacity to address climate-related adverse effects and (b) strengthening the population's capacity to deal with climate and climate-related health risks.¹²
- 7. The assessment incorporates subnational considerations for health-related climate actions (see annex A for the methodology)** with regard to its 22 regions (see Figure 1).¹³

FIGURE 1.

Administrative boundaries of Madagascar's regions.



Source: World Bank's Cartography Unit

KEY MESSAGES

Temperature

- Temperatures have increased by 0.52°C since the 1960s.
- Temperatures are projected to increase by 0.65–0.69°C during the 2030s in the south in Ihrombe and Atsimo Andrefana and by 1.3–1.5°C in the southeast in Atsimo Andrefana and Menabe.

Precipitation

- Mean precipitation at the national level has decreased by 59.38 millimeters (mm) over the last half-century, with the most substantial decreases occurring on the northern side of the eastern coast in the Analanjirofo region (-158.35 mm).
- It is projected that precipitation will continue to decrease by 200 mm during the 2030s and 2050s, especially in the central areas of Alatora Mangoro and Boeny and in the northern regions of Sava and Diana.
- Although Madagascar's average precipitation levels are projected to decrease for the 2030s and the 2050s, intense precipitation patterns are expected to increase, especially during January and February. Intense rainfall is projected in the 2030s for Androka and Antanarativo as well as for the entire country in the 2050s except for the eastern and western coasts.

Climate Hazards

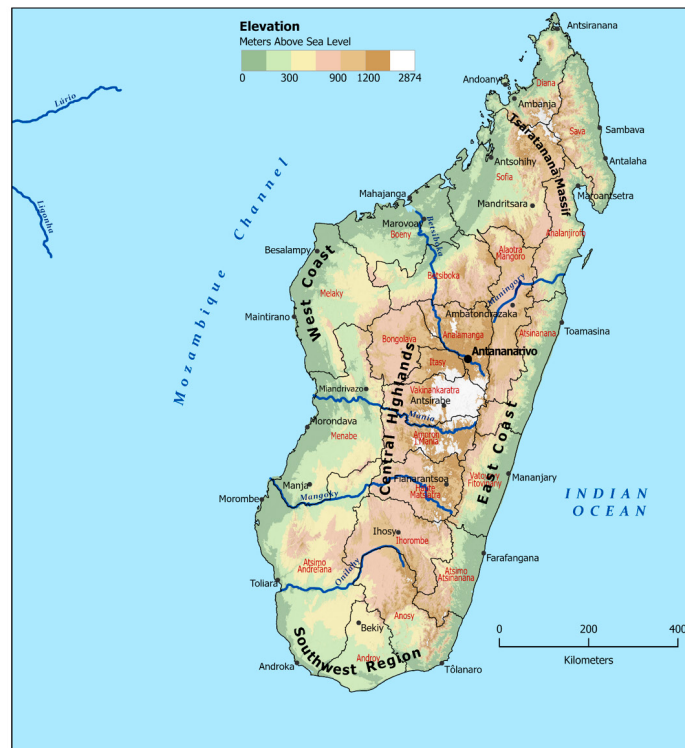
- Although temperatures are expected to increase in the 2030s and 2050s, projections show that the country will not experience extreme daytime heat conditions (>35°C). However, it will experience an increase in the number of tropical nights (>20°C), specifically in the regions around the central highlands.
- Madagascar has one of the highest cyclone risks in the continent, with an average of 3–4 cyclones per year. Projections estimate intense cyclonic activity. Damaging cyclonic winds (>200 km/h) are the most common in the northern regions of the Tsaratanana Massif of Diana and Sava.
- Intense rainfall events, along with forest loss, put the elevated areas of the eastern coast at high risk of landslide events.
- Drought risk is high in Madagascar: the country has been steadily affected by droughts over the past five years. The regions of Betsiboka, the northern area of Analamanga, and the south in Androy are projected to have the greatest number of consecutive dry days during the 2030s and 2050s.
- Madagascar also experiences frequent wildfires. Since 1953, the country has lost around 44 percent of its forest due to anthropogenic activity. The projected increase in the maximum number of consecutive dry days may increase wildfire risks. Wildfire intensity is expected in western areas of the country, particularly in Sofia.

CLIMATOLOGY

MADAGASCAR'S TOPOGRAPHY

8. Located in the Indian Ocean off the coast to the east of southern Africa and Mozambique, Madagascar is the fourth-largest island country in the world.¹⁴ The terrain comprises five topo-geographical areas: the east coast, the Tsaratanana Massif, the central highlands, the west coast, and the southwest region (see Figure 2). Madagascar has a complex topography: with central highlands surrounded by coastal lowlands, it is characterized by a variety of bioclimatic zones — each presenting distinctive human-environmental challenges.

FIGURE 2.
Madagascar's topography.



Source: Natural Earth, ASTER GDEM Version 3

OBSERVED AND PROJECTED CLIMATOLOGY

9. Madagascar has two seasons: a hot, rainy-cyclonic season from November to April and a cooler, dry season from May to October.

According to the 1991–2020 observed data, precipitation values fall within the range of 102 mm from November to April, peaking at 312 mm in January, and decreasing to 88 mm in April, with the most rainfall resulting from the cyclonic season. Temperatures, however, show minor variations — ranging from 23.9°C in November to a maximum of 24.9°C in February (the warmest month) and decreasing to 23.7°C in April. From May to October, precipitation values are at the lowest, ranging from 32 mm in September to 51 mm in May. During this period, temperatures vary from 21.9°C in May to a low of 19.3°C in July (the coolest month).

TEMPERATURE

10. Madagascar has been experiencing a general warming trend since the 1960s. Though Madagascar's mean temperature increased by 0.23°C per decade between 1971 and 2020, its maximum temperature rose by 0.31°C per decade within the same period.

During the observed period of 1991–2020, March and May had the highest temperature increase of 0.61°C. The hottest month occurred in January: it ranged from an average maximum of 31.26°C to a minimum of 23.61°C in Boeny on the coastal northwest, while Vakinankaratra atop the central highlands had a range that extended from a maximum of 25.83°C to a minimum of 16.54°C. During the coolest month of July, the average maximum and minimum temperatures were 29.40°C and 17.79°C in the case of Boeny, while the corresponding temperatures in Vakinankaratra were 20.01°C

and 9.68°C. Only slight variations exist between the average monthly temperatures during the warm and cool seasons.

11. Under the SSP3-7.0 scenario¹⁵, mean national temperatures are expected to increase by 0.61°C (with a 10th and 90th percentile range of 0.32–0.86, respectively) during the 2030s and by 1.24°C (0.97–1.74) during the 2050s.

The mean annual temperature nationwide is expected to increase to 23.30°C (23.0–23.6°C) during 2020–2039 and to 23.93°C (23.7–24.4°C) during 2040–2059. Projected temperature changes will vary minimally by subnational unit and season; however, the expected maximum temperatures will rise significantly during the spring months by the mid-century (see Figure 3).

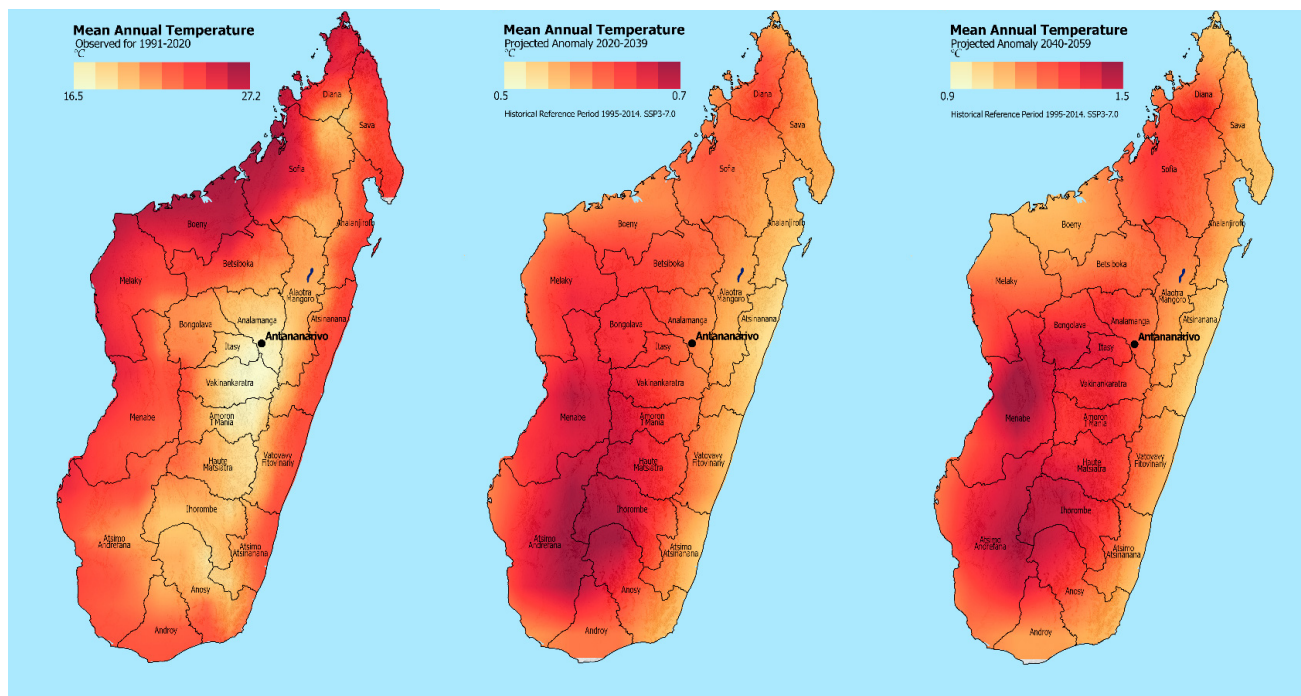
PRECIPITATION

12. National mean precipitation decreased by 59 mm from 1971 to 2020.

Statistically significant (>95%) trends during the spring months of September, October, and November (SON) showed decreased precipitation in the southwest region (-11.87 mm per decade in Atsimo Andrefana), the central highlands (-30.66 mm per decade in Vakinankaratra), and the savanna region in the interior of the west coast (-14.21 mm per decade in Betsiboka). The summer months of December, January, and February (DJF) have consistently experienced the greatest interannual precipitation variability across the island over the last half-century, with the wettest month being January and the driest month varying between May and October by region and volume.

FIGURE 3.

Madagascar's observed (1991–2020) mean annual temperature (°C) and projected anomalies, under SSP3-7.0, for 2020–2039 and 2040–2059.



Source: World Bank's Climate Change Knowledge Portal (CCKP)

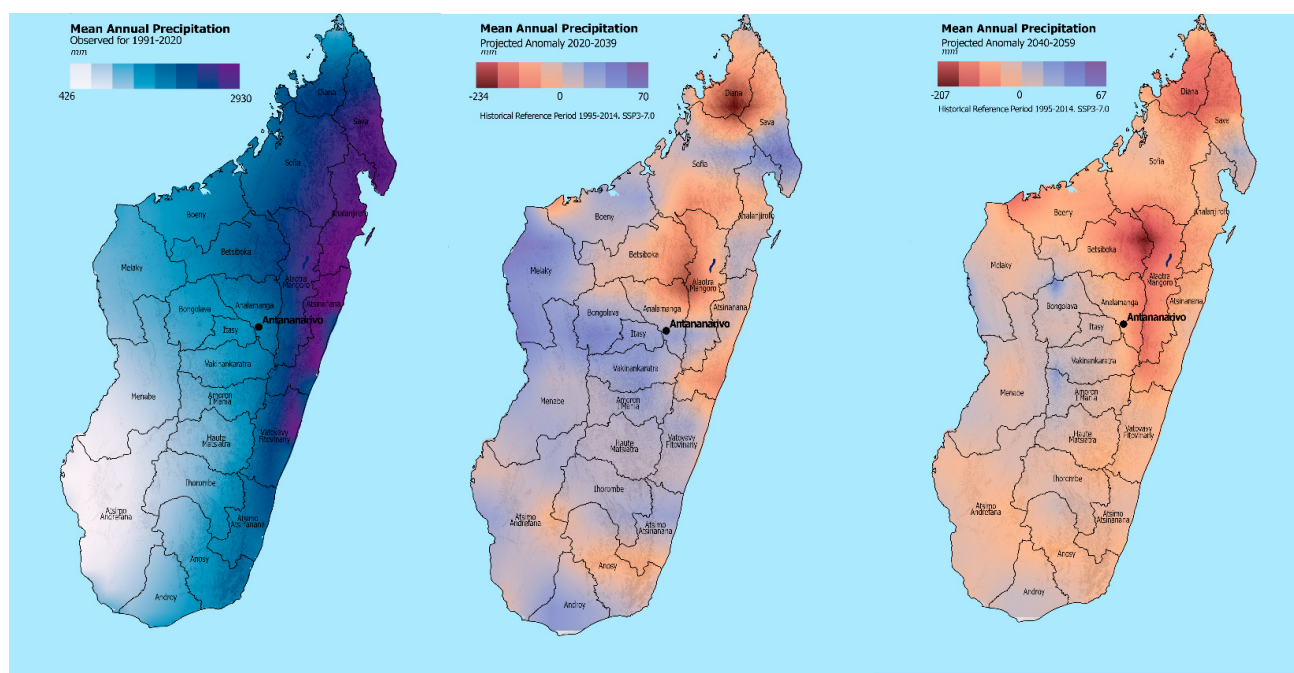
13. National mean precipitation is expected to decrease by the end of the century, with a high degree of uncertainty and significant regional variations. Projected precipitation anomalies are projected to decline by a median of -1.25 mm but with a wide range from -110.46 mm to 120.44 mm compared with the 1995–2014 reference period. This trend is far more nuanced at the regional levels during the wet summer months when all the regions receive roughly half of their annual precipitation amounts. In the north, the Diana region is projected to experience a decline in precipitation. Analamanga, in the higher elevations, is forecasted to experience an increase in summer month precipitation compared with the reference period (see Figure 4).

CLIMATE HAZARDS

14. Several climate-related hazards affecting population health in Madagascar are linked to changes in baseline temperatures and precipitation. The most common climate-related hazards affecting Madagascar are storms (cyclones), floods, landslides, droughts, wildfires, SLRs, and extreme temperatures. The overall impacts of such events in Madagascar should not merely be attributable to changing environmental conditions; they are also compounded by anthropogenic causes including rapid deforestation, mining, urbanization, and inadequate housing.

FIGURE 4.

Observed (1991–2020) mean annual precipitation (mm) and projected anomalies, under SSP3-7.0, for 2020–2039 and 2040–2059.



Source: World Bank's CCKP

STORMS

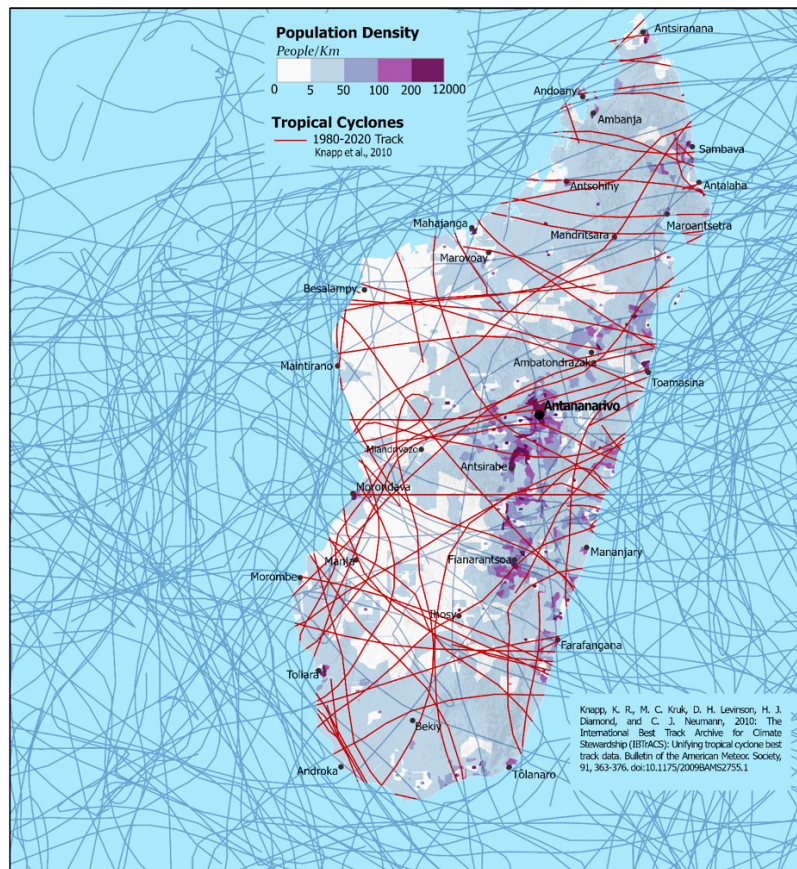
15. Madagascar has one of the highest risks of cyclones on the continent — averaging 3–4 cyclones per year. Storms in Madagascar — classified at a “high” hazard level by the World Bank Global Facility for Disaster Reduction and Recovery (GFDRR) — constitute the most damaging and frequent natural hazard in the country,¹⁶ particularly on the east coast (see Figure 5). Between 1980 and 2020, storms made up 63 percent of the country’s total natural hazards. The 51 storms, which occurred during the 1991–2022 period, mostly during the storm season of November to March, affected more than 12.5 million people and left more than 2,000 dead.¹⁷ Moreover, storms also generate significant losses and damages, with high-speed winds, on average, contributing to over 68 percent, followed by storm surges (20 percent) and storm-related flooding (12

percent).¹⁸ Back in 2011, it was estimated that the country experienced direct storm-related losses of USD87 million on a yearly basis, with most losses occurring at the household levels.¹⁹

16. By the end of the century, cyclone frequency over the Indian Ocean is projected to decrease; however, its intensity is projected to increase. Climate change is expected to interact with the risks of cyclones and extreme weather events in complex ways, including the possibility of generating increased windspeed and precipitation intensity, which are currently poorly understood. Global modeling of climate change impacts on cyclone intensity and frequency points to a general trend of reduced cyclone frequency but increased intensity and frequency of the most extreme events. Specifically, models suggest that storm intensity will

FIGURE 5.

1980–2020 Cyclone paths and main populated places.²⁰



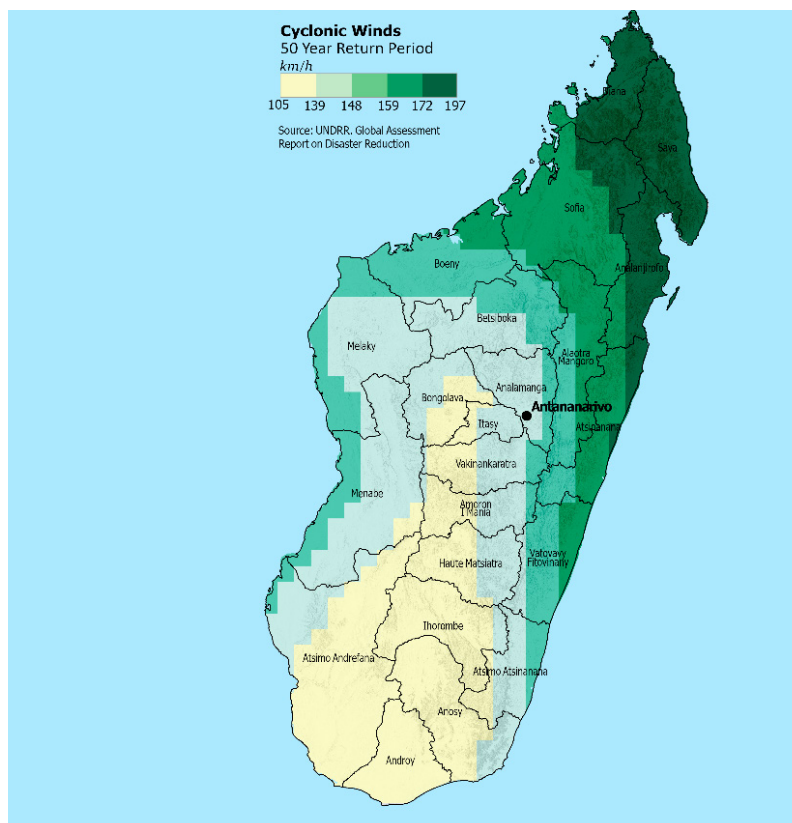
increase by 46 percent and shift toward the north of the country by 2100.²¹ Additionally, hurricane return periods²² data acquired from the UN Office for Disaster Risk Reduction (UNDRR) — shows that over a 50-year return period, cyclonic winds would range from 105 km/h in the southern region to 197 km/h in the northeastern areas — a spatial pattern that is replicated in all return periods (see Figure 6). Winds above 200 km/h would result in the widespread destruction of infrastructure and crops.

FLOODS

17. Floods constitute 11 percent of the total natural hazards in the country, leading to losses of lives and damages. In the past 30 years, more than 30 flood events have occurred, which have killed more than 150 people and affected almost 10 million. Flood events commonly occur during the rainy season from November to March, when the country is prone to cyclonic activity, due to the intense precipitation. Floods in the country have been classified by GFDRR as a high-level hazard: this means that a life-threatening flooding event will occur at least once every 10 years. In 2011, it was estimated that the country

FIGURE 6.

50-year return period.²³



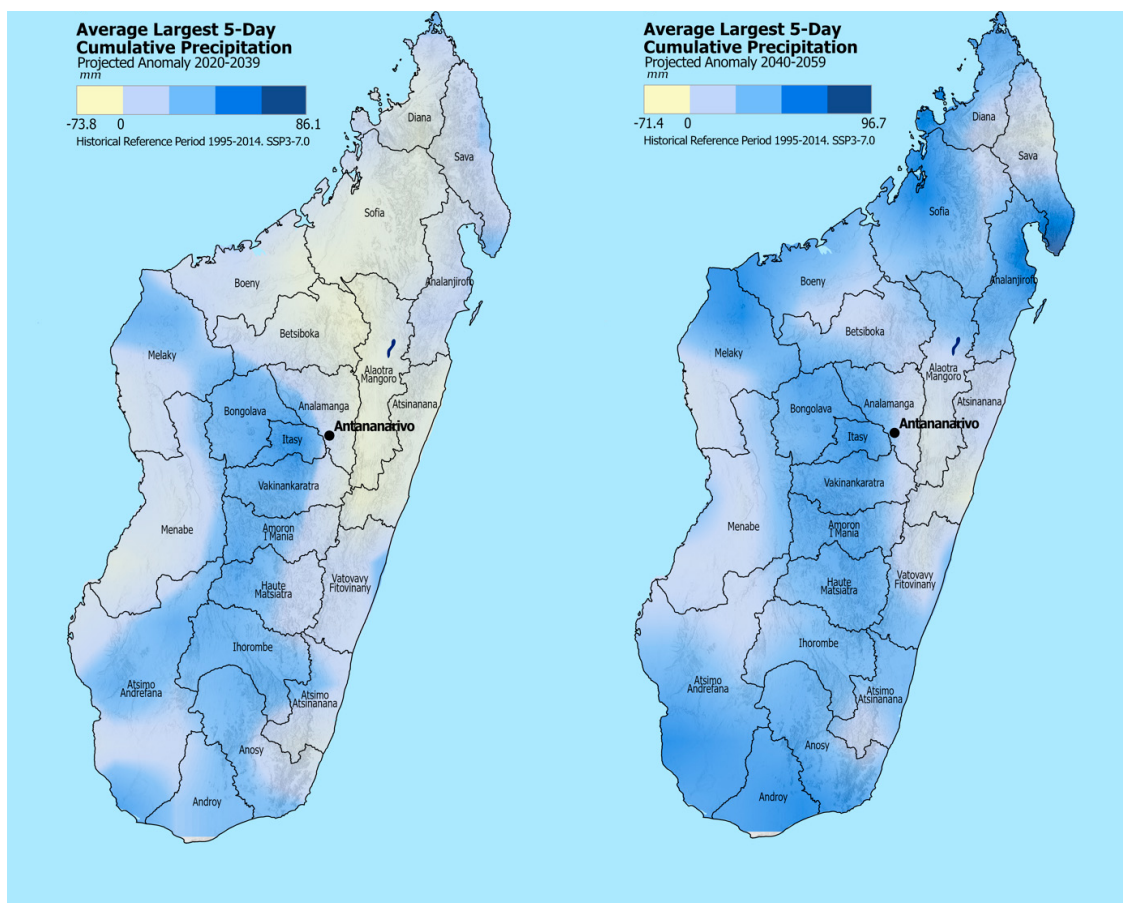
experienced USD13 million in direct losses from flooding yearly, with emergency costs for flooding of approximately USD3.1 million per year²⁴. Moreover, the construction of homes on hilltops and the build-up of waste in drains and culverts have further exacerbated the damages and vulnerability of communities to floods, particularly in residential areas.

- 18. Madagascar's average precipitation levels are projected to decrease in the 2030s and 2050s; however, intense precipitation is projected to increase, particularly in January.** In Madagascar, in the 2030s, intense precipitation is expected to increase in the central plains and southern areas, reaching a maximum

of nearly 50 mm in the Itasy region. By the 2050s, most of the country will experience an increase in 5-day cumulative precipitation,²⁵ indicating intensifying rainfall events, with maximum values of 96.7 mm in the southern and northwestern regions (see Figure 7). With intense precipitation over short periods, flash flood events would be particularly common in urban areas where permeability is low and in low-lying areas such as the west coast and the southern region, where intense rainfall is projected to increase.

FIGURE 7.

Projections for the average largest 5-day cumulative precipitation (mm) for the 2030s and 2050s, under an SSP3-7.0 scenario.



Source: World Bank's CCKP

LANDSLIDES

19. Though most of the country is classified as having a low risk of landslides, with the southwestern areas having a very low risk, Madagascar's increased intense precipitation for the 2030s and 2050s could further trigger landslides, particularly in high-slope areas with eroded soils. Very high-risk areas are mainly located along the east coast with its elevated areas, the region of Vakinankaratra, the highest point of the central highlands, and

the Diana region (see Figure 8). Under the SSP3-7.0 scenario, the population under the very high-risk level is expected to increase from 10.6 to 15.7 million (see Table 1).

TABLE 1.

Population exposed to landslides by risk level.

LANDSLIDE RISK LEVEL	2020–2039		2040–2059	
	POPULATION (IN MILLION)	PERCENTAGE	POPULATION (IN MILLION)	PERCENTAGE
1	10.6	30.3	15.7	30.3
2	17.6	50.3	26.1	50.2
3	5.7	16.3	8.5	16.4
4	1.1	3.1	1.6	3.1

Source: NASA – International Disaster Charter

FIGURE 8.

Rainfall-triggered landslide index.



Source: NASA – International Disaster Charter

DROUGHTS

20. The risk of drought in Madagascar is high.

Already, droughts have exerted a dramatic impact on the southern part of the country.

Over the past 30 years, there have been reports of eight droughts in the country — leading to food shortages and famine, which have affected more than nine million people. In 2022 — the fourth consecutive year of drought, the vegetation in the southern region, which was impacted due to water scarcity, severely impacted the food system.²⁶ Using the Normalized Difference Vegetation Index (NDVI) — a quantitative method for measuring the level of healthy vegetation and a drought indicator,²⁷ the analysis shows that plants in the southern part of Madagascar have been more water-stressed than their historical values. This is due to the reduction of the water used for agricultural irrigation as a result of the lack of rainfall (see Figure 9).

21. Projected erratic rainfall patterns, extended dry seasons, and the lack of improved land use practices will exacerbate the effects of droughts in the country.

Based on the Climate Change Knowledge Portal's (CCKP) estimates, the annual Standardized Precipitation Evapotranspiration Index (SPEI)²⁸ for Madagascar are projected to be -1.9 and -3.7 for the 2030s and the 2050s, respectively. Furthermore, even when storms and floods are expected to increase in intensity during the same periods, the dry season is expected to be prolonged with an approximate 15 percent national decrease in monthly precipitation, particularly in July and October during the 2050s. The number of consecutive dry days is also projected to increase by 4.5 (to 142 maximum days with less than 1mm annual average) and by 7.4 (to 146 maximum days with less than 1mm annual average) in the 2030s and the 2050s, respectively (see Figure 10).

FIGURE 9.

NDVI Anomaly from September 17, 2021 to September 16, 2022.²⁹

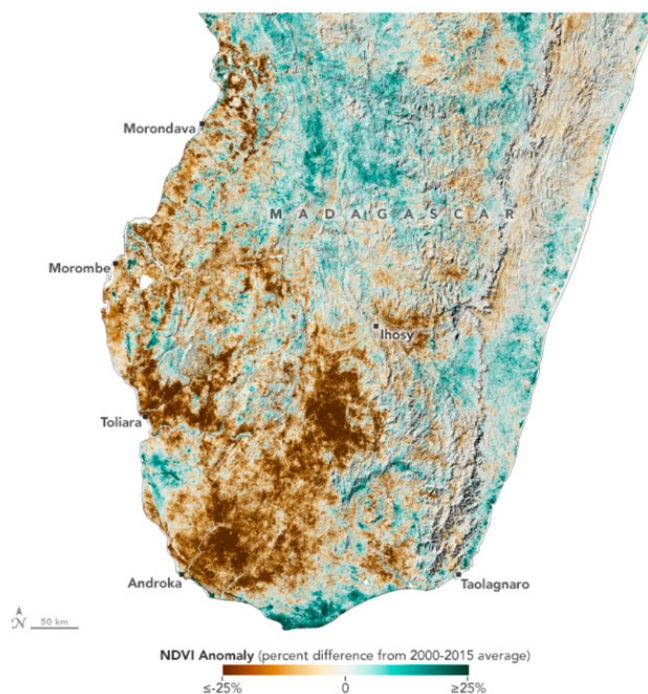
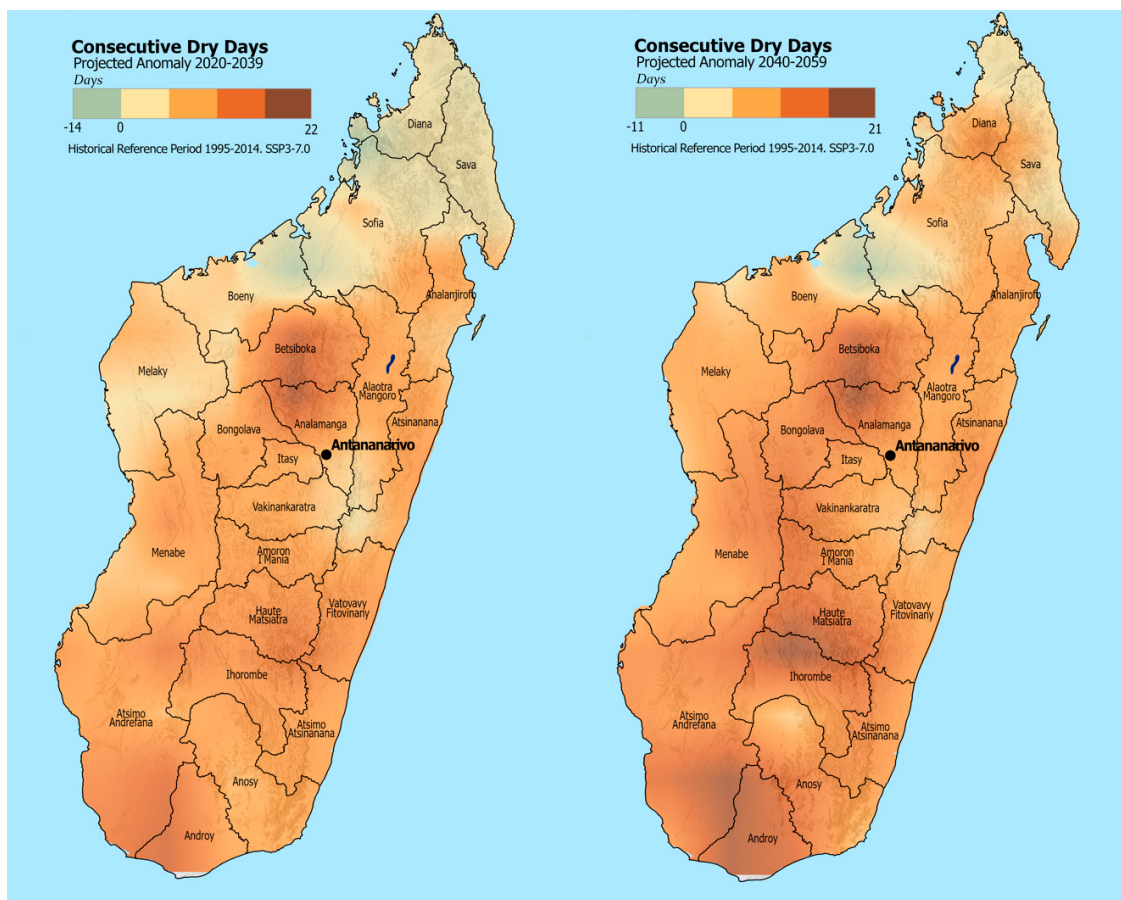


FIGURE 10.

Projections for consecutive dry days during the 2030s and 2050s, under the SSP3-7.0 scenario.



Source: World Bank's CCKP

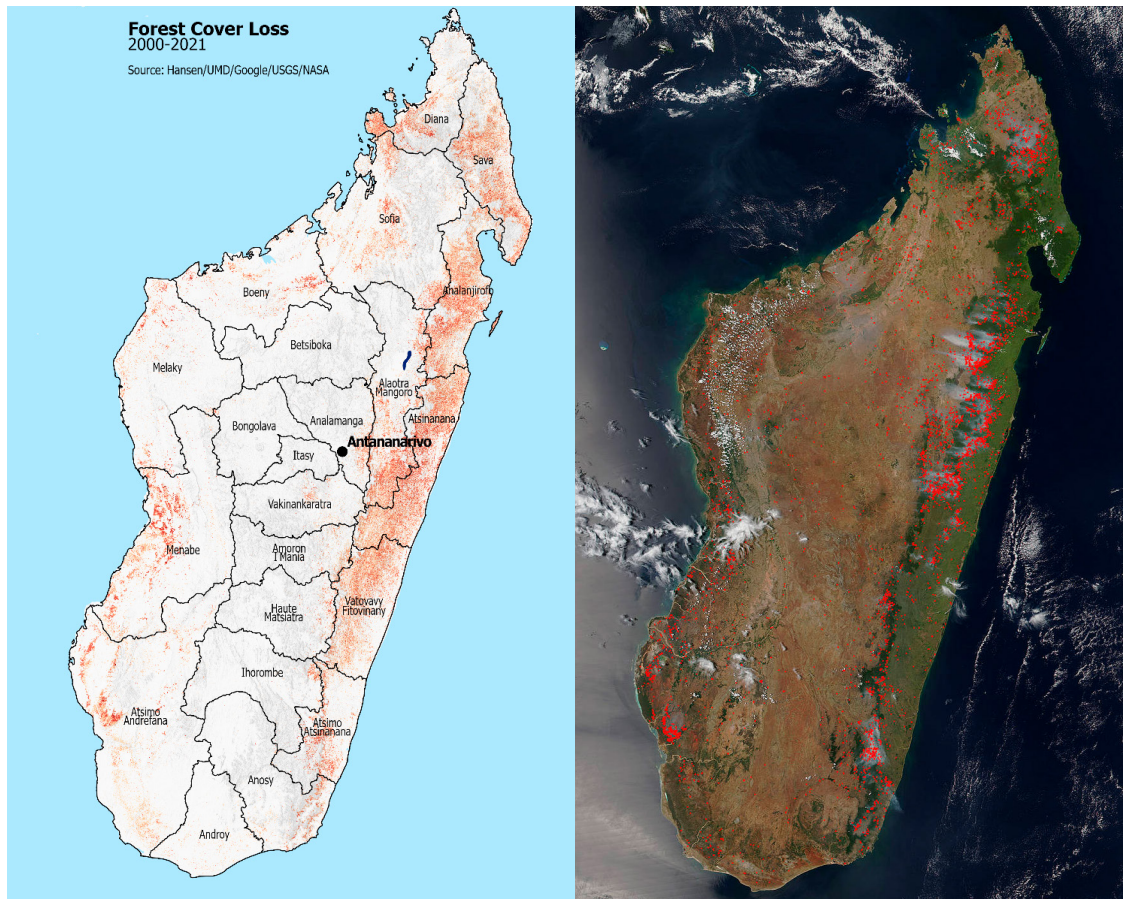
Most of these dry days are expected to occur during the dry season (May to October). The regions of Androy in the south, Betsiboka, and the northern area of Analamanga are projected to have the greatest number of consecutive dry days (22 days) during the 2030s and 2050s. By the 2050s, most regions in the country are expected to have more than five consecutive dry days. Exceptions are some areas in Diana, Sofia, Sava, and Boeny located along the northeastern coast: they will have negative dry days (that is, increased precipitation).

WILDFIRES

22. Madagascar also experiences regular wildfires, which decreases air quality, and the risks may grow due to the projected increase in the maximum number of consecutive dry days. A key contributing factor to the country's wildfires is deforestation. Since 1953, the country has lost 44 percent of its forests (see Figure 11) — mostly due to anthropogenic fires used for agricultural land clearing (*slash and burn*). Most of the forest cover loss has occurred along the eastern coast, with the secondary impact experienced along the western coast — particularly in the Diana and Menabe regions.

FIGURE 11.

Madagascar's forest cover loss 2000–2021³⁰ and detected wildfires (red) in 2015.³¹



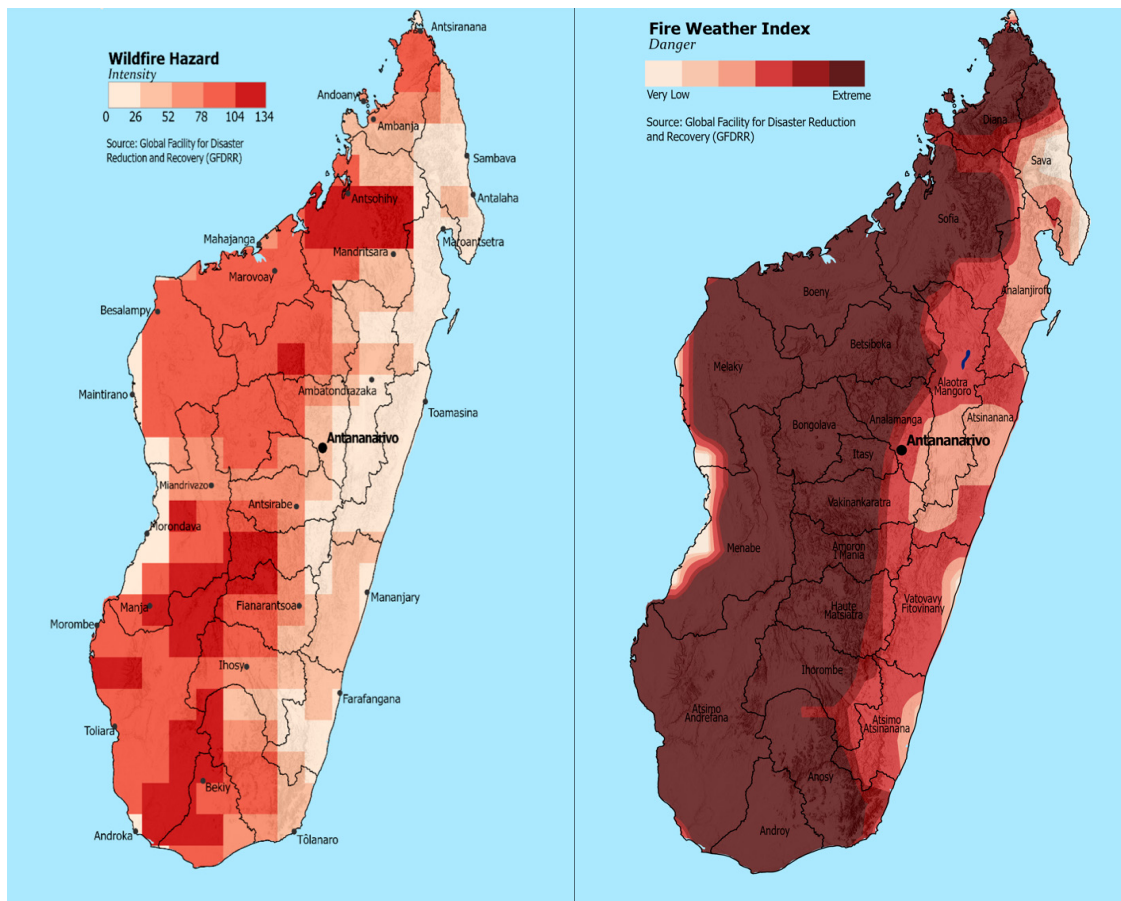
GFDRR classifies wildfires in Madagascar as a high-level hazard: this means there is a greater-than-50-percent change in weather conditions that support wildfires (see Figure 12).³² From 2012 to 2019, satellites detected an average of 356,189 fires per year, amounting to 0.6 fires/km² per year on average. Most of these fires occurred in the country's western and northwestern regions (see Figure 11). Areas near Toliara and Morondava have experienced the highest density of fires in the country. In fact, wildfires are prevalent in most regions of the country, except for the central highlands and areas in the southern region.³³

23. Wildfires can be exacerbated by climate change through increased temperatures and reduced rainfall, and the literature suggests that wildfire seasons may lengthen due to climate change.

Decreased precipitation patterns, increased consecutive dry days, and high deforestation rates would increase wildfire frequency, thereby affecting human health and endangering biodiversity. Although studies have not yet been published on predicting the impact of wildfires in Madagascar, projections on temperature and precipitation indicate that they would enable wildfires.³⁴ Projections of future climate estimate an increase in the frequency of fire occurrences, an increase in the duration of the fire season, and the severity of the fire.³⁵

FIGURE 12.

Wildfire Hazard Intensity and Fire Weather Index.



Source: GFDRR

SEA-LEVEL RISES (SLRS)

24. Over the past century, the rate of SLRs has roughly tripled in response to global warming of 0.8°C. SLRs pose a significant threat to islands across the globe, including Madagascar. Historical sea-level data for Madagascar is limited, though some estimates state that between 1994 and 2008, the sea level rose by 0.6 centimeters (cm) per year in Madagascar.³⁶ As reported in the Sixth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) in 2021,³⁷ the mean global sea surface rose by 0.20 meters (m) between 1901 and 2018 — equivalent to an average SLR of

1.3 mm/year between 1901 and 1971 and 1.9 mm/year during the 1971–2006 period.

25. Projections for SLRs are complex: while there is high confidence that extremes in sea level will increase, there is low confidence in the region-specific projections on storm surges. SLR projections for Madagascar indicate an increase of 34 cm (50th percentile) by 2059 (29 cm and 43 cm for the 10th and 90th percentiles) under the SSP3-7.0 scenario.

EXTREME HEAT

26. Temperatures are projected to continue to rise, though near- and mid-term projections (2030s and 2050s) show that only coastal areas will experience extreme daytime heat conditions, but most of the country will experience warmer nights. Upland Analamanga will experience a mean increase of 58.36 summer days annually (40.68, 86.13) compared with coastal Analanjirifo's mean increase of 47.54 summer days annually (26.54, 77.00) by 2040–2059. Though Analamanga's summer months will have a much greater change in the number of hot days during

the summer months than Analanjirifo, the majority of the hot days will increase during the fall months in both cases (see Figure 13). In contrast, Analanjirifo will experience an increase in tropical nights annually by a median of 74.76 (29.72, 97.64) compared with Analamanga's 21.08 (3.24, 35.07), mostly during the summer months (see Figure 13). In general, the total number of tropical nights will decrease as one moves from the coast toward higher elevations, which means that the capital region will still act as a refuge for evading the hottest nights that the coastal regions will endure more frequently.

TABLE 2.

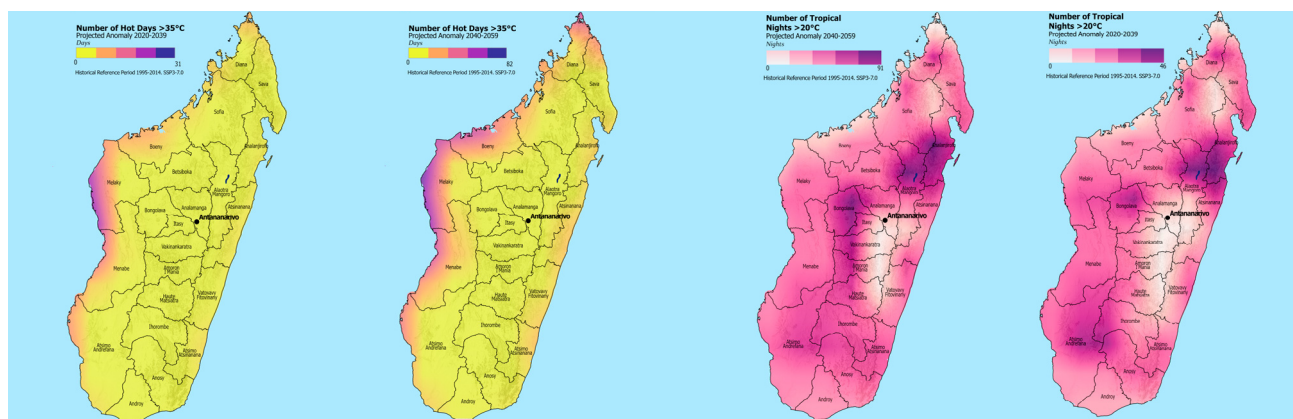
Population exposed to more than 1 day of extreme temperature by the 2030s and 2050s.

	>1			
	2020–2039	PERCENTAGE	2040–2059	PERCENTAGE
Number of Hot Days	4,643,000	13	13,604,500	25
Number of Tropical Nights	25,537,000	70	48,767,600	90
Total Projected Population (SSP3)	36,317,000		53,897,800	

Source: World Bank's CCKP

FIGURE 13.

Projected change in the number of hot days (>35°C) for 2020–2039 and 2040–2059 and projected change in the number of tropical nights (>20°C) for 2020–2039 and 2040–2059.



Source: World Bank's CCKP

KEY MESSAGES

Nutrition Risks:

- Stunting and malnutrition are major climate-sensitive concerns in Madagascar: approximately 40 percent of children experience stunting, 8 percent suffer from wasting, and 23 percent are underweight.
- More than 1.6 million people are food insecure and in need of humanitarian assistance, particularly in the regions of Androy, Anosy, and Atsimo Andrefana.
- Poor agricultural practices, a lack of adequate hydro-agricultural infrastructure, and a dearth of education are the main drivers of malnutrition in the country.
- Climate change has exerted a largely negative impact on rice production in Madagascar, particularly due to severe droughts, leading to significantly below-average soil moisture conditions.
- Changes in precipitation and temperature will affect fisheries and coastal communities where marine products are the main source of protein.

Waterborne Diseases

- Madagascar has reported a prevalence level of diarrhea of 8–10 percent among children since 2003.
- Subnationally, diarrheal prevalence is highest in the Androy region at 16.2 percent, followed by Vatovavy Fitovinany (14.7 percent), Menabe (13.8 percent), and Antananarivo (13.3 percent).
- Less than half of the households have access to improved drinking water sources (48 percent).
- Fifty-three percent of the households are not using any methods for treating water before consumption.
- Less than 35 percent of the households have improved sanitation facilities.
- Areas with limited access to safely managed drinking services will likely experience greater vulnerability to waterborne diseases in the face of increased precipitation, floods, droughts, and storm events.

Vector-Borne Diseases

- Malaria is the main vector-borne disease in the country, with more than 25 million people (88 percent) at high risk.
- Malaria transmission and vector reproduction are sensitive to seasonal changes in rainfall and temperatures, as well as extreme weather events. It is projected that by 2070, 46 million people will be at risk of malaria.

Air Quality Health risks

- According to the Air Quality Index (AQI), which measures the concentration of Particulate Matter (PM) 2.5 and PM1.0, Madagascar had an AQI value of 77 in 2023. Though it is considered to be moderate, it is still 2.7 times above the World Health Organization's (WHO) recommended guidelines. Ambient air pollution (AAP) is notably affected by wildfires and brick production and burning, which tend to increase during the dry season.
- Indoor air pollution is a major concern in Madagascar: two out of five households (42 percent) cook indoors and 98 percent use solid fuel for cooking.
- Both AAP and household air pollution (HAP) increase risks for acute respiratory infections — the top morbidities affecting children.

Zoonoses

- Plague is endemic in Madagascar. Wildfires have increased due to conducive temperature and precipitation conditions, compounded by deforestation rates. These conditions have altered the natural habitats of rodents and driven them to inhabited areas, thus increasing the risk of zoonotic infections.

In the context of high biodiversity, such as in Madagascar, coupled with decreasing natural habitats due to wildfires or droughts, increases interaction between animals and humans, therefore increasing risks for zoonotic diseases.



CLIMATE-RELATED HEALTH RISKS

27. Madagascar suffers from significant health challenges, particularly communicable, maternal, neonatal, and nutritional diseases that have been further exacerbated by the socioeconomic environment of the country.

The three main contributors to the country's burden of disease had been constant between 1990 and 2019: respiratory infections and tuberculosis (TB), enteric infections, and maternal and neonatal diseases.³⁸ The burden of disease in Madagascar is affected by socioeconomic determinants of health such as income, environmental factors, access to basic services, and urbanization. Although the healthcare system has improved as reflected in the increase in the life expectancy of males from 56 to 63 years and of females from 58 to 68 years,³⁹ it has been hit hard by the COVID-19 pandemic. To date, the country has administered less than 2.5 million doses of the Covid-19 vaccine and it is projected that more than two million people could fall below the poverty line due to the economic crisis caused by the pandemic.⁴⁰

28. The current burden of disease could be exacerbated due to climate change, with climate-related health risks not evenly distributed across the population, leaving some groups more exposed and vulnerable than others.

The factors affecting a population's vulnerability to climate are often similar to those that affect health more broadly.⁴¹ However, climate change may exacerbate health inequalities, especially among certain vulnerable population groups including the poor, rural populations, those living in informal urban settlements, women and young children, the elderly, those living with pre-existing conditions and disabilities, and displaced populations. Notably, rural communities, children under five years old, women, and poor communities in Madagascar are already at high risk. Therefore, investments in adaptation and mitigation measures must carefully consider groups who would directly benefit from or may be disadvantaged by adopted measures.

29. Health outcomes resulting from the increased intensity and frequency of climate hazards induced by climate change exhibit strong spatial variations, putting some groups at higher risks than others.

In Antananarivo, those living in informal urban settlements are at a high risk of mortality due to flooding and landslide events during the cyclonic months. In the southern regions such as the Ambovombe-Androy district,⁴² children are at high risk of malnourishment and enteric diseases due to the impact of the droughts on edible crops and access to safe water.

30. Madagascar's CHVA assesses five climate-related health risk categories:

(a) nutrition, (b) waterborne disease risks, (c) vector-borne disease risks, (d) air quality health risks, and (e) zoonotic diseases. Each category is assessed in terms of current and future risks, with considerations for national and subnational peculiarities wherever possible.

NUTRITION RISKS

31. 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. Specifically, they can exert acute and chronic effects on agricultural production, storage, processing, distribution, and consumption. Notably, global food production can be affected via changes in crop yield, changes in biomass food composition and nutritional quality, and via the disruptions of food supply chains and transportation. Furthermore, short-term shocks (for example, natural disasters) can drastically reduce yields or redefine the spatio-temporal patterns of crop suitability.

32. Climate-related and natural hazards have intersected with human factors to exacerbate nutrition risks for the population.

The Malagasy government has identified natural hazards (including climate-related), poor agricultural practices, a lack of adequate hydro-agricultural infrastructure, and a dearth of education as the main drivers of malnutrition in the country. In the southern region, which has been experiencing prolonged droughts, around 80 percent of the population depends on rainfed agriculture, increasing the risks of adverse nutritional outcomes. Overall, extreme weather events, coupled with vulnerabilities in generating agricultural outputs and severe multidimensional poverty, exacerbate risks for Madagascar's food supply chain.⁴³ While this assessment does not analyze the stunting percentage attributable to climate change, it does examine climate and nutrition linkages in Madagascar through a food security lens, focusing on the weather and climate impacts on agricultural and fishing productivity.

33. Stunting and malnutrition are major health challenges in Madagascar.

Based on the

government's estimates in 2021, approximately 40 percent of children experience stunting, 8 percent struggle from wasting, and 23 percent are underweight.⁴⁴ Out of the 22 regions in Madagascar, all but two have a very high prevalence of stunting — defined by WHO as greater than 30 percent.⁴⁵ Of these regions, the highest levels of stunting are found in Vakinankaratra (60 percent), Amoron'i Amoron'i Mania (55 percent), Haute Matsiatra (54 percent), and Bongolava (52 percent). It is also important to point out that the regions with high prevalence of stunting are agriculturally productive regions, therefore highlighting that the malnutrition challenge is also linked to feeding practices and social dynamics, which are beyond the scope of this assessment.

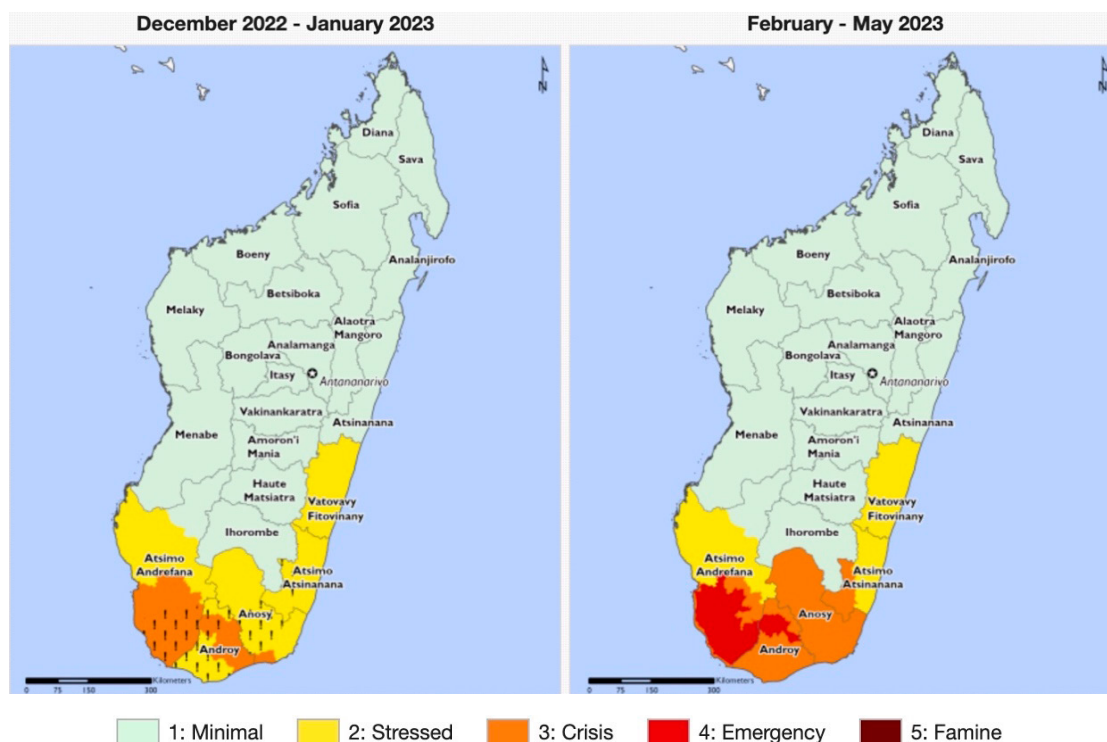
In terms of malnutrition in Madagascar, the United Nations' (UN) estimate is nearly 50 percent.⁴⁶ A 2021 assessment by the United Nations Children's Fund (UNICEF) found that half a million children under the age of five are expected to be malnourished in Madagascar (with over 20 percent severely malnourished); this is four times the number of malnourished children in 2020.^{47,48} The consequences of malnutrition, especially in children, are far-reaching, with profound implications for human and physical capital, which can constrain a country's overall economic growth and development.

34. Regarding food insecurity, 1.64 million people are food insecure and need humanitarian assistance.

Notably, the southern part of the country — particularly the regions of Androy, Anosy, and Atsimo Andrefana^{49,50} — has been chronically food insecure since the 1980s (see Fig 14).⁵¹ The “lean season” or *kere* (meaning “hunger”) typically arrives around September and October in the southernmost

FIGURE 14.

Food Insecurity in Madagascar from February to September 2022.



Source: FEWS Net

region of Madagascar, with minimal rains exerting a devastating impact on the poorest communities, as it dries up crop fields and the grasslands that feed cattle. As consecutive dry days are projected to increase in the 2030s and 2050s, the potential for food insecurity to increase will also be likely.

35. The impact of climate and climate change on Madagascar's food insecurity is exacerbated by the significant dependence of the country and the population on agriculture, forestry, and fishing. The value added by agriculture, forestry, and fishing to the country's national GDP is 24.8 percent.⁵² Moreover, it is estimated that approximately 90 percent of Madagascar's population depends on agriculture, livestock, and fishing activities.⁵³ Therefore, production shortfalls are very likely to aggravate food

insecurity at the household levels. Quantity — both in terms of food availability and calories consumed — and the quality of food products play a considerable role in nutrition outcomes. Additional drivers of malnutrition include poor feeding practices and infectious diseases such as diarrhea.

36. Impacts on cereal crop production, particularly rice, will be an especially critical climate risk factor for nutrition in Madagascar. The main staple crop in Madagascar is rice, followed by maize, cassava, and sweet potato, which also play large roles, while pulses and major cash crops such as vanilla, sugar, coffee, cocoa, cloves, and pepper constitute important sources of plant protein.⁵⁴ Research and documentation from previous years suggest that climate change has had a largely negative

impact on rice production in Madagascar, particularly due to severe droughts leading to significantly below-average soil moisture conditions, which can impact root and tuber crop production.^{55,56} In the highlands, cold stress and blast disease — a fungus commonly known as rice rotten neck — have reduced rice yields, thus adding to the challenges of poor soil fertility, droughts, and weed infestation in the lowlands where the majority of rice production takes place in Madagascar.⁵⁷ Changing temperature and precipitation baselines, coupled with climate shocks (for example, droughts and floods), have affected agricultural production and yield. This has not only impacted price and profit but also personal consumption at the household levels.

37. Climate change effects on food security and agriculture are interlinked with the effects on the jobs and income of smallholders, as trade from agriculture and livestock constitute the largest share of disposable income. Overall food production is expected to be lower than normal by 63 percent due to weather, pests, and elevated costs from agriculture equipment or supplies.⁵⁸ Specifically, the lack of rain and droughts are among the top shocks impacting households in the south of Madagascar, leading to crop losses due to pests and the concomitant rises in food prices. Labor productivity has also been affected due to heat exposure.

38. Changes in precipitation and temperature are projected to affect fishing and food production in coastal communities, where marine products are an important source of protein. In southwest Madagascar, small-scale fisheries employ 87 percent of the adult population and provide the sole protein source for 99 percent of households, according to a study by researchers at the University of

Hawai'i and the civil society organization Blue Ventures.⁵⁹

However, rising sea temperatures and acidification, which influence the abundance, migratory patterns, and mortality rates of marine life, have led to adverse health, economic, and social consequences for people dependent on fisheries and aquaculture.⁶⁰ In 2016, the decline in rainfall due to the El Niño weather patterns resulted in a 95 percent loss in harvests,⁶¹ which consequently led to approximately 30–60 percent of the population to become food insecure, including 35,000 children who were moderately malnourished and 12,000 who were severely malnourished.⁶² In 2021, droughts connected with climate change contributed to severe food insecurity in southern Madagascar, plunging 1.1 million people into food insecurity and doubling the number of malnourished children in the region compared with 2020.⁶³

39. Cyclones and tropical storms, projected to worsen due to the severe, prolonged droughts during the dry season and intense rainfall patterns during the wet season,⁶⁴ as well as pests, have been destroying crops and infrastructure across Madagascar. Notably, tropical storms Ana and Dumako have affected Anamalanga, Antananarivo, and the vanilla-growing areas in the north, while cyclones Batsirai and Emnati have struck the southeastern areas. Madagascar's agricultural production has also been impacted by locust plagues and other crop pests such as the fall armyworm,⁶⁵ which can be climate-sensitive: they occur in tandem with climate-related hazards such as droughts.⁶⁶

40. To counter the adverse agricultural effects, farming techniques will need to be adapted in order to prevent food insecurity. To that end,

common adaptation measures — irrigation, the application of fertilizers to reduce plant susceptibility, the adoption of drought-resistant and nutritious short-cycled crop varieties (such as sorghum), farmer capacity-building around climate-smart agroecological techniques, and marine conservation efforts for sustainable fisheries management — have come under consideration as a response to climate change.^{67,68} **Without adaptation, climate change is likely to substantially aggravate food insecurity and compromise nutrition outcomes in Madagascar.** While there is uncertainty on the precise number of individuals in Madagascar who will be at risk of food insecurity because of climate variability, recent findings suggest that globally, the population at risk could increase by up to 30 percent as a result of climate change between 2010 and 2050.⁶⁹

WATERBORNE DISEASE RISKS

41. Water quality, which is in part affected by climate-related hazards such as floods or landslides, has been associated with an increased incidence of waterborne diseases in Madagascar. Current drivers of waterborne diseases throughout the country are attributable to many factors including water sources, the quality and quantity of drinking water, sanitation facilities, and hygiene practices — each of which can be negatively affected by climate-related factors, in particular, floods and landslides. Madagascar is faced with a significant burden of waterborne diseases such as diarrhea, dysentery, cholera, food poisoning, and parasitic infections, particularly affecting children under five years of age. Specifically, the prevalence of diarrhea in Madagascar among children has been 8–10 percent since 2003.⁷⁰ In 2021, the Demographic Health Survey (DHS) reported a prevalence

of 9 percent of diarrhea among five-year-old children and those younger.

42. Just as significantly, not all children suffering from diarrhea are receiving the medical treatment they need. According to the DHS, 41 percent were taken to a health facility, while 20 percent did not seek treatment. Among the children who had diarrhea and sought medical attention, only 28 percent attended to a health facility for treatment. The mother's level of education also plays an important role in whether treatment is sought: approximately 39 percent of those who had no education sought treatment for their children in contrast to 49 percent for those who had secondary education.

43. Subnationally, diarrheal prevalence is highest in the Androy region at 16.2 percent, followed by Vatovavy Fitovinany (14.7 percent), Menabe (13.8 percent), and Antananarivo (13.3 percent). The regions of Atsinanana, Alaotra Mangoro, and Bongolava have the lowest prevalence levels — 5.3 percent, 5.4 percent, and 5.7 percent, respectively.⁷¹ The regions with the higher levels of diarrheal prevalence are mostly lacking in improved water sources and manifest higher rates of open defecation. This is seen in the case of Androy: the proportion of improved water sources is just 36 percent, non-improved toilet facilities constitute 41 percent, and the open defecation rate is 49 percent.

44. However, in other regions, the percentages of diarrhea, water sources, and sanitary facilities at the subnational levels offer a mixed picture. For example, although Antananarivo has high proportions of improved water sources and sanitation facilities, as well as a relatively low rate of open defecation, diarrhea is still highly prevalent. Conversely,

even though Betsiboka has low percentages of improved water sources and sanitation facilities, along with a high rate of open defecation, the prevalence of diarrhea is lower than that of Antananarivo.

45. Water sources, waste, and sanitation services can be impacted by climate-related hazards, thus increasing waterborne and water-related diseases in the country.

Less than half of the households have access to improved drinking water sources (48 percent); moreover, 86 percent of these households are in the urban areas. Access to drinking water in urban areas is primarily through public taps or standpipes (38 percent) and tap water in the dwelling yard or plot (23 percent). On the other hand, approximately 27 percent use surface water and 22 percent rely on unprotected spring sources. In addition to challenges with access to safe drinking water, treatment practices are not widespread in the Malagasy population: 53 percent of households do not treat their water before consumption.

Apart from the lack of access to safe water sources, limited sanitation and hygiene practices also exacerbate the risks of diarrhea and other water-related diseases. Less than 35 percent of the households have an improved sanitation facility, 22 percent have limited access to sanitation services, and 32 percent engage in open defecation. Coupled with a lack of sanitation access, approximately 70 percent of the households have inadequate handwashing facilities — lacking in soap and/or water.⁷²

46. While the climate-related hazards' impact on waterborne diseases is complex, studies on different regions in the world, including northern and southern Africa, estimate that warming temperatures would increase the

relative risk of diarrhea by 10 percent by the 2030s.⁷³

In Madagascar, changes in precipitation and temperature patterns are likely to cause the re-emergence of water-related diseases, as floods in urban and rural areas result in the mixing of waste and sewage with fresh water, thus enabling water-related disease outbreaks.⁷⁴ Furthermore, more intense droughts, particularly in the southern region, would reduce water quality, as the lack of fresh rain would prevent the flushing of stagnant waters.⁷⁵ The remaining water sources would become over-used, thus increasing the risk of diseases being spread from person to person. Informal settlements and poor water sanitation and hygiene (WASH) infrastructure would multiply the risk of climate-sensitive waterborne diseases. Further research is needed to understand the direct and indirect effects of climate-related hazards on waterborne diseases in the context of Madagascar.

VECTOR-BORNE DISEASES

47. Vector-borne diseases are expanding their spatio-temporal suitability due to changes in precipitation and temperature patterns.⁷⁶

Diseases such as dengue, chikungunya,⁷⁷ malaria, and the Rift Valley Fever,⁷⁸ which are currently present in Madagascar, are susceptible to climate change. While neglected tropical diseases, such as dengue and chikungunya, represent 0.1 percent of total disability-adjusted life years (DALYs) in the country, malaria contributes to almost 4 percent.⁷⁹ This assessment focuses on malaria due to its burden of disease and data availability on the impact of climate on malaria's prevalence and vector suitability.

MALARIA

48. Malaria is the main vector-borne disease in the country, with more than 25 million people (88 percent of the population) at high risk.

In Madagascar, malaria is transmitted by the *Anopheles funestus*, *Anopheles gambiae*, and *Anopheles arabiensis* mosquitoes;⁸⁰ further research has also found the presence of *Anopheles coustani*.⁸¹ Subnationally, the Anosy region has the highest prevalence at 32 percent, followed by Atsimo Atsinanana (27 percent) and Ihorombe (21 percent). Each year, 1–2 million people are diagnosed with malaria: there is an increase in the incidence of the disease from 31 percent in 2017 to 70 percent in 2020. By 2020, approximately 674 deaths were related to malaria, affecting mostly children 5 years old or younger. Children under 5 years old and pregnant women are key vulnerable population segments, as malaria infection can cause maternal anemia, fetal loss, premature delivery, intrauterine growth retardation, and the delivery of low birth-weight infants.⁸² To deal with the high prevalence of malaria, approximately 69 percent of the households have at least one insecticide-treated nets (ITN).

49. Malaria transmission and vector reproduction are sensitive to seasonal changes in rainfall and temperatures, as well as extreme weather events.

⁸³ Agricultural communities are notably at risk of malaria, as flooded rice farming increases the exposure of the population to suitable areas for vector reproduction. Moreover, ponds created by humans are also a malaria transmission source. Between January 2008 and 2012, a study highlighted a covariation between rainfall and temperature and vector suitability — highlighting a transmission peak of March–April, right after the peak of the raining season when water tends

to stagnate and the warm temperature enables vector reproduction.⁸⁴

50. Without adaptation measures, ongoing climate change is likely to increase malaria prevalence, especially along the highlands in Madagascar.

⁸⁵ Changes in temperature, precipitation, and humidity affect the life cycle of vectors and their spatio-temporal suitability. Projections for the short and medium terms in Madagascar are going to be different at the subnational levels. Currently in the highlands (including Antananarivo), which have cooler temperatures, there is a low risk of malaria due to the low temperature decreasing mosquito suitability.⁸⁶ However, rising temperatures and changing precipitation patterns are expected to increase suitable areas for the *Anopheles* mosquitoes at higher altitudes.⁸⁷ Furthermore, research estimates that by 2070 and under the high-emissions scenario, about 46 million people will be at risk of malaria due to optimal weather conditions for mosquito reproduction.⁸⁸ Moreover, toward the end of the century, it is estimated that an average increase of an additional 1.6 months of vector suitability in the highland areas (altitude >1,000 m) in the African region when compared with the 1970–1999 period.⁸⁹

AIR QUALITY HEALTH RISKS

51. Ambient air pollution (AAP) and household air pollution (HAP), which pose a health risk and exacerbate respiratory illnesses, are highly prevalent in the country.

Exposure to urban air pollution, as well as smoke from indoor cooking, wildfires, and dust storms, can affect health by contributing to the development of severe chronic health conditions. This is due to the inhalation of fine particulate matter at 2.5 micrometers or smaller (PM2.5) and other toxins that can enter the deeper

sections of the lungs and bloodstream. People who are particularly vulnerable to particulate air pollutants include those with asthma and chronic obstructive pulmonary diseases (COPDs), children, and those with close exposure to the sources of air pollution such as women who cook with biomass and firefighters who combat wildfires.

52. The Air Quality Index 2023 shows a moderate concentration of PM2.5 and PM1.0 in Madagascar (AQI=77), which is 2.7 times above WHO's recommended guidelines.

Antananarivo, the capital, has the highest exposure to outdoor air pollution with a PM2.5 concentration of 27 micrograms per cubic meter ($\mu\text{g}/\text{m}^3$). This is in contrast with WHO's recommended $15 \mu\text{g}/\text{m}^3$ as the mean threshold PM2.5 concentration for a 24-hour period. Air quality notably deteriorates during the rainy season. In urban areas such as Antananarivo, increased temperatures can result in "heat island" effects with an increased risk of smog formation where the air containing increased levels of ozone and PM stagnates, thereby impacting health acutely and chronically through damages to the cardiovascular and respiratory systems.

Ambient air quality is also impacted by smoke from wildfires as well as brick production and burning — both of which typically occur during the drier months of May to October in Madagascar. Brick production constitutes an additional source of income. Droughts and increased temperatures can increase the frequency, intensity, geographic proximity, and length of the wildfire season in the country, worsening wildfire-induced air pollution.

Additionally, increasing temperatures and atmospheric carbon dioxide can extend the allergy season due to its impact on plant

phonologies, and while this is not well-documented in Madagascar, recent research in other countries has shown that poor air quality is significantly associated with the risk of autoimmune diseases.^{90,91} Predicted air quality deterioration is linked to the risk of autoimmune diseases such as connective tissue disorders, inflammatory bowel diseases, and rheumatoid arthritis.

53. Indoor air pollution is a major concern in Madagascar. Two out of five households (42 percent) cook indoors and 98 percent of the households use solid fuel — made up of coal/lignite, charcoal, straw/branches/grass, or agricultural residues — for cooking. In rural areas, only 2 percent of the households use non-polluting fuels such as electricity, oil, natural gas, or biogas — a figure that rises to 6 percent in urban areas. Approximately 71 percent of the households in urban areas use charcoal for cooking, while the rural proportion is around 17 percent. Rural households (77 percent) also tend to use wood for cooking.

Exposure to indoor air pollution can also be affected by changes in precipitation patterns due to climate change. Exposure to biomass air pollution can change during the storm/cyclonic months in Madagascar — mainly January and February. During these months, cooking must be done indoors in rooms, which may have poor or no ventilation. Further, during heavy rains, there is limited access to dry wood for fuel, and wet firewood is not only harder to burn but also produces more smoke, thereby increasing air pollution. Although there are no projections on indoor air pollution exposure due to climate change, it is essential to better understand the exposure pathway and the impact of climate change, due to the high prevalence of respiratory illnesses in the country.⁹²

ZOONOSES

54. Madagascar is among the countries with the highest levels of biodiversity, thus increasing the interactions between humans and animals and the risks of zoonotic diseases such as plague, which is endemic in Madagascar. In particular, the country has experienced small and isolated outbreaks of primarily bubonic plague. Climate change has exacerbated the outbreaks of plague by creating suitable conditions for vectors of the infection to thrive. For instance, in 2019, plague was reported in parts of the country not previously impacted by the disease; this is likely linked to climatic factors underpinning the change in transmission patterns.⁹³ Similarly, Madagascar has been experiencing the rapid spread of pneumonic plague due to the emergence of optimal climatic conditions that enable rat populations — the vectors of the infection — to thrive.⁹⁴ In 2017, Madagascar experienced a record-level pneumonic plague outbreak that afflicted two densely populated cities including the capital, Antananarivo, resulting in 2,417 reported cases and 209 deaths, with considerable health and socioeconomic consequences.⁹⁵

The increase in wildfires due to adequate temperature and precipitation conditions, coupled with deforestation rates, has also altered the rodents' natural habitats and driven them to inhabited areas, thereby increasing the risks of zoonotic infections. Given the context of high biodiversity and decreasing natural habitats leading to increased interaction between animals and humans, zoonotic diseases will continue to be a critical risk for the country.^{96,97} In August 2021, a new surge of plague cases was reported.



ADAPTIVE CAPACITY OF THE HEALTH SYSTEM

LEADERSHIP AND GOVERNANCE

55. Aware of the current and potential negative impacts of climate change on health and its health system, the Government of Madagascar has been actively developing policies and plans to support mitigation and adaptation actions. Among the sector policies and plans relevant to climate change and health, there is a special emphasis on capacity building and information systems. These documents provide the overarching national policy, mostly focusing on adaptation. Documents include the National Adaptation Plan (NAP), the National Adaptation Action Plan for the Health Sector to Climate Change (originally Plan D’Action National D’Adaptation Du Secteur Santé Au Changement Climatique à Madagascar or **PNASS**), the Strategic Plan for Climate Change, Nationally Determined Contributions (NDCs), and the Communications to the United Nations Framework Convention on Climate Change (UNFCCC).

TABLE 3.

Key policy documents relevant to climate change and health.

AGENCY	POLICY DOCUMENT
Ministry of Health (MoH)	National Adaptation Action Plan for the Health Sector to Climate Change (2016)
	National Health Security 2020–2024
	National Malaria Control Policy (reviewed in 2020)
	National Action Plan for Nutrition 2017–2021
	National Policy for Health and Environment
	Strategic Plan for Adaptation to Climate Change in the Health Sector Integrating the Transparency of the Paris Agreement (2021)
National Bureau of Climate Change Coordination (NBCC)	Third Communication to UNFCCC
	National Determined Contributions (NDCs) — 2016
	National Adaptation Plan
Ministry of Interior	Contingency Plan on Cyclones and Floods 2019–2020
	National Risk and Disaster Management Strategy 2016–2020

Source: Elaborated by the World Bank

56. The PNASS aims to strengthen the technical, institutional, and organizational capacities of the health sector in the face of climate change. The activities to be carried out to increase the health sector's resilience to climate change are grouped under seven components: (a) risk and capacity assessment, (b) capacity building, (c) integrated monitoring of the environment and health, (d) response, (e) research, (f) monitoring and evaluation, and (g) program coordination and management. However, most of the activities being implemented are related to surveillance and the integration of information systems; they are dependent on external financing mechanisms. Activities focusing on preparedness and climate-resiliency⁹⁸ systems are not included in the Action Plan, while performance and progress monitoring is lagging.

AUTHORITY AND ACCOUNTABILITY

57. The NBCC is the main government agency charged with developing the key policy guidelines and promoting efforts to integrate climate change into the policies and programs of other ministries such as the Ministry of Health (MoH). The NBCC focuses mostly on the elaboration of the overarching national documents on climate change adaptation and mitigation. It has developed the National Adaptation Plan, the NDCs, and the communications to the UNFCCC, and provided different ministries with technical support on sector-specific strategies. However, the Bureau lacks a monitoring and performance system to track the progress of the implementation of climate-related strategies by the different ministries. Moreover, it has neither the enforcement capacity and budget lines to allocate resources for implementation nor the systems in place to ensure the adoption of the NAP or other key policy documents.

The monitoring of the implementation of strategies and activities of each ministry is also lagging.

58. MoH's Environmental Health Department is in charge of climate change and health, and it maintains engagement and coordination up to the regional levels. In executing its responsibility of implementing the **PNASS**, the Environmental Health Department has focused mostly on implementing activities related to capacity building, information systems, and emergency response. For example, the department recently conducted training sessions for 33 focal points that are aimed at providing technical support for developing subnational action plans for climate change and health. However, there is limited integration of the climate adaptation activities in other departments within MoH, thus constraining the integration of these activities into the health system. Other activities being coordinated from the Environmental Health Department, include the development of early warning systems via SMS, and the mobilization of key public and private stakeholders for emergencies, notably for nutrition programs.

59. Implementation challenges can mostly be attributed to the limited budgets being allocated to the Action Plan and the lack of human resource capacities at the district and local levels. For example, financial support and capacities for technical guidance on emergency response and preparedness at the local levels, as well as for the development of contingency plans in case of extreme weather events, are limited. Even for strategies currently being implemented, monitoring mechanisms for overseeing the use of resources are absent. In addition, enforcement mechanisms and budgets to ensure that the regional or local levels carry out the development of action

plans or implement any other climate-related efforts are limited; thus, implementation is left at their discretion.

CROSS-SECTORAL COORDINATION

- 60. There is cross-sectoral collaboration between ministries such as WASH, nutrition, health, and meteorologic services though it is inconsistent across the sectors.** An example of collaboration is the one between MoH and the Ministry of Water Hygiene and Sanitation to formulate a Master Sanitation Plan for strengthening water and sanitation infrastructures in the more populous cities where water tends to be more polluted than in other locations. They are also focusing on specific plans for the southern and eastern regions, as the latter's frequent exposures to climate-related hazards make them key priorities for the country.

In the case of the collaboration between MoH and the Department of Meteorological Services, this has mostly focused on data collection and information systems, such as the development of the climate and health bulletin. Regarding nutrition, there are collaboration mechanisms with other sectors such as Agriculture and the Department of Meteorological Services. However, some sectors, such as Education, are not engaged in food security and nutritional efforts (as in incorporating educational programs for healthy diets and good agricultural practices in schools) due to limited budgets.

Overall, food security and nutrition risks have been highly projectized, which has hindered large-scale cross-sectoral and multi-stakeholder collaboration. However, current efforts are in place to address the situation and improve coordination, such as the upcoming Phase 2 of the Multi-Phase Programmatic

Approach on Improving Nutrition Outcomes by the World Bank.

- 61. The effectiveness of cross-sectoral coordination and the level of participation has been curtailed by the lack of clear roles and limited budgets for furthering collaborative work frameworks for climate and health.** Monitoring and accountability systems to ensure cross-sectoral implementation are limited, thus undermining the possibilities of improving a collaborative response to climate-related health challenges.

HEALTH WORKFORCE

- 62. Madagascar's health workforce faces numerous challenges including insufficient staffing levels, urban-rural maldistribution, the lack of a proper skill mix, limited educational access, poor absorption capacity, and rural retention issues.** Overall, in health facilities, there are only 1.99 doctors available per 10,000 inhabitants and 2.98 nursing and midwifery personnel⁹⁹ per 10,000 inhabitants; this is well below the recommended WHO standard of 44.5 health workers per 10,000 people.¹⁰⁰ Furthermore, many primary health care (PHC) facilities are not headed by doctors who follow the health sector's regulations. A small-scale survey conducted by the World Bank in 2020 found that 75 percent of the surveyed PHC heads were not medical doctors but nurses, midwives, or volunteers, who were not formally part of Madagascar's public health service. Furthermore, many doctors change between health facilities frequently.

Moreover, current existing gaps in staffing positions are mostly in rural areas, thus increasing the vulnerability of rural communities. The skill mix is also maldistributed, with only 28 percent of all doctors

operating in rural areas, where 79 percent of the population lives.¹⁰¹ Furthermore, no incentive programs have been identified to shift the distribution to rural areas.

63. Madagascar's health workforce has limited knowledge, technical capacity, and resources to prevent and manage current and future climate-related health risks. Yet, a systematic approach to developing the capacity of the health workforce to integrate climate change with emergency preparedness and response is absent. Notably, medical education is focused on the clinical aspect while technical training on public health is limited — a deficit that is further compounded by the lack of prioritization of climate change in the medical school's curricula.

64. Healthcare personnel are also exposed to and at risk of climate-related hazards and extreme weather events. This can further constrain how the health system is able to respond to climate shocks. Further research is thus required to analyze the geographic distribution of healthcare personnel and their exposure to climate-related hazards.

65. Promising examples of education and training in climate-related health risks have been identified. In 2016–2017, the midwifery curriculum was revised with the inclusion of a module on public health highlighting climate-related health risks. As mentioned earlier, 33 focal points at the district level on climate change and health were trained by the Environmental Health Department to develop capacities for formulating detailed action plans that are targeted at climate-related health risks at the district level.

HEALTH INFORMATION SYSTEMS

66. Integration of climate data with climate-sensitive diseases is done through the surveillance system by the Environmental Health Department within MoH, in collaboration with the Department of Meteorological Services and the German International Cooperation Office (GIZ). However, the use of this data seems to be underutilized, as it has not been incorporated into actionable plans at the national, regional, district, or community levels. The use of data is limited to the production of the climate and health bulletin that serves as an early warning system. The bulletin provides monthly mean temperature and precipitation forecasts and a list of diseases sensitive to those weather conditions at the subnational levels (regions). Weather data on the monthly temperature and the forecasted precipitation in average millimeters are provided by the Department of Meteorological Services. The list of diseases includes malaria, diarrhea, malnutrition, acute respiratory infections, intoxication from marine animals, and plague, which coincide with the climate-related health risks previously analyzed in this CHVA (see Section III).

Besides providing the data, the Department of Meteorological Services provides training and equipment to focal points at MoH so that the latter can access the data and use it to enhance their climate-sensitive disease preparedness. However, there are no mechanisms to ensure that the climate data is being used and incorporated into the decision-making process for preparedness and response to climate-related events at MoH.

67. Since 2009, a real-time service platform via mobile text message (SMS) provided through AirTel — the main mobile carrier in the country — has been implemented as an early

warning system by MoH, the Department of Meteorological Services, and Viamo — a private consulting firm. Airtel provides the 3-2-1 SMS service, which provides information on climate and health risks free of charge to the Malagasy population. Users only need to type “321” on their mobile phones to receive information on current warnings for climate-related hazards and health risks similar to what is provided through the climate and health bulletin. Between December 2020 and Nov 2022, this service reached around 130,000 users. However, these users are mostly in the central area of the country (Vakinankaratra and Analamanga regions) — representing more than 25 percent of the users — thus leaving the most climate-vulnerable populations underserved.

Viamo and Airtel also provide a hotline with automated real-time SMS alerts and audios for disaster risk preparedness in case of climate or natural shocks. The data is available on a web-based dashboard, which enable the Bureau National de Gestion des Risques et des Catastrophes (National Bureau for Disaster Risk Management, BNGRC) and development partners to access the data for better coordination and response. In 2022, around 8 million users received information regarding cyclone-related risks.

Although these services are free and open to the public, there are no climate and health information mechanisms at the district and fokontany levels, hindering the capacity of communities to establish or develop preparedness mechanisms in the face of climate-related hazards or climate-driven outbreaks of health risks.

68. The Department of Meteorological Services is currently collecting data on temperature,

humidity, and precipitation through the technical support and funding of the World Meteorological Organization (WMO), the National Oceanic and Atmospheric Administration (NOAA), and the Indian Ocean Commission (IOC). There are ongoing efforts by the Department of Meteorological Services to install new weather stations to increase the granularity of data obtained. However, there is a lack of budgets and resource allocations for the maintenance of current weather stations. The department is also working with IOC to develop models for climate projections under the Building Resilience in the Indian Ocean (BRIO) project to use the ALADIN-Climat tool, which provides climate projections with a 12km resolution. However, these climate projections do not include climate-sensitive disease considerations.

69. The Department of Meteorological Services also collaborates with the Ministry of Agriculture to provide information on climate-sensitive crops through the Agro-Bulletin. It sends Information on the crop calendar and the weather forecast (the average precipitation and temperature) — mostly for crops that are sensitive to changes in weather conditions, such as rice, maize, and sorghum — at the beginning of the rainy season to allow farmers to plan accordingly.¹⁰²

ESSENTIAL MEDICAL PRODUCTS AND TECHNOLOGIES

70. Essential medicines and medical equipment are purchased and procured by a nonprofit organization through a pull system that is decentralized at the district level and distributed to health facilities. A procurement system established by the Malagasy government called SALAMA, oversees the delivery of drugs from the National Essential

Drugs List to the district pharmacies (PhaGDis). The PhaGDis are wholesale pharmacies managed by non-governmental organizations (NGOs) that are contracted at the health district level. The district pharmacies then distribute the drugs to community managed pharmacies (PhaGeCOM) located in basic health centers (CSBs). However, medicines are not consistently free which is partially attributable to SALAMA's lack of subsidies from the Ministry of Health and their dependence on the sale of their products, as it is an financially autonomous entity.

SALAMA also manages products for specific programs such as family planning, malaria, HIV and AIDS, child health, and maternal health. The pull system allows health facilities to ensure preparedness activities that account for seasonal outlooks and climate-related health risks. While there is a user fee for medicines, those participating in specific programs, such as malaria and family planning, can obtain them for free. For instance, in the case of climate-sensitive diseases such as malaria, the supply chain is organized by funding sources managed through SALAMA. Organizations such as USAID and the Global Fund to Fight AIDS, Tuberculosis and Malaria (GFATM), among others, have contributed to the supply of malaria commodities.¹⁰³

71. Despite having a pull system that is decentralized at the district level, health facilities face constant stockouts. As of 2014, an assessment found that generic medicines had stockouts of 25–49 percent at health centers and 10–29 percent at hospitals. In the case of malaria commodities, the figures were 17–54 percent and 11–22 percent, respectively. The assessment highlighted two key factors for this situation.

One of them is transportation challenges. While SALAMA has quarterly delivery schedules to organize and manage the transportation from a central warehouse to districts, delivery delays occur due to the distance for transportation or the accessibility of health facilities, resulting in stockouts. In 2015, a USAID report showed that only 60 percent of Level-1 CSBs (CSB1) and 70 percent of the Level-2 CSBs (CSB2) were accessible by car at some point during the year, mostly due to limited road infrastructure and climate-related hazards that affect road accessibility.¹⁰⁴

The second factor contributing to stockouts is due to the health facilities' challenges with managing stock levels. Health facilities at the community or district level have not develop protocols for their stock levels. Another related issue leading to stockouts is that the health facilities do not consider distribution time and thus fail to account for safety stocks.¹⁰⁵ At the same time, even when health facilities tend to request more medicines to prepare for increased cases of malaria during the rainy season, the central level and SALAMA may not accommodate these requests, as these are adjusted based on monthly averages. Finally, the absence of pre-positioning of supplies protocols or estimations for climate-related health risks — as in the case of malnutrition during the lean season, malaria, diarrhea, or respiratory infections — would also lead to the health facilities experiencing stockouts.

SERVICE DELIVERY

72. Madagascar's health service delivery is strained by an external environment that is exacerbated by climate change and the capacity constraints of its health system. There is a critical drought-driven food insecurity situation in the south region of

the country, affecting more than 1.5 million people. In addition, constraints in the supply chain — in terms of medical products, the lack of a sufficient health workforce, and limited resource allocations — also weaken the country's health service delivery. The vulnerability of the country's health system and its service delivery are reflected by the country having one of the lowest COVID-19 vaccination rates. This increases the risks of outbreaks and related-morbidities and mortality, while impacting service delivery, especially immunization and family planning services.¹⁰⁶ It is estimated that more than two million people could fall below the poverty line due to the economic crisis caused by the COVID-19 pandemic. Rural areas are even more vulnerable due to the gaps in the number of health facilities, the availability of basic and specialized services, affordability due to out-of-pocket (OOP) expenditures, and the quality of care.

73. Additional shocks and stressors related to climate change have the potential to exacerbate existing issues and barriers to quality health service delivery. Nonetheless, the PHC Directorate — the entity in charge of developing quality norms for health service delivery — has not included climate change risks as key considerations for norms that ensure quality of service amid climate-related hazards. Moreover, the directorate lacks the technical capacity to further efforts that can strengthen the resiliency of PHC services.

WATER, SANITATION, AND HYGIENE (WASH)

74. The resiliency of WASH to climate change is pivotal for preventing outbreaks of water-related diseases. However, many households lack the basic water and sanitation infrastructure: only 34 percent use improved sanitation

facilities. The Ministry of Water has focused its efforts primarily on increasing water access, with less of a focus on sanitation systems. Although the existing codes for water and sanitation infrastructure seek to ensure the resiliency of WASH services and incorporate subnational considerations that integrate climate-related risks (that is, droughts in the south and cyclones in the east), enforcing and monitoring the adoption and implementation of these codes has been inconsistent and challenging. The Ministry of Water also lacks adequate plans for strengthening sanitation in the face of climate-related hazards. Overall, current WASH projects have limited budgets and depend mostly on external partners for executing their activities.

HEALTH FACILITY PREPAREDNESS

75. Though health infrastructure codes on climate-related hazards exist, there is limited information on the retrofitting requirements for the infrastructure of facilities to ensure climate-resilient features. Despite the existence of mandatory building codes, detailed guidelines on retrofitting existing facilities to encompass climate-resilient features are absent. In addition, budgets to adopt and implement these codes are limited. Finally, there are no mechanisms to monitor the uniform adoption of these codes or to enforce them.

76. The Contingency Plan for Cyclones and Floods 2019–2020 includes the health sector as a key area of emergency preparedness and response. However, MoH does not have a specific health system emergency response contingency plan. Although emergency plans are expected to be developed at the facility level, they are not consistent across facilities. Moreover, there are no monitoring mechanisms

to ensure the development of these plans or the business continuity of the health system amid climate-related hazards. At the same time, there are limited funds for health facilities to prepare for climate hazards. In the face of climate hazards, health facilities have to rely mostly on informal plans and informal roles in close coordination with the commune-, district-, and fokontany-level administrations to address climate shocks when they occur.

77. The Environmental Health Department is developing guidelines for incorporating mitigation and adaptation features at the facility level. These efforts are centered on developing eco-responsible health centers — focusing on electricity and water-saving features as well as the correct management of stocks. Currently, there is guidance on improving green areas (that is, by planting trees) near the health facilities, as well as installing solar panels at health facilities as a measure to strengthen resiliency in the face of power outages. In addition, there is ongoing work being supported by WHO to (a) make an inventory of greenhouse gases (GHG) emitted by health establishments and (b) update the assessment on the vulnerability and capacity of the health sector.

78. Climate change impacts a wide range of health programs that are important for service delivery (including nutrition and food security, maternal and child health, and communicable diseases such as malaria), making it vital to incorporate them into all health activities. Malnutrition is a major challenge in the country, and food security is projected to worsen due to changes in precipitation patterns. However, there is a lack of research into country- and context-specific, climate-resilient agricultural methods, seeds, and crops. Furthermore, responses to nutrition are highly

projectized — occurring mostly at the local level as well as characterized by limited coordination and a lack of an overarching strategy for the projects (though UNICEF is currently conducting a nutrition mapping project).

Nonetheless, positive changes are afoot. Development partners are implementing limited monitoring and oversight of projects. In addition, there are currently efforts (including the World Bank-financed nutrition program, Multiphase Programmatic Approach 2) to increase the multi-sectoral integration of nutrition programs: it is bringing together Agriculture; MoH; and the Office of National Nutrition (ONN), which sits directly under the President.

HEALTH FINANCING

79. The main challenge undermining the implementation of strategies to achieve universal health coverage is limited financing. Madagascar's health system spends USD19.80 per person per year — less than a quarter of the regional average of USD80.¹⁰⁷ Since 1995, total health expenditure has remained at nearly 4–5 percent of GDP, hitting 5.2 percent in 2019. Domestic government resources finance only about 30 percent of the health sector's budget, with the rest of the budget coming from private sources and OOP payments that make up 35.5 percent of health expenditures.¹⁰⁸ Moreover, regular salary expenditures for health personnel accounted for 71 percent of the allocated domestic financing in 2022 — significantly higher than those typically observed in low-income economies. This allocation has resulted in limited resources for operational activities at the community and primary levels, negatively impacting service delivery for the most vulnerable population.

80. The PNASS estimates costs of USD3.7 million for implementing key strategies for the health sector in the face of climate change.

From that budget, 38 percent would be directed to capacity building (USD1,421,798), followed by the integrated monitoring of environmental health at 23 percent (USD 850,000) and emergency response (18 percent). The rest of the budget would cover program coordination and management, monitoring and evaluation, research, and risk and capacity assessments.¹⁰⁹ This estimated budget is targeted solely for the national level, leaving regional, commune, district, fokontany, and facility levels with no budgets for climate adaptation or mitigation work, including emergency preparedness. Moreover, although budgets have been estimated, they are not being financed; thus, they depend on development partners or the private sector to be implemented.

81. The central MoH does not have a budget line for climate-related activities, including emergency preparedness and other adaptation measures. Work on climate change appears to be limited to its Environmental Health Department.

Despite generating cost estimates for the key strategies from the **PNASS**, MoH depends on external funders to allocate resources for implementing the activities. Development partners — such as GIZ, WHO, and USAID — are among the key stakeholders advancing climate and health strategies in Madagascar. However, most of the activities outlined in the **PNASS** have had a weak or low level of implementation due to the lack of resources being allocated, as the MoH's resource allocations to climate change and health are limited. For example, the climate and health bulletin was developed in partnership with a private consulting firm — the main mobile company Airtel — and funding from GIZ. The other **PNASS** activities

will be funded by a forthcoming World Bank project for pandemic preparedness.

82. Health services provision is mostly fee-for-service, thus curtailing access to health care. In addition, mechanisms to protect the poorest from health financial risks are limited, with no mechanisms in place to account for climate-related risks.

Mechanisms instituted — such as the community health insurance, vouchers (for example, those for children and pregnant women exist only in some regions, and free services are provided only for specific programs), and the Equity Fund (*Fonds d'Équité*) — suffer from fragmentation and do not cover all regions or all population groups. These mechanisms do not provide protocols or channels to protect climate-related vulnerable populations. Moreover, while costs have increased for climate-sensitive diseases such as malaria, the malaria funding envelope has not increased concomitantly to meet these needs.¹¹⁰

TABLE 4.

Health system's adaptive capacity gaps.

ADAPTIVE CAPACITY GAPS OF MADAGASCAR'S HEALTH SYSTEM	
HEALTH SYSTEM BUILDING BLOCK	SUMMARY OF GAPS IN ADAPTIVE CAPACITY
Leadership and Governance	• The NBCC does not have the enforcement capacity and budget lines to allocate resources for implementation. Nor does it have the systems in place to ensure the adoption of the NAP. • Implementation challenges are mostly due to limited budgets being allocated to the Action Plan and the lack of human resource capacities at the district and local levels. • Cross-sectoral coordination mechanisms lack clear definitions of roles, activities, and budgets to incentivize participation.
Health Workforce	• The health sector faces an imbalance in the number, skill mix, and deployment of the health workforce, including large urban-rural disparities. • Health personnel lack formal training as heads of PHC facilities, especially with regard to preparedness and response amid climate-related hazards. • Further research is required to analyze the geographic distribution of health personnel and their exposure to climate-related hazards. • Packages to incentivize the distribution of the health workforce to climate-vulnerable areas are non-existent.
Health Information and Disease Surveillance Systems	• Climate data produced by the Department of Meteorological Services are not well integrated into MoH's decision-making and strategic planning, as well as at the facility level. • Both the climate and health bulletin and the 3-2-1 SMS service lack concrete recommended actions for climate-related health risks or climate-related hazards. Moreover, these systems do not use climate vulnerability as a criterion to direct messages.
Essential Medical Products and Technologies	• The distribution of essential medicines lacks contingency plans for climate-related hazards, which hinder adequate distribution. • The centralization of the SALAMA system poses a distribution challenge with regard to remote and distant communities. There is a lack of decentralized warehousing and storage to shorten times for the delivery of products amid extreme weather events.

Health Service Delivery	• Climate change and its associated impacts are not mainstreamed into the operations and decision-making of health programs at all levels. • Cross-sectoral coordination lacks clear roles and strategies. • Climate-resilient healthcare facility, health infrastructure, and WASH infrastructure assessments are lacking, which makes prioritizing the needs and enforcing the adoption of building codes challenging. • The PHC directorate lacks technical capacities on climate and health.
Financing	• PNASS lacks the budget for implementing its strategies and activities, making it dependent on development partners for financing. • Protection mechanisms for the population are limited and do not target climate-vulnerable populations. • Budgets are centralized at the national level, thus limiting operability capacities at the district and fokontany levels.

Source: Elaborated by the World Bank

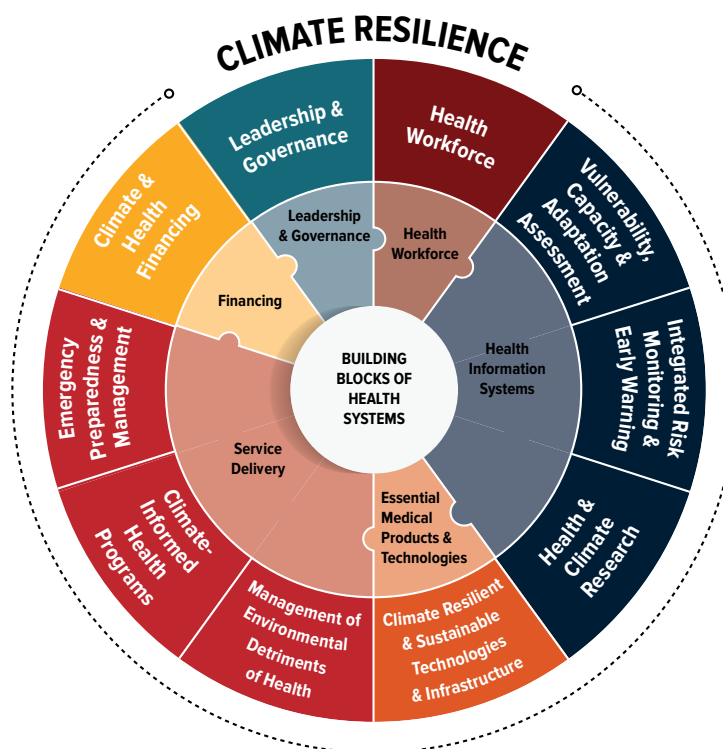


RECOMMENDATIONS

83. This section outlines a set of recommendations to enhance health system resilience and adaptation to climate change, including potential health interventions and strategies that can be put in place. These recommendations are intended to further the implementation of the National Action Plan for the Health Sector to Climate Change (PNASS). They are based on an assessment of both the magnitude of the current and projected climate-related health risks, the existing gaps in the adaptive capacity to manage and/or prevent these risks, and the feasibility of developing them in the short and medium terms.

FIGURE 15.

The WHO operational framework for climate-resilient health systems.



This section is organized by using the WHO framework for climate-resilient health systems (Figure 15) and drawing from the consultations and the review of all relevant governmental policies, as well as the World Bank's Health, Nutrition, and Population (HNP) Climate and Health Guidance Note. Further details on the stakeholders' involvement concerning the recommendations are in **Annex C**. Recommendations for integrating climate and health into the World Bank-financed health operations are in **Annex B**. These recommendations — based on in-country interviews — were reviewed and validated at a workshop held on May 31, 2023. It emphasized the importance of **prioritizing the PNASS and the associated strategies** to facilitate implementation, given the limited available resources.

LEADERSHIP AND GOVERNANCE

- a. **Strengthen intersectoral coordination through the implementation of the One Health platform, including climate-related health risks, with a focus on tracking the progress of the PNASS and the efforts led by different stakeholders.** Notably, programs addressing malnutrition and the high levels of food insecurity in the south could benefit from the improved coordination and monitoring of activities and progress to ensure effectiveness, avoid duplication, and improve collaboration.
- b. **Develop and implement a comprehensive communications strategy to increase the awareness and visibility of the PNASS and its prioritized strategies.** Currently, these documents are not widely known within MoH and other ministries, as well as among stakeholders engaged in climate and health initiatives.

HEALTH FINANCING

- c. **Establish a budget line at MoH for the implementation of the strategies and activities identified in the PNASS and incorporate the objectives of the PNASS into the annual planning of departments throughout the MoH.** A budget line and the integration of the **PNASS** activities into the annual planning would help to ensure that they are completed while decentralizing activities currently covered by the Ministry. This would help with the execution and institutionalization of climate adaptation activities more effectively.
- d. **Use climate and health vulnerability as a criteria for implementing the PNASS and allocating resources.** Specifically, climate vulnerability can be used to prioritize health workers and allocate resources and activities to the locations most vulnerable to climate-related hazards so that efforts targeted at the implementation of adaptation actions for reducing the population's risks could advance.

HEALTH WORKFORCE

- e. **Extend the existing training on climate to all health workers, including those at the community level, as well as subnational-level administrators such as those working at the district and facility levels, along with local authorities such as the chief fokontany.** Additionally, the pre-service training curriculum should be adapted to include climate-related health risks and climate emergency preparedness and response.

HEALTH INFORMATION SYSTEMS

- f. **Prioritize the expansion of the 3-2-1 SMS information system to reach climate-vulnerable areas and populations.** Broadening

the coverage of the system will enable the effective dissemination of climate and health emergency response and preparedness early warning messages to those most susceptible to climate-related hazards and extreme weather events. This includes tailoring the timing and frequency of messages to match the climate-related hazards faced by different populations.

- j. **Develop formal standard operating procedures that focus on preparedness for climate-related hazards.** Preparedness processes should include communication and coordination systems for decision-making, training for healthcare workers and first responders, and the establishment of evacuation plans tailored for different climate exposures.

SERVICE DELIVERY

- g. **Implement a climate adaptation and resilience certification system for the healthcare and WASH infrastructures.** The certification system should include an assessment of facilities against existing climate-resilient infrastructure codes and identify health facility needs, thus facilitating the prioritization of resource allocations and supporting the enforcement of these codes. Such a system may be integrated with existing health facility quality assessments.
- h. **Develop training modules on climate and health risks for PHC personnel.** These modules should be directed to the national, regional, district, and fokontany levels, including commune mayors and other local-level key stakeholders coordinating with primary health facilities (CSBs).
- i. **Formulate detailed contingency plans on the procurement of essential medicines amid extreme weather events, such as storms or floods.** These plans should include pre-positioning protocols in climate-vulnerable communities; clear roles and coordination with fokontany, non-governmental organizations (NGOs), and other key stakeholders; along with the regular testing and updating of contingency plans based on the feedback of previous events.



ANNEXES

ANNEX A. METHODOLOGY

AIMS OF ASSESSMENT AND CONCEPTUAL FRAMEWORK

The objective of this Climate and Health Vulnerability Assessment (CHVA) is to assist decision-makers in planning effective adaptation measures to address climate-related health risks.

Where available, these measures are provided at a subnational level to assist regional health planners. The recommendations of this CHVA are primarily aimed at the health sector and the related sectors dealing with climate change-related health risks, such as disaster risk management.

Adaptation priorities need to run 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 precisely predict the magnitude of how severe climate exposures facing populations will become. Many factors 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, mitigating existing greenhouse gas (GHG) emissions and developing and implementing measures to protect human development from the changing climate are, in addition to adaptation measures, of paramount importance.

Investing 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 in place to deal with these risks, and the provision of recommendations to meet the identified gaps. The primary focus of this

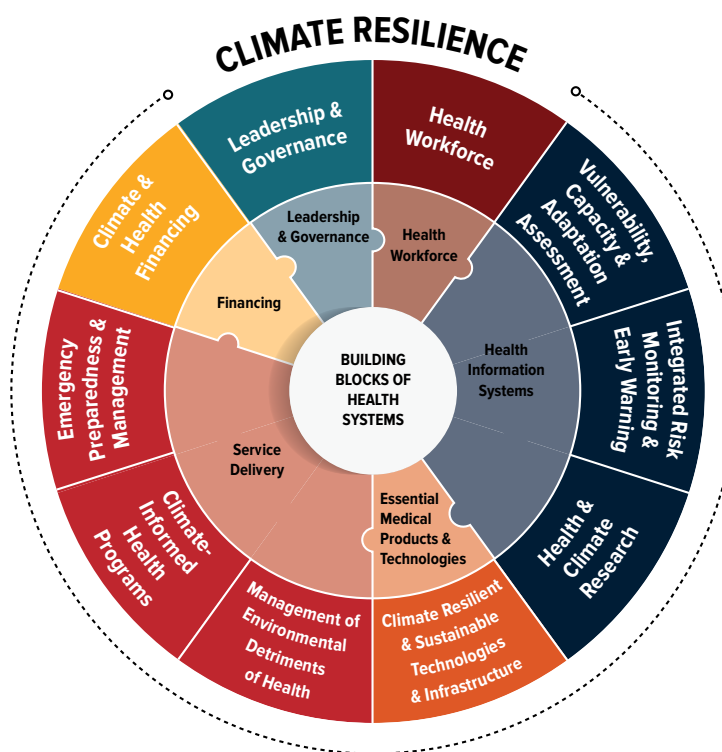
assessment is, therefore, on climate adaptation and resilience measures. However, as the Assessment Report Six (AR6)¹¹¹ of the Intergovernmental Panel on Climate Change (IPCC) makes clear, “Global surface temperature will continue to increase until at least the mid-century under all emissions scenarios considered.” Mitigation is no longer a sufficient strategy, regardless of the pace at 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, it also includes recommendations to reduce GHGs or facilitate the decoupling of emissions from progress toward human development goals.

The report utilizes WHO’s operational framework for building climate-resilient health systems to analyze adaptive capacity for the purpose of adequately addressing current and future identified risks. Following this framework (see Figure 16), the assessment is structured around the six Health System Strengthening (HSS) building blocks. These six categories structure the assessment of capacities and gaps — now and into the future. The framework then considers the 10 components of a health system’s climate resilience to develop the “Recommendations” section.

This assessment follows a step-wise linear approach. The first step characterizes the **climatology** in Madagascar by highlighting the observed and future climate exposures relevant to health. The second step examines **climate-related health risks**, including identifying the vulnerable populations most at risk. The final step assesses the **adaptive capacity of the health system** by identifying gaps in managing current and future

FIGURE 16.

WHO's operational framework for building climate-resilient healthcare systems comprising 10 components and their connections to the building blocks of health systems.



Source: World Health Organization

climate-related health risks. Together, these steps inform a series of **recommendations** to reduce climate-related health vulnerability in Madagascar. The assessment was based on a review of the published literature, national statistics, and an in-country mission to consult with the key counterparts in the government.

CLIMATOLOGY

This section describes observed climatic changes and projected climate trends — prioritizing climate-related hazards in relation to human health risks in Madagascar. Climate information was acquired from the World Bank Group's Climate Change Knowledge Portal (CCKP). Observed climate data was presented in a 50km x 50km

spatial resolution for 1901–2020. Model-based climate projection data was derived from the Coupled Model Inter-Comparison Project Phase 6 (CMIP6), with the projections shown through the five shared socioeconomic pathways (SSPs). This assessment explores the projected climate change under SSP3-7.0 for the short (2030s: 2020–2039) and medium (2050s: 2040–2059) terms. The SSP3-7.0 scenario is a high-GHG emissions scenario in which countries are increasingly competitive and emissions continue to climb, doubling from the current levels by 2100.

CLIMATE-RELATED HEALTH RISKS

This assessment focused on **five climate-related health risk categories**: (1) nutrition, (2) waterborne

disease risks, (3) vector-borne diseases, (4) air quality health risks, and (5) zoonotic diseases. The exclusion criteria for selecting the categories are based on two principles:

1. These risks represent the most pressing health risks to the population in Madagascar as reflected in the Demographic and Health Survey (DHS) and the PNASS, as well as during meetings held with the key stakeholders.
2. Scientific evidence are available for each climate-related health risk category.

Other climate-related health risks have not been included in this assessment, such as but not limited to direct injuries and mortality associated with natural hazard events, heat-related morbidity and mortality, along with mental health and well-being.

ADAPTIVE CAPACITY OF THE HEALTH SYSTEM

The extent to which the health system in Madagascar is prepared for and has the capacity to manage changes in hazards, exposure, and susceptibility will determine their resilience in the coming decades. In this assessment, Madagascar's adaptive capacity¹¹² to prevent and manage climate-related health risks is examined according to the WHO's six health system building blocks, as shown in Figure 16. See also Annex C for the Adaptive Capacity Rapid Assessment and the summarized Adaptive Capacity and Climate Change-Related Health Risks Gap Analysis that informs this section.

It should be noted that several factors outside the scope of the health sector can also drive reductions in Madagascar's adaptive capacity to manage the health risks of climate change in its institutions and people. 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

the 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 more equitably distributed.

ANNEX B. RECOMMENDATIONS FOR WORLD BANK-FINANCED PROJECTS

As part of the CHVA, provisional recommendations for climate actions that can be taken as part of the World Bank-financed Health, Nutrition, and Population (HNP) projects in Madagascar have been developed. They are expected to represent a subset of the overall recommendations in the final CHVA presented to the Government.

The CHVA has identified core gaps and recommendations for strengthening climate adaptation in the country, as outlined above. The current World Bank-financed health projects — primarily the Pandemic Preparedness and Basic Health Services Delivery Project (P174903) and Phase 2 of Improving Nutrition Outcomes Using the Multiphase Programmatic Approach (P175110) — offer opportunities for beginning to address some of the challenges identified in the CHVA. Some climate-related actions have been identified in the project appraisal documents (PADs) and can be enforced through project implementation, while others can be integrated into the project implementation, or through additional financing that is tentatively planned for the Pandemic Preparedness Project.

The areas outlined below are those that both (1) relate to gaps identified in the CHVA and (2) are in the PADs of the World Bank-financed health projects in Madagascar or climate-related areas included by the project implementation unit (PIU) in their work plan. These recommendations, which are complementary to the overall recommendations within the CHVA, identify specific avenues for the implementation of the CHVA recommendations through the World Bank projects.

I. PANDEMIC PREPAREDNESS AND BASIC HEALTH SERVICES DELIVERY PROJECT (P174903)

The Pandemic Preparedness and Basic Health Services Project includes core activities that strengthen surveillance, preparedness, and response to epidemic-prone diseases, inclusive of climate-sensitive diseases. The PAD outlines the core activities for strengthening preparedness and response to climate-sensitive diseases as part of the overall project. The CHVA has identified (1) specific actions to fill gaps through the implementation of the climate activities outlined in the PAD and (2) additional ways whereby gaps identified through the CHVA can be addressed through project implementation.

COMPONENT 1: STRENGTHENING CAPACITIES FOR PANDEMIC PREPAREDNESS AND RESPONSE

Subcomponent 1.2: Improve Cross-sectoral Coordination, Collaboration, and Capacity for Preparedness and Response (USD20.1 million equivalent, International Development Association [IDA])

DECENTRALIZED DISTRICT- AND REGIONAL-LEVEL CLIMATE EMERGENCY PREPAREDNESS AND RESPONSE CAPACITY

This subcomponent currently includes investments to strengthen the emergency response capacity at the local levels, including developing emergency preparedness and response capacities at the district and regional levels. Developing the emergency response capacity for the health aspects of climate events is incorporated within this activity, as outlined in the PAD. Along with the general development of emergency operations centers at the local level, specific areas to strengthen the decentralized capacity for climate emergencies at the district and regional

levels can include addressing needs identified in the CHVA:

- Developing **local-level emergency response plans** for the outbreaks and health aspects of other emergencies. While the CHVA identified that local-level training on developing emergency response plans, it is unclear whether these plans have been developed and whether specific individuals/entities have been assigned the responsibility to ensure that they are developed. The project offers an opportunity to develop these plans at the local level.
- **Budgeting for climate emergency preparedness and response** can be incorporated into decentralized capacity development. The CHVA identified that there is currently a gap in available budgets for emergency preparedness and response at the local levels. Budgets can be aligned with local emergency preparedness and response plans to climate-related hazards.
- **Incorporation of climate preparedness actions into local-level climate emergency preparedness and response** including the preparedness of the following areas for climate shocks — health facilities (both the physical building and the emergency response), water and sanitation systems, and referral systems — should be done. Currently, the renovations of some health centers and water and sanitation systems are included in the project.

SURVEILLANCE COORDINATION

This subcomponent also currently includes cross-sectoral coordination for preparedness and response, which is focused on the development of the One Health platform and the International Health Regulations (IHR) capacity to promote animal, human, and environmental health. The CHVA identified the need for strengthening the

intersectoral coordination for climate emergency preparedness and response and the lack of budgets, as well as clear roles and points of engagement, which have contributed to gaps in intersectoral collaboration. While the coordination components of this subcomponent focus specifically on One Health and surveillance and do not necessarily include the broader aspects of climate emergency and response coordination, there are core activities that the coordination strengthening could include to address the gaps identified in the CHVA:

- **Development of regular platforms (meetings, analytics, etc.) for reviewing and using the surveillance and One Health data** to review surveillance planning and actions, including climate-sensitive diseases and overlaying meteorologic data with surveillance data;
- Development of **multisectoral preparedness and response plans** with specific roles for each sector and responsible party within the sector; and
- **Budgeting / identification of resources** for each sector to carry out their assigned function.

Subcomponent 1.3: Strengthen Human and Animal Disease Surveillance (USD18.0 million equivalent, IDA)

This subcomponent encompasses developing digital data systems linked to the DHIS2 system for the surveillance and notification of epidemic-prone diseases, including climate-sensitive diseases. Based on mission discussions, this work will include the establishment of early warning systems for epidemic-prone diseases — a need identified during the mission. Key considerations for the development of this system to ensure that it provides early warning for climate-related diseases include the following:

- **Multisectoral and decentralized early warning notification:** The early warning system will need to notify agencies across relevant sectors and at all levels from the national to the facility levels. The sectors and levels that need to be notified corresponding to the diseases should be built into the system. Further, these levels will need to be coordinated in their response and there will need to be mechanisms for using the data across the sectors and at different levels. Climate-sensitive diseases will also need to be integrated into the early warning systems.
- **Response coordination and planning:** Multi-sectoral and multi-level response action plans should be put into place, with considerations for different diseases when early warning systems are activated.
- **Data use:** To further the use of early warning systems and plan for future outbreaks, mechanisms for data use at decentralized and national levels should be put in place. Currently, there are climate and health bulletins. Utilizing the analysis generated in these bulletins, and training on data use at the national through district levels that include identified actions and follow-ups on these actions could help ensure the substantive use of these data.

COMPONENT 2: STRENGTHENING THE RESILIENCE AND PERFORMANCE OF BASIC HEALTH SERVICES (USD64.9 MILLION EQUIVALENT – USD32.9 MILLION FROM IDA AND USD32 MILLION FROM GLOBAL FINANCING FACILITY [GFF])¹¹³

Subcomponent 2.2. Strengthen PHC Financing by Increasing the Autonomy and Accountability of CSBs and Providing Financial Protection for the Poorest (USD22.9 million equivalent, including USD12.9 million from IDA and USD10 million from GFF, Portion B)

The CHVA found that there is limited funding for and attention to climate adaptation activities at the local and health facility levels. Several activities could be incorporated within this subcomponent to strengthen climate adaptation at the local and health facility levels:

- **The inclusion of climate vulnerability in the formula for allocating funds to PHC facilities** (CSBs) to increase the amount of funds for climate-vulnerable health facilities will give them more resources to address climate vulnerability needs. Climate vulnerability could be identified using existent climate vulnerability maps, with the level of vulnerability potentially ranked on a scale.
- **The inclusion of climate adaptation actions in community-supported organizations' (CSOs) monitoring** of health facilities and fokontany or communes could help ensure that facilities are taking climate adaptation actions. In cases where they receive additional funds because of their level of climate vulnerability, CSOs can ensure that the funds are directed to climate adaptation activities while maintaining health facility autonomy. CSOs could potentially use climate adaptation criteria from a green health facility scorecard (described below) to monitor health facilities.

- **Incorporating budgeting for climate adaptation in public financial management (PFM) capacity development** will help communes and health facilities ensure that there are funds available for climate adaptation activities.

Subcomponent 2.3. Strengthen Human Resources Management (USD20 million equivalent, IDA)

The CHVA found that the presence of health workers in rural areas, including climate-vulnerable areas, is a challenge undermining the climate adaptation of health facilities. This subcomponent includes the development of a system for improving the distribution, motivation, and rural retention of health workers. To strengthen the number and quality of health workers in climate-vulnerable areas, the suggestions are as follows:

- **Climate vulnerability could be included as a criterion for the placement of health workers.** This would entail more vulnerable areas being prioritized for health workers — potentially increasing the speed at which health workers are sent to these areas and the number of health workers in these areas.
- **Climate vulnerability could also be included in the formula for determining health worker compensation.** Compensation for health workers sent to remote, rural areas should be increased to improve their retention in these areas.
- The project also includes the pre-service training of health workers, including training on climate emergency preparedness and response. This may be expanded to include **health facility climate adaptation** training more broadly and linked with key activities — such as climate emergency response plans, health facility building measures, and water and sanitation measures — to reinforce the execution of these actions at the health facility level.

II. PHASE 2 OF IMPROVING NUTRITION OUTCOMES USING THE MULTIPHASE PROGRAMMATIC APPROACH (MPA2, P175110)

Subcomponent 2.2: Strengthen the Availability and Utilization of Health and Nutrition Data (USD3.6 million)

The use of climate and health data was identified in the CHVA as a gap. The project includes strengthening the availability and use of health and nutrition data and incorporates overlaying meteorologic data with nutrition data. The inclusion of **improved analytics and platforms for climate-related nutrition data use** (such as meetings and analytic outputs), including reviewing data and identifying actions based on data, could help improve the use of climate-related nutrition data.

Subcomponent 2.3: Strengthen Supervision and Management Capacities at Regional, District, and Central Levels (USD10.9 million equivalent)

This subcomponent includes strengthened multi-sectoral planning and budgeting at the regional level. As limited local-level planning and budgeting for climate adaptation activities were identified as gaps in the CHVA, the inclusion of **climate adaptation in work planning and budgeting** could be incorporated within the execution of this subcomponent to strengthen the execution of climate adaptation activities. Food security activities should also incorporate seasonal planning to account for variable climatic conditions throughout the year.

Subcomponent 2.4: Results-based financing (RBF) to improve the quality of service delivery (USD4.4 million equivalent)

This subcomponent includes a climate-related quality indicator to be identified in the PAD. Based



on the CHVA's identification of the implementation of climate adaptation measures at the health facility level as a need, focusing on this **results-based financing (RBF) quality measure on climate adaptation** could strengthen climate adaptation at health facilities. Options include the existence of climate emergency preparedness and response plans, climate adaptation

measures in health facility buildings, and water and sanitation measures. The RBF quality measure could be aligned with or selected from adaptation measures in the green health facility scorecard, as described below. Facilities could integrate climate adaptation measures into their structural strengthening plans, using their performance-based bonuses as a financing source.

ANNEX C. KEY RECOMMENDATIONS AND RELEVANT LINE MINISTRIES IN MADAGASCAR

RECOMMENDATIONS	RELEVANT LINE MINISTRIES	WHO'S CLIMATE AND HEALTH OPERATIONAL BUILDING BLOCK
Strengthen intersectoral coordination through the implementation of the One Health platform, which includes climate-related health risks, with a focus on tracking the progress of the National Adaptation Action Plan for the Health Sector to Climate Change (PNASS) and the efforts led by different stakeholders	Ministry of Health (MoH); National Bureau of Climate Change Coordination (NBCC); Development Partners (World Health Organization [WHO], World Bank, United Nations Children's Fund [UNICEF], and German Cooperation Office [GIZ])	Leadership and Governance
Develop and implement a comprehensive communications strategy to increase the awareness and visibility of the PNASS and its prioritized strategies	MoH; NBCC	
Establish a budget line at MoH for the implementation of the strategies and activities identified in the PNASS and incorporate its objectives into the annual planning of departments throughout the MoH	MoH; Ministry of Finance	Climate and Health Financing
Use climate and health vulnerability as criteria for implementing the PNASS and allocating resources	MoH; NBCC; Department of Meteorological Services	
Extend the existing training on climate to all health workers, including at the community level, as well as subnational-level administrators at the district and facility levels, along with local authorities like the chief fokontany	MoH; Regional, District and Fokontany focal points	Health Workforce
Prioritize the expansion of the 3-2-1 SMS information system to reach climate-vulnerable areas and populations	MoH; Department of Meteorological Services; Viamo; Air-Tel	Health Information Systems

Implement a climate adaptation and resilience certification system for health care and the water sanitation and hygiene (WASH) infrastructure	MoH; Department of Meteorological Services; Viamo; Air-Tel	Health Service Delivery
Develop training modules on climate and health risks for primary health care (PHC) personnel	MoH; Directorate of Primary Health Care	
Formulate detailed contingency plans for the procurement of essential medicines amid extreme weather events, such as storms or floods	MoH; SALAMA; Department of Meteorological Services; NBCC	
Develop formal standard operating procedures that focus on preparedness for climate-related hazards	MoH; NBCC; Regional, District, and Fokuntany focal points	

ANNEX D: BACK-TO-OFFICE REPORT — MADAGASCAR'S CLIMATE AND HEALTH VULNERABILITY ASSESSMENT (CHVA) WORKSHOP

A workshop — held on May 30, 2023 — reviewed and validated the results of the Climate and Health Vulnerability Assessment (CHVA), with a focus on the CHVA recommendations. The workshop had broad participation.

The main workshop was structured into three different sessions: (1) climate and climate-related health risks; (2) adaptive capacity; and (3) recommendations. In addition, a session on the recommendations for the World Bank projects was held with the project implementation unit (PIU) of the Ministry of Health (MoH).

Workshop discussions focused on the recommendations and highlighted the following:

1. The results of the CHVA's assessment of adaptive capacity and recommendations were based on in-country interviews with a sample that was largely representative of the workshop participants.
2. The intent of the recommendations is to further the implementation of the National Health Adaptation Plan to Climate Change (PNASS), not to duplicate it.
3. The recommendations are based on the current level of adaptive capacity in the country and do not touch on all areas of climate risks.
4. In addition to the 2018 PNASS, there is a 2021 Climate and Health Strategy that will be reviewed and incorporated into the CHVA. These points will be further articulated and incorporated into the CHVA.

OVERALL CHVA RECOMMENDATIONS

The workshop discussed four main adjustments to strengthen the CHVA recommendations, which will be incorporated into the document:

1. The **training recommendations** should be adjusted to reflect (a) the existence of a training manual on climate and health for health workers; (b) the need to extend this training to subnational-level administrators and ensure that all health workers are trained in service in the curriculum; and (c) the need to adapt the training curriculum to be incorporated into the pre-service training of health workers.
2. **Strengthened intersectoral coordination** is also emphasized in the recommendation concerning the monitoring of different actors engaged in climate and health. Specifically, this recommendation should indicate the use of the One Health platform as the coordination platform for climate and health. The emphasis should be placed on (a) tracking the implementation of the PNASS and the associated strategy; (b) using data to assess the progress on the PNASS; and (c) instituting mechanisms to ensure the substantive participation of all actors in climate and health.
3. There is a need to **develop and implement a communications strategy** to increase the awareness and visibility of the PNASS and the associated strategy. The existence of the documents is not widely known — at MoH as well as other ministries and stakeholders engaged in climate and health.
4. The **recommendations on the 3-2-1 information system** should be adjusted to (a) ensure that the messages currently propose specific actions for the population based on the climate and health information; and (b) prioritize the expansion of the currently inadequate reach

of the messages, particularly to climate-vulnerable populations.

In addition to these adjustments, the workshop emphasized the importance of **prioritizing the PNASS and the associated strategy to facilitate implementation, given the limited available resources**. The existing recommendation to prioritize the PNASS based on climate vulnerability and risks will be positioned as a central recommendation and extended to its strategy.

Further, the workshop reviewed four recommendations in detail and developed specific actions to implement them, assessing what should be done to achieve the recommendations, who should be responsible for the actions, and when the actions should be completed.

RECOMMENDATIONS FOR THE WORLD BANK'S PROJECTS

On May 31, a discussion was held with the MoH's PIU on options for incorporating the recommendations from the CHVA in the World Bank-financed projects. The following aspects were accepted as options for incorporating the CHVA recommendations.

Pandemic Preparedness and Basic Health Service Delivery Project (PPSB)

- 1. Coordination of climate change and health** will be supported through the One Health platform at the national level and coordinated at the subnational levels, including support for the multi-sectoral climate and health response plans.
- 2. Early warning systems for climate emergencies and climate-sensitive disease outbreaks** will be incorporated into the overall support for early warning systems.
- 3. Operational support for climate change emergency preparedness and response, including climate emergency response planning**, will be supported through assistance provided to the emergency response committees (COUSP) at the regional and district levels.
- 4. Support for pre-positioning pharmaceuticals for climate-sensitive diseases and during climate shocks** will be given through the overall support for pre-positioning medications for and during emergencies.
- 5. Public financial management (PFM) capacity building for budgeting and budget advocacy for climate adaptation and emergency preparedness and response** will be provided to the regional and district levels as part of the overall PFM capacity building.
 - i. It was discussed that **climate vulnerability could be explored as a criterion in the formulas for the following**. However, two aspects are still being considered: (a) first, whether climate-vulnerable areas differ from areas meeting the existing criteria of being poor and / or remote should be explored; and (b) second, the incorporation of climate vulnerability into the criteria may come at a later stage since decrees for these formulas are close to being finalized and released. Those decrees include: (a) Distribution of funds to the basic health centers at commune level (CSBs); (b) Deployment of health workers to locations; and (c) Health worker retention packages.
- 6. Climate emergency preparedness and response training** will be incorporated into the support of the overall HR training.
- 7. The PNASS and strategy will be launched** as part of the launch of the Pandemic Preparedness Plan to support advocacy for the documents.

PHASE 2 OF THE MULTIPHASE APPROACH (MPA2) FOR NUTRITION

1. A **dashboard for the continual overlay of the climate and health data** will be developed. (Climate and nutrition data are currently being analyzed periodically in the analytics produced by the Nutrition Cluster Technical Group.)
2. Climate adaptation needs will be incorporated into work planning and budgeting as well as the seasonal planning of activities, with the caveat that the project will not be able to finance the implementation of all these needs.
3. **Climate emergency preparedness and response measures will be incorporated into results-based financing (RBF) measures**, and climate adaptation / emergency preparedness and response activities **may also be used as criteria for using a portion of the funds.**



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