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Briefing Note

CLIMATE CHANGE AND HEALTH IN MOZAMBIQUE:

IMPACTS ON DIARRHEAL DISEASE AND MALARIA

June 2017
This document was produced for review by the United States Agency for International Development. It was prepared by Chemonics for the ATLAS Task Order.

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ATLAS reports and other products are available on the ClimateLinks website:
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Cover Photo: Direct Relief, March 2016. Three boys test a new bed net provided through a partnership of the NGO Malaria Consortium and the Government of Mozambique.

BRIEFING NOTE

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June 2017

Prepared for:

United States Agency for International Development

Climate Change Adaptation, Thought Leadership and Assessments (ATLAS)

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BRIEFING NOTE

INTRODUCTION

The purpose of this briefing note is to summarize for policy makers the results of the scientific study, Climate Change and Health in Mozambique. This study was financed by the United States Agency for International Development's (USAID) Africa Bureau under the Adaptation Thought Leadership and Assessments Project (ATLAS). It was conducted in close collaboration with Mozambique's National Institutes of Health, with input from a team of leading experts in the fields of health and climate change: Dr. Kris Ebi, Dr. James Colborn, and the Climate Systems Analysis Group at the University of Cape Town. This summary is purposefully written with a minimum of technical terminology to provide actionable information to decision makers. The full study examines in detail the associations between climate-sensitive health outcomes (specifically diarrheal disease and malaria) and weather and climate, and projects how risks could change under a changing climate. The work contributes a Mozambique-specific lens to the growing knowledge base exploring the causal links between climate and health in sub-Saharan Africa, summarized from the 2014 Intergovernmental Panel's Climate Change's (IPCC) Fifth Assessment Report[1] below:

- Climate change may increase the burden of a range of climate-relevant health outcomes (medium confidence).
- Climate change is a multiplier of existing health vulnerabilities (high confidence), including insufficient access to safe water and improved sanitation, food insecurity, and limited access to health care and education.
- Detection and attribution of trends is difficult because of the complexity of disease transmission, with many drivers other than weather and climate, and short and often incomplete data sets.
- Evidence is growing that highland areas, especially in East Africa, could experience increased malaria epidemics due to climate change (medium evidence, very high agreement).
- The strong seasonality of meningococcal meningitis and associations with weather and climate variability suggest the disease burden could be negatively affected by climate change (medium evidence, high agreement).
- Climate change is projected to increase the burden of malnutrition (medium confidence), with the highest toll expected in children.

[1] The IPCC uses specific language to describe certainty in key findings. The degree of certainty in each key finding of the assessment is based on the type, amount, quality, and consistency of evidence (e.g. data, mechanistic understanding, theory, models, expert judgment) and the degree of agreement. The summary terms to describe evidence are: limited, medium, or robust; and agreement: low, medium, or high. Confidence in the validity of a finding synthesizes the evaluation of evidence and agreement. Levels of confidence include five qualifiers: very low, low, medium, high, and very high.

The linkages between climate change and health are often complex and indirect, making attribution of climate change effects on health outcomes challenging. Climate change is a stress multiplier for health, putting pressure on vulnerable systems, populations, and regions, and exacerbating existing health issues. For example, higher than average temperatures are associated with the incidence of some food- and waterborne diarrheal diseases that drive high rates of childhood mortality. Rising temperatures and more extreme temperatures can also change the range, seasonality, and incidence of diseases like malaria. As temperatures increase beyond the typically normal averages, as noted in the following analyses, these diseases are likely to become more prevalent if action is not taken.

> ***"Climate change represents an inevitable, massive threat to global health that will likely eclipse the major known pandemics as the leading cause of death and disease in the 21st century. The health of the world population must be elevated in this discussion from an afterthought to a central theme around which decision-makers construct rational, well informed action-oriented climate change strategies.***
>
> ***— DANA HANSON, PRESIDENT, WORLD MEDICAL ASSOCIATION***

As with many countries in Africa, the scientific knowledge describing the health risks of climate variability and change is lacking in Mozambique. The Mozambican National Communication to the United Nations Framework Convention on Climate Change (UNFCCC) and the National Adaptation Program of Action (NAPA) recognize that climate change will bring about health impacts but do not elaborate on their nature and distribution. Similarly, the National Institute of Disaster Management (INGC) published a report in 2009 investigating the effects of climate change on disaster risk in the country. The report highlighted a growing risk but did not elaborate on the specific risks throughout the country. Although current associations between weather variables and a range of adverse health outcomes are generally understood – mostly derived from studies conducted in other countries – improved knowledge of current and projected risks in the different regions of Mozambique is needed to formulate evidence-based policies and programs. At the same time, there is an increasing call for health policy to be informed by research findings.

OBJECTIVE OF STUDY

The principal objective of this work is to build the scientific knowledge base that will support informed investments in the health sector and improve strategic planning mechanisms to integrate climate considerations into health-sensitive programs in Mozambique. The findings will help to shape the Ministry of Health's preparedness and response to emerging climate risks by working in concert with Mozambique's new national climate and health observatory, which combines climate and weather data to predict disease outbreaks, raise awareness of climate and weather impacts on health, and encourage government and public discourse on climate-sensitive health issues.

The focus of this work is statistical evaluation of the relationship between climate and climate-sensitive disease outbreaks. A preliminary evaluation of the relative coverage and completeness of data on the climate-sensitive diseases tracked by the *Boletins Epidemiológicos Semanais* (see box to right) found that data on diarrheal disease and malaria offered sufficiently consistent national coverage and reporting rates to support the analysis. Furthermore, these are two of the most prevalent and devastating diseases in Mozambique, making it key to understand how climate change impacts their occurrence.

THE MINISTRY OF HEALTH'S WEEKLY EPIDEMIOLOGICAL BULLETIN

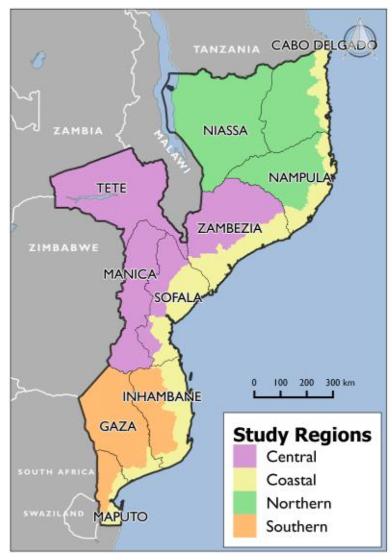
The BES (Boletins Epidemiológicos Semanais) tracks incidence information on priority diseases such as malaria, measles, meningitis, diarrhea, dysentery, cholera, poliomyelitis, rabies, plague, and neonatal tetanus. Collation of health information begins at the service/facility level and information is aggregated to the district level on a weekly basis, offering the opportunity to analyze disease incidence at a weekly scale.

GEOGRAPHIC SCOPE OF STUDY

To account for Mozambique's large expanse and varied ecosystems, the statistical analyses of both climate and diseases were conducted at the national and regional scale. The four regions, depicted in Figure 1, include:

- **Northern** – Niassa Province and non-Coastal districts of Nampula and Cabo Delgado Provinces
- **Center** – Tete and Manhiça Provinces, and non-Coastal districts of Zambezia and Sofala Provinces
- **Southern** – Non-Coastal districts of Inhambane, Gaza and Maputo Provinces
- **Coastal** – Coastal districts of Cabo Delgado, Nampula, Zambezia, Sofala, Inhambane, Gaza and Maputo Provinces

Figure 1. Map of study regions



HISTORICAL AND FUTURE CLIMATE CHANGE IN MOZAMBIQUE

An understanding of the historical climate in Mozambique provides a baseline to correlate climate with health risks and offers evidence about the impacts of future climate change on health. The baseline analysis evaluated historical trends in temperature from 1961–2010 as well as the climatological differences between the periods 1981–1999 (earlier period) and 2000–2014 (later period). Projected future climate change was estimated using a set of models that account for various factors to determine likely climate scenarios for 2045–2065. Available climate models include those derived from Global Climate Models (GCMs), downscaling, and Regional Climate Models (RCMs). Table 1 summarizes the findings for both historical climate trends and future climate projections.

Table 1: Climate trends and projections

Parameter	Observed climate trends	Projected future climate change
Temperature 	A clear and statistically significant increase in mean temperatures of 1.5°–2°C occurred across the country from 1961–2010.	• Temperatures will continue to rise by approximately 1ºC in the next 20 years and between 3ºC and 5ºC by the end of the 21st century. • An increase in the number of days exceeding 35ºC and a decrease in the number of nights below 25ºC will occur. • The difference between the daily maximum temperatures and daily minimum temperatures, called the diurnal temperature range, will also increase.
Rainfall 	Although differences in rainfall are less clear due to the large interannual variability in the rainfall records, the data do suggest that: • The rainy season in the Northern and to a lesser extent the Central region is currently experiencing delayed start and earlier end. • Zambezia Province and the Coastal parts of Nampula Province received lower average precipitation in the more recent period as compared to the earlier period. • Most of the rest of the country experienced very marginally higher average precipitation.	Rainfall will continue to vary. While no statistically significant rainfall changes are projected, the current delayed start and earlier end to the rainy season in the Northern Region will likely continue and the intensity of single rainfall events is likely to increase.
Dry Periods 	• More consecutive dry days occurred in the more recent period compared to the earlier period across Zambezia and Sofala Provinces. • In some areas of Zambezia Province, this difference was as high as 60 days.	

THE LINK BETWEEN DIARRHEAL DISEASE AND CLIMATE

Diarrheal diseases are a group of climate-sensitive health outcomes of significant concern in Mozambique, with over 7 million cases reported between 1997–2014. In 2015, diarrheal disease was the fifth leading cause of death, and the fourth leading cause of death and disability combined.

The causal pathways between weather/climate and diarrheal disease are complex: climate can impact transmission through heavy rains and rising temperatures, as well as floods that pollute waters with fecal matter. Although diarrheal diseases are a leading cause of morbidity and mortality in Africa, the quality of evidence on linking climate and diarrheal diseases in Sub-Saharan Africa is considered very low.

The burden of diarrheal disease varies regionally within Mozambique:

- The Northern and Central regions exhibit strong seasonality of disease outbreaks. Disease burden is about 15 to 20 cases per 100 people per week.
    - — In the Northern region, diarrheal disease peaks during late February–March, around the fourth week of the rainy season.
    - — In the Central region, diarrheal disease peaks in late March–April, around the eighth week of the rainy season.
- The Coastal region has one pronounced disease peak in late February/early March and a less prominent, if any, peak later in the year. Disease burden is about 15 to 20 cases per 100 people per week.
- The Southern region has the least seasonality of disease outbreaks. A slight peak occurs around March but less variability arises throughout the year, and no pronounced periods without disease exist. Disease burden is about 32 cases per 100 people per week. The population in the south may be particularly sensitive to diarrheal disease because rainfall in that region exhibits less seasonality.

Regardless of this variation, the number of cases peaks toward the middle to late part of the rainy season in all regions and incidence is lowest in the middle of the year, corresponding with the cool, dry, winter months of June, July and August, when the monthly mean temperature often drops below 20°C and little rain falls.

HISTORICAL CLIMATE AND DIARREAL DISEASE ASSOCIATIONS

The selection of climate variables examined in relation to diarrheal disease incidence was based on a combination of previous literature and scientific understanding of causal pathways of diarrheal disease. Diarrheal incidence was related with temperature by correlating incidence with the hottest day of the week. Incidence was also correlated with rainfall using the number of wet (rainy) days as a measure.

High temperatures and the number of wet days in a week increase outbreaks of diarrheal disease in Mozambique, with significant associations in all regions for both temperature and precipitation. A statistically significant four-week lag exists between rainfall and outbreaks, while outbreaks increase almost immediately after high temperatures. These findings are summarized below.

At the national scale:

- Each additional 1ºC increase in the hottest day of the week increased diarrheal disease counts by 1.13 percent that week.
- For every additional day where rainfall was at least 1 mm (wet day) per week, an estimated 1.04 percent increase in diarrheal disease arose per week, four weeks later.

At the regional scale:

- **Northern, Central and South regions:** For every additional day where rainfall was at least 1 mm (wet day) per week, diarrheal disease increased 1.86 percent, 1.37 percent and 2.09 percent in the Northern, Central and Southern regions, respectively.
- **Coastal region:** Patterns in this region appeared to be the least affected by precipitation; an additional day where rainfall was at least 1 mm (wet day) resulted in a 0.63 percent increase, four weeks later.
- **All regions** exhibited a statistically significant increase in diarrheal disease for each 1°C increase in the maximum temperature. These increases are measured by Incidence Rate Ratios (IRRs).[2] While the Coastal region's diarrheal disease burden had the smallest association with an additional wet day, it was the most sensitive to an increase in the maximum temperature.
- **Coastal region:** For every additional 1ºC increase per week in the maximum temperature, diarrheal disease counts increased by nearly 6 percent in this region.

The regional results are summarized in Figure 2, which demonstrates the relationship between rainfall and maximum temperature on diarrheal disease incidence by region.

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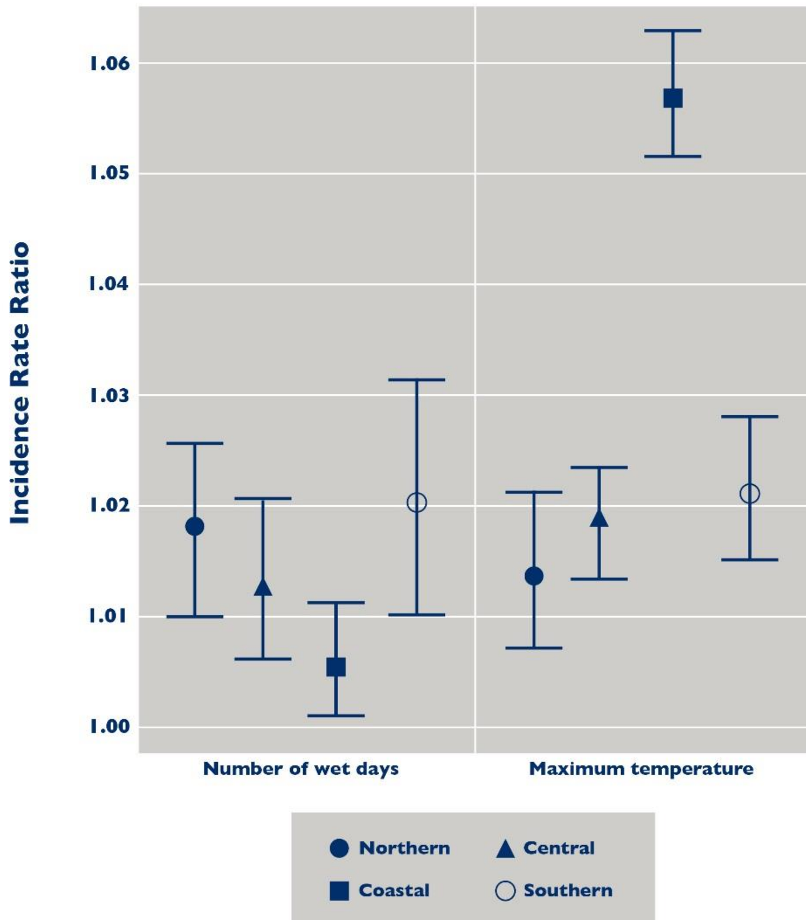
[2] The ratio of the incidence of diarrheal disease with a one-unit increase in the climate variable compared with the baseline within the time period analyzed). IRR values were 1.45, 1.87 and 2.15 in the Northern, Central and Southern regions, respectively.

Figure 2. Regional relationship between Incidence Rate Ratios and two climate variables



Note: This figure shows the regional relationship between Incidence Rate Ratios (ratio of the incidence of diarrheal disease with a one-unit increase in the climate variable compared with the baseline within the time period analyzed) and the two climate variables most significantly correlated with diarrheal disease: days with rain (number of wet days within a given week with a four-week time lag) and maximum temperature for the same week. The positive relationship shown here suggests that as the number of rain days and maximum temperatures increase, disease incidence rates increase.

DIARRHEAL DISEASE UNDER A CHANGING CLIMATE

Future risk from diarrheal disease was evaluated for the period 2046–2065, using the mean values for the worst-case (Representative Concentration Pathway (RCP) 8.5 emissions scenario)[3] climate scenario for rainfall and the mean value for temperature from 11 GCMs used in the Intergovernmental Panel on Climate Change's (IPCC) Fifth Assessment Report. Taking into consideration each climate parameter known to be significantly correlated with diarrheal disease incidence, annual minimum temperatures are projected to increase on average 2.39,

[3] RCPs are used in the IPCC's Fifth Assessment Report to represent a set of mitigation scenarios with targets defined in terms of radiative forcing (cumulative measure of human emissions of greenhouse gases from all sources expressed in Watts per square meter) of the atmosphere by 2100. The four RCPs include one mitigation scenario leading to a very low forcing level (RCP2.6), two stabilization scenarios (RCP4.5 and RCP6) and one scenario with very high greenhouse gas emissions (RCP8.5).

1.94º, 2.17º and 2.09ºC, respectively, across the Northern, Central, Coastal and Southern regions. Thus the burden of disease in the future is projected to increase as shown in Table 2:

Table 2: Projected increases in the burden of disease (2045–2065)

		Northern Region	Central Region	Coastal Region
	As minimum **temperatures** rise, diarrheal disease incidence is expected to increase slightly.	3.27% per week	2.37% per week	1.84% per week
	A slight increase in diarrheal disease incidence is expected with the increase in the number of days with **rainfall** of at least 1 mm (wet days). These numbers, while fairly small, are statistically significant and represent a burden on already strained health systems, which will have to treat these additional cases.	0.91% per week	0.42% per week	0.29% per week

"The importance of investing more in existing solutions is enhanced by the fact that diarrhea currently does not receive significant funding in Mozambique, as malaria, HIV, and TB currently are considered the top health priorities in the country. The expected increase in diarrheal incidence resulting from future climate change, coupled with the current increasing incidence and population trends in the country, make this even more of a priority."

— EDUARDO SAMOGUDO, DIRECTOR, MOZAMBIQUE NATIONAL INSTITUTES OF HEALTH

THE LINK BETWEEN MALARIA AND CLIMATE

As a result of the expected changes in climate over the next several decades, the malaria profile in Mozambique is expected to change. Preparation for these changes requires knowledge about the changes expected in disease incidence due to a changing climate.

The relationship between malaria transmission and climate is complex: climate can impact the transmission of malaria by affecting the lifecycle of the parasite, the mosquito, the human host or any combination of the three. Predicting how changes in precipitation or temperature might affect transmission geographically requires detailed knowledge about all other factors involved in transmission, including number of breeding sites, vector species distribution, infection rates and more, many of which are difficult if not impossible to measure.

Different timeframes were analyzed for malaria incidence countrywide, including periods from 2010–2012 and 2013–2014. Malaria cases remained steady between 2010 and 2012, then rapidly increased between 2013 and 2014. The aim of this analysis was to uncover why malaria incidence rose between 2013 and 2014 compared to the earlier years. Incidence data were compared to several statistics across the historical climate record between 1979–2014. Rainfall measurements that help predict malaria outbreaks included the count of rain days per week, rain days greater than 50 mm per week and mean rainfall per rain day.

HISTORICAL CLIMATE AND MALARIA ASSOCIATIONS

Key findings for the malaria analysis presented in this document are highlighted below. It should be noted that even considering vector control interventions, climate remained a significant predictor of incidence (Figure 3):

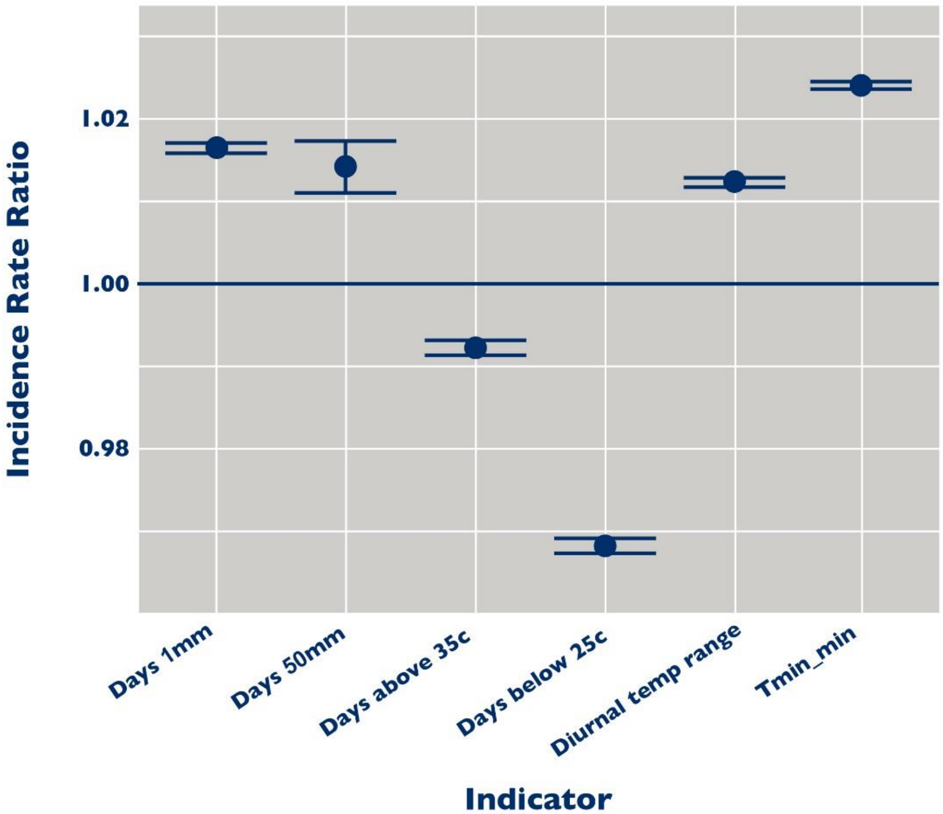
- Days with at least 50 mm precipitation had the strongest association with incidence: an increase of one day with at least 50 mm precipitation during any given week led to an 11 percent decrease in malaria incidence four weeks later.
- Days above 35ºC and below 25ºC had relatively strong relationships with the incidence of malaria. A one-day increase in number of days above 35ºC during any given week led to a 6 percent decrease in malaria incidence two weeks later, while a one-day increase in number of days below 25ºC during any given week led to a 7 percent decrease in malaria incidence two weeks later.
- For each 1ºC increase in the weekly average minimum temperature, a 2 percent increase in malaria incidence was expected four weeks later.
- Important differences in incidence exist between the periods analyzed, specifically 2010–2012 and 2013–2014:
    - From 2010 through 2012, a one-day increase in days with at least 50 mm precipitation in a week led to a 7 percent increase in malaria incidence four weeks later.
    - In comparison, from 2013 to 2014, number of days above 50 mm precipitation was negatively associated with malaria incidence: a one-day increase in days with at least 50 mm precipitation in a week led to a 2 percent decrease in malaria incidence four weeks later.

MALARIA RISKS UNDER A CHANGING CLIMATE

Climate impacts are strongly associated with malaria incidence and are expected to affect the future malaria profile of the country.

- As temperatures continue to rise, and given the strong statistical link between the increased number of days above 25ºC, **malaria incidence is expected to increase in previously unsuitable regions such those in the higher elevation regions of northern Tete and western Niassa Provinces near the border with Malawi.** Malaria risks are likely to remain consistent across the rest of the country.
- Since no strongly significant rainfall changes are projected for the next 20 years, precipitation variability will continue to contribute to malaria incidence through this time period, which will translate into continued malaria risks.
- The increased variability in precipitation, as well as the complicated relationship between malaria and temperature, means that **malaria transmission will likely be more variable and unpredictable in the future**.

Figure 3. Relationship between incidence rate ratios and six climate variables



Note: Relationship between incidence rate ratios (a ratio of the incidence of malaria with a one-unit increase in the climate variable compared with the baseline) and the six climate variables most significantly correlated with malaria at the weekly timescale: days 1mm – the number of days receiving at least 1 mm of rain; days 50mm – the number of days within a week when at least 50 mm of rain was received; days above 35°C – the number of days during a given week when temperatures exceeded 35°C; days below 25°C – the number of days during a given week when temperatures fell below 25°C; diurnal temp range – the difference between the daily maximum temperatures and daily minimum temperatures; and T-min – the lowest minimum temperature of the coldest night during the week. Incidence rates above 1.0 suggest a positive correlation between malaria and the variable. For example, as the number of days with rain (number of wet days) and days with at least 50 mm of rain increase, malaria incidence rates increase. The same is true for diurnal temperature range and minimum temperatures. Rates below 1.0 suggest a negative relationship between malaria and the indicator. For example, incidence decreases as the number of days above 35°C increases (i.e., as hotter temperatures occur); and incidence is reduced as the number of days below 25°C increases (as minimum temperatures increase).

RESPONDING TO THE RISKS

As climate change increases temperatures and alters the hydrological cycle, the burden of diarrheal disease and malaria risk in Mozambique is expected to increase without additional health system interventions. The projected additional cases of diarrheal disease and potential increase in malaria risks in higher elevation areas are potentially preventable using seasonal weather forecasts and targeted responses. For example, creating an early warning and response system that enables advance warning of when temperatures are expected to be higher or when weeks are expected to be wetter than normal would provide valuable time for decision makers to put interventions in place. Developing and deploying such an early warning system would increase population resilience to outbreaks of disease over coming decades.

Examples of specific interventions include:

- Diarrheal disease – modify supply chain flows to guarantee timely delivery of critical oral rehydration stocks to local health care centers; and increase education on appropriate use and handling of water (such as boiling drinking water) and sanitation practices that can reduce transmission of diarrheal pathogens.
- Malaria – improve disease surveillance throughout the entire country; implement a system to detect unexpected rises in cases; and build awareness of the population and health workers in areas prone to outbreaks and where transmission is expected to be more variable due to climate change.

THE IMPORTANCE OF CONTINUED INVESTMENT IN MALARIA

Malaria risk is expected to increase throughout the country as a result of climate change, though the complicated relationship between climate and malaria makes it difficult to predict exactly how significant and where those changes will be. The expected increase in climate variability will also result in more variability and unpredictability in malaria transmission. This has the potential to affect the acquisition of disease immunity, resulting in outbreaks with more severe disease and more deaths. There is, therefore, an impetus to ensure that surveillance systems are in place to forecast the likelihood of outbreaks before they occur, if possible, and to respond to them before they become widespread. In a larger context, climate variability reaffirms the need to continue to invest in elimination and control efforts in Mozambique, because these will likely become more challenging due to the expected changes in climate.

NATIONAL RESPONSE TO DATE

Mozambique's climate change action is guided by the country's "National Climate Change Adaptation and Mitigation Strategy" (ENAMMC) and the "Action Plan for Poverty Reduction" (PARPA). These documents outline strategic priorities and specifically mention health risks and the importance of early warning, as well as strengthening the capacity to prevent and control the spread of vector-borne diseases. Tackling the challenges of understanding and responding to climate risks in the health sector means working across disciplines and organizations. Collaboration between government ministries that track key population vulnerability indicators, health, weather and other environmental variables is essential. Furthermore, these ministries need to continue to build partnerships with organizations outside the Government of Mozambique that work on health and climate issues.

This close collaboration is at the heart of Mozambique's climate and health observatory, established under the auspices of the National Institutes of Health in 2016 with the goal of providing information to aid decision making around health issues. To do this, the observatory assembles, analyzes, reviews and synthesizes all available data (e.g., meteorological, demographic, nutritional and health) for the country. The observatory is Mozambique's first community of practice for health professionals and reflects the importance of cross-agency and cross-departmental work and the need for evidence-based policy and decision making. By working together with other agencies, it takes advantage of existing academic and state-based public health investments.

RECOMMENDATIONS FOR ACTION

Reducing health risks will require modifying current policies and programs and implementing new ones to explicitly consider climate variability and climate change. Adaptation actions should focus on building more resilient health systems, reducing overall vulnerability, and developing specific system capacities by investing in several entry points, including:

1) Information systems
2) Leadership and governance foundations
3) Risk management.

Specific actions that align with Mozambique's 2014–2019 Health Sector Strategic Plan, which prioritizes primary health care, equity, and better quality of services, are detailed below.

1. Information Systems

Support research. Mozambique will be better prepared to aid its citizens through improved understanding of past trends and future projections in climate and their relationship to health outcomes. The analysis presented here is one of a handful of studies available on the relationship between weather, climate variability and climate change, and disease incidence for Mozambique. More research is needed to understand the climate–disease relationship and identify practices that will more effectively manage risk as climate continues to change. Building on the results of this study, for example, a statistical evaluation of the relationship between El Niño Southern Oscillation (ENSO) events and disease outbreak could help to define thresholds of risk based on changing sea surface temperatures, informing the design of early warning systems, particularly in the southern region. Additionally, exploring the associations between weather and vector-borne diseases such as dengue could offer insights on improved diagnosis and response, particularly in the coastal region.

Improve epidemic detection and response. Exploring technological options for improving health data collection, such as SMS-based forms sent directly by health post workers, could facilitate the timely flow of information and responses. Such systems could improve early warning specifically by detecting changes in disease incidence more quickly and in time for people to respond more promptly to an emerging outbreak. This information would be particularly useful in regions where malaria is currently not present, such those in the higher elevation regions of northern Tete and western Niassa Provinces near the border with Malawi.

Deploy early warning systems. Having advance (early) warning that temperatures are expected to be higher or that a week is expected to be wetter than normal — and therefore that an increase in incidence rates is likely — would provide valuable time to put interventions in place. Information on sea surface temperatures indicative of ENSO events, available four to six months in advance, could offer a window of opportunity for response efforts, particularly in areas where research indicates a strong association between events and disease outbreaks.

Build awareness. Communicate to the public and policy makers the risks posed by climate variability and climate change, as well as options for disease control, prevention, and treatment.

2. Leadership and Governance Foundations

Enhance cross-sectoral governance and collaboration. Negotiate sharing agreements that could contribute to improved epidemic detection systems and ultimately support the development of early warning systems. Disease surveillance systems could benefit from being coupled with climate and weather information to build the evidence base on the links between disease and climate, information that is an essential precursor to the establishment of early warning systems.

Develop capacity within the health system. Mozambique's doctor–patient ratio is among the lowest in the world, and climate variability and climate change may increase local demand for services. The country already faces chronic shortages of skilled staff and low productivity stemming from poor working conditions. Health workers work long hours serving patients and may also be required to conduct additional support activities beyond administering care. Systems for tracking, motivating, and retaining staff are weak. While health service workers may recognize the links between climate extremes such as droughts and floods and health sector impacts, they often have limited access to relevant climate information to modify their treatment and diagnosis plans in response to these changes. Important areas of investment in capacity development include:

- Training professional staff on the health risks posed by weather, climate variability, and climate change.
- Training professional staff to differentially diagnose diseases based on early warning signs of health risks (using climate information).
- Building capacity to incorporate climate information into decision making. Beyond the development of the country's health information system, the ability to use data for decision making is extremely weak. The health information system and its subsystems do not produce comprehensive, timely, or quality data for policy makers. During decision making, reforms and improvements should consider the use of weather and climate information and decentralization of health service delivery.

3. Risk Management

*Advance integrated risk monitoring***.** Well-functioning surveillance systems are crucial for effective disease control programs. The country's health information system tracks weekly and monthly reports of disease incidence, but faces recording challenges that result in important health information gaps, including improper diagnoses, as well as reporting inconsistencies. Additionally, the fact that these systems initially collect data using paper-based methods and do not report in real time means that delays across the information chain at the national level, including analysis and feedback, can limit monitoring and response options.

Promote climate-smart health programming. Ensure that the information available on climate and disease impacts is used in the planning of resources and supply chain management.

Strengthen public health services and facilities. Health care facilities are faced with many challenges. Most operate off-grid and require alternate fuel supplies to support lighting, refrigeration, and sterilization, including the collection of medical commodities from district depots if supplies are unreliable. Furthermore, many of these facilities are located long distances from district storage facilities and are only accessible via unpaved roads that are challenging to drive on, especially during the rainy season.

Support emergency preparedness and management. Establishing contingency plans to deploy surge support, both in staff and supplies, to areas where disease risks may rise in light of forecasts, could make supply chains more resilient to shocks.

The Government of Mozambique has demonstrated a strong commitment to addressing the needs of its population and achieving the Sustainable Development Goals (SDGs). Good governance and sound public financial management are the pillars for achieving these objectives. Carrying out these recommendations can reduce current vulnerability to weather and climate variability and help to manage future health risks from climate change. Policy and program choices made today will enable resilience in a future climate.