

# Madagascar

# Climate Change and Health Diagnostic

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Risks and Opportunities for Climate-Smart  
Health and Nutrition Investment

INVESTING IN CLIMATE CHANGE AND HEALTH SERIES



JOINT OFFICE FOR CLIMATE AND HEALTH



WORLD BANK GROUP

# Madagascar Climate Change and Health Diagnostic

**Risks and Opportunities for Climate-Smart Health  
and Nutrition Investment**

**Investing in Climate Change and Health Series**

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This document is part of the “Investing in Climate Change and Health” series, which aims to provide management and task teams with the tools and resources necessary to improve WBG action on climate change and health. Other documents published by the World Bank in this series include:

- *World Bank Approach and Action Plan for Climate Change and Health*, 2017.
- *Geographic Hotspots for World Bank Action on Climate Change and Health*, 2017.
- *Climate-Smart Healthcare: Low-Carbon and Resilience Strategies for the Health Sector*, 2017.
- *Methodological Guidance, Climate Change and Health Diagnostic: A Country-Based Approach for Assessing Risks and Investing in Climate-Smart Health Systems*, 2018.

Diagnostics for other countries will also become available as this program evolves.

## Acknowledgments

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## **How to use this document**

This report has been structured according to guidance presented in *Methodological Guidance, Climate Change and Health Diagnostic: A Country-Based Approach for Assessing Risks and Investing in Climate-Smart Health Systems* (World Bank 2018). It has been designed to provide direct guidance in assessing capacity to manage climate-sensitive health and multi-sector risks, to improve risk management, and to link with investment. The report can be read through or in parts: Section 1 provides an overview of methods for transparency and replicability; Section 2 establishes the climate change and health linkages in Madagascar; Section 3 serves as a review of the Malagasy health system; Section 4 describes interventions to address the climate-sensitive health risks; and Section 5 links the interventions to ongoing and pipeline investments.

## **Intended audience**

This document is primarily directed to World Bank Group (WBG) staff working on health, nutrition, and population projects and programs. Much of the content may also be useful to those inside or outside of this institution working on related issues in areas such as agriculture, environment and natural resources, water and sanitation, energy, transport, urban development, and others. As a cross-cutting discipline, climate change and health issues are germane to projects in many disciplines. Although some of the language in this document is specific to WBG policies and procedures (e.g., task team leaders, global practices, etc.), the document has value beyond this institution as other development banks, bilateral aid agencies, and communities are tackling common issues. Tools described here can be applied in many of these contexts.

Policymakers and managers likely will find this document useful as it provides an assessment of climate change and health impacts and opportunities that may inform higher level dialogue and decision making. Operational teams should find value in the specific tools and approaches here that can be integrated within WBG lending programs. The examples should also provide useful context for all readers.

## Alignment with World Health Organization and World Meteorological Organization policy advice

Alignment among international organizations and agencies is critical. No one has a monopoly on the resources necessary for operational success. In the case of climate change and health in Madagascar, the World Health Organization (WHO) and the World Meteorological Organization (WMO) are working with the government, supporting the interagency working group on climate change and health, and developing recommendations that align with and support government-identified priorities and needs. This document aims to build on this base of technical knowledge and government support to directly link much needed interventions to financial investment.

### *Building on WHO precedent*

Beginning in 2015, the WHO began preparing climate change and health country profiles to raise awareness of the health impacts of climate change, support evidence-based decision making to strengthen the climate resilience of health systems, and promote actions that improve health while reducing carbon emissions. WHO prepared a profile for Madagascar that built on the government's already considerable work (WHO 2016). The profile identified key climate change and health impacts and articulated opportunities for action. These are important in the context of this diagnostic because they implicate areas of alignment of WHO priorities with those prescribed by the government. Each of the WHO recommendations is being or has been addressed, indicating a strong commitment on the side of the Government of Madagascar (GoM) toward achieving established climate change and health targets. This World Bank Group work has also been developed to reinforce these recommendations and support the government in undertaking these initiatives.

The following table presents how the WBG has worked in direct response to the WHO recommendations.

WHO RECOMMENDED ACTIVITY	WBG-SUPPORTED RESPONSE
<b>Adaptation</b>	
Scale up the activities of the Malagasy interagency climate change and health working group.	The WBG convened the interagency working group twice during the development of this report (June and October 2017). Additionally, the working group has provided consultation and review throughout, and directly influenced the recommended interventions.
Strengthen the strategic alliance of the working group on health and climate change and mobilize resources for the implementation of the National Adaptation Plan on Health and Climate Change.	Government partners in the interagency working group have participated in WBG consultations, furthering strategic alliances. The interventions described in this report are directly linked to WBG resources to support the achievement of improved and widespread climate-smart health outcomes.
Implement activities to increase the climate resilience of health infrastructure.	A recommended intervention of this report.
<b>Mitigation</b>	
Develop a national strategy for climate change mitigation that considers the health implications of climate change mitigation actions.	A recommended intervention of this report.
Conduct a valuation of the health co-benefits of climate change mitigation policies.	A recommended intervention of this report.

WHO RECOMMENDED ACTIVITY	WBG-SUPPORTED RESPONSE
<b>National Policy Implementation</b>	
Mobilize authorities and development partners for the implementation of policies and strategies integrating adaptation and mitigation measures for climate change.	More than 75 representatives from government agencies and foreign development institutions participated in WBG consultations, highlighting the links between development programs and opportunities for mutual support.
Develop a normative, legal, and technical framework for the implementation of interventions relating health sector adaptation to climate change and mitigation.	A recommended intervention of this report.

### *Aligning with WMO priorities*

Since 2008 the WMO has supported the National Meteorological Agency (Direction Générale de la Météorologie à Madagascar [DGM]) to collaborate with the health sector by establishing a collaborative, interministerial working group on climate and health, which has since become a foundational institutional arrangement for the government.

WMO's policy priority is to support governments of all African nations to implement the five pillars of the Integrated African Strategy on Meteorology (Weather and Climate Services), aiming to correctly position weather and climate services as an essential component in national and regional development frameworks and sustainable development in Africa. The Strategy will ensure the implementation of a structured Global Framework for Climate Service (GFCS) in Africa toward promoting the production and incorporation of science-based weather and climate information and services into African development policy. The health sector is one of five priority sectors for the GFCS, and so the efforts outlined in this report directly respond to supporting this priority. Furthermore, implementation of the Madagascar National Framework for Climate Services, as prioritized in the Nationally Determined Contribution (NDC), includes support to the health sector.

PILLARS OF THE INTEGRATED AFRICAN STRATEGY ON METEOROLOGY (WEATHER AND CLIMATE SERVICES)	WBG-SUPPORTED RESPONSE
Increase political support and recognition of NMHSs and related WMO regional climate centers.	A recommended intervention in this report.
Enhance the production and delivery of weather and climate services for sustainable development.	A recommended intervention in this report and a common objective of the WBG PPCR program.
Improve access to meteorological services, in particular for marine and aviation sectors.	Not directly recommended in this report, but noted. Madagascar's most vulnerable populations reside in coastal areas and depend on artisanal fishing which would benefit from enhanced marine services.
Support the provision of weather and climate services for climate change adaptation and mitigation.	A recommended intervention in this report.
Strengthen partnerships with relevant institutions and funding mechanisms.	WBG, in coordination with WMO and others, supports the Integrated Strategy, convened the Africa Hydromet Forum of AMCOMET in September 2017.
Mobilize authorities and development partners for the implementation of policies and strategies integrating adaptation and mitigation measures for climate change.	More than 75 representatives from government agencies and foreign development institutions participated in WBG consultations, highlighting the links between development programs and opportunities for mutual support.
Develop a normative, legal, and technical framework for the implementation of interventions relating health sector adaptation to climate change and mitigation.	A recommended intervention of this report.

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# Executive Summary

In Madagascar, climate change is already impacting health, and this damage will continue. Without adequate investment in health sector resilience, recent development gains are likely to be reversed, with serious consequences for Madagascar's people and environment. Even so, sustainable pathways to a resilient health sector are possible, despite growing evidence of climate change impacts across the country. What is needed is a clear understanding of these pathways to build resilience, taking into account robust projections of the country's climate and development future.

This report highlights the most prominent climate change impacts facing Madagascar, with a particular emphasis on health, and provides investment relevant solutions to build resilience. Through the establishment of priority interventions to address the identified vulnerabilities, this report links evidence to opportunities for development actors, while providing specific input into the design of a World Bank investment. In doing so, the report builds momentum for the emerging climate and health activities in the country and seeks to facilitate multi-sector dialogue to enhance Madagascar's policy planning.

## Climate Change and Its Impacts on Health

Madagascar is distinctively susceptible to climate impacts and natural disasters given its extensive coastline and location in the Indian Ocean. The foremost climate change stressors in Madagascar can broadly be described as: (1) increased temperatures; (2) extended drought periods and increased variability of rainfall; (3) intensification of cyclones and floods associated with cyclonic disturbances; and (4) climbing sea level and sea surface temperatures. They are projected to become more pronounced over time with a continued rise in global emissions. The cumulative impact of these climate stressors could drag many already vulnerable people back into extreme poverty, with much of this reversal attributable to negative impacts on health.

There are many ways to categorize the impacts of climate change on human and environmental health. The Intergovernmental Panel on Climate Change (IPCC) provides one such approach; this describes three pathways through which climate impacts health: (1) a direct exposure; (2) indirect exposure (in which health impacts are mediated through environmental and ecosystem changes); and (3) another indirect pathway mediated through societal systems (e.g., food and water distribution systems).

Applying the IPCC's exposure framework as a lens to analyze climate impacts on health in Madagascar, the following key threats emerge:

## Direct Impacts on Health

- Injuries, death, and diseases due to extreme weather and climate events
- Heat-related mortality

## Natural System Mediated Impacts

- Infectious and vector-borne diseases, including helminthic, water-borne and hygiene related diseases
- Acute and chronic respiratory infections

## Human System Mediated Impacts

- Chronic and acute undernutrition
- Poor mental health
- Any illness that requires professional medical care

## Climate-Smart Healthcare Assessment

Climate-imposed health risks will play out in the context of Madagascar's health sector capacity, exacerbating the existing health challenges facing the country. The ability of the health system to manage potentially disruptive climate shocks and stresses is a fundamental determinant of the country's resilience and an important consideration in the assessment of its risks and vulnerabilities.

Madagascar did not achieve any of its Millennium Development Goals (MDGs) by 2015. The country has a high communicable disease burden: almost 30 percent of all deaths are still attributable to preventable and infectious and parasitic diseases, while Madagascar has the fourth highest chronic malnutrition rate in the world. Climate is expected to act as a risk multiplier on these already parlous statistics, exerting additional stress on its health sector capacity.

Despite the 2009–2013 political crisis, there have been some improvements in the country's public health performance, particularly in regard to improved access to drinking water, malaria pre-elimination efforts, and improved child immunization rates and health outcomes (WHO 2014a; World Bank 2015a). However, health coverage remains limited and the sector has generally suffered from instability and turnover (World Bank 2015a). The health sector has been constrained by a lack of financing, inequitable service delivery, and poor quality of service. In addition to the comparatively low overall health budget, current health expenditure is highly inequitable between urban and rural areas.

Low levels of access are a particular cause for concern with regard to the system's ability to manage climate-related stresses,

including increases in patient numbers that arise during extreme weather events. Additionally, the urban concentration of health facilities relative to those available in rural areas, coupled with inadequate transportation infrastructure, indicates a further pressure point regarding potential climate impacts on health. Climate change is expected to harm poor people living in rural areas disproportionately, and currently the health sector is unprepared to respond to these expected impacts.

## Key Health Risks

There are considerable health risks associated with environmental degradation and climate change in Madagascar. Many of these impacts have already been felt in some ways. An analysis of climate impacts and projections on current health outcomes, overlaid with an assessment of the country's capacity to adapt and respond to these, points to key areas of climate-related health risk: (1) nutrition; (2) waterborne disease; (3) vector-borne disease; (4) disaster-related impacts on health outcomes and health-system functioning; and (5) air pollution.

While none of these are new to the island, each stands to expand geographically and have greater impact in our new climate era.

## Recommended Climate-Smart Interventions

As opposed to most environmental health hazards, where exposures can be reduced over time with improved control (e.g., exposure to tobacco smoke or groundwater sources of arsenic), climate change will increase for several decades even after a reduction in emissions. Vulnerabilities will also shift, reflecting changes in climate and urbanization, technology, access to safe water and improved sanitation, and factors associated with development choices. Given that health risks from climate variability are, in general, not new, health systems have policies and programs to manage some climate-sensitive health outcomes. However, as these policies and programs were largely developed without taking significant climate changes into account, they will become increasingly less effective as climate change alters disease risk. Further, because health risks vary spatially and temporally, the extent to which a particular program or intervention could be affected by a particular hazard at a given time will depend on local vulnerabilities and capacities.

What is needed is a programmatic approach to increasing health sector performance in the face of climate change. Modifying current programs to manage each climate-related hazard separately may lead to inadequate preparation of health systems to manage multiple and synergistic exposures. A holistic approach that incorporates a range of interconnected climate-smart interventions, as well as

those that incorporate interventions outside of the health sector, should be adopted to meet climate-smart health system goals.

In addition to addressing vulnerability and risk, it is worthwhile to also consider low-carbon interventions. Mitigation and adaptation are truly two sides of the same climate change coin; if extensive efforts are to be undertaken to adapt to the health-related impacts of climate change, one should also consider how to improve health-related systems so they contribute less to underlying causes of the threats. New investments in any sector should thus contribute to building resilience to climate change, while integrating low-carbon interventions. Investment in low-carbon healthcare systems can foster clean and independent energy, safe water, clean transport, and clean waste disposal mechanisms.

### Resilience Interventions

Action that addresses the five core climate change risks to the health sector is key in building a resilient health sector in Madagascar, supported by a range of crosscutting, policy driven recommendations aimed to strengthen its ability to respond to climate risks.

The interventions outlined in Figure ES.1 are illustrative of the types of actions that can be taken, but are not comprehensive given the expectation that others will emerge with implementation and as the full scope of needs becomes apparent. Broadly, recommended interventions aim to: improve understanding and monitoring of health vulnerability and the relationship to the environment and climate; anticipate and prepare for changing risks over different spatial and temporal scales; promote multi-dimensional and

iterative risk management; and add flexibility to current public health interventions, which can help them perform better under a variety of climate scenarios.

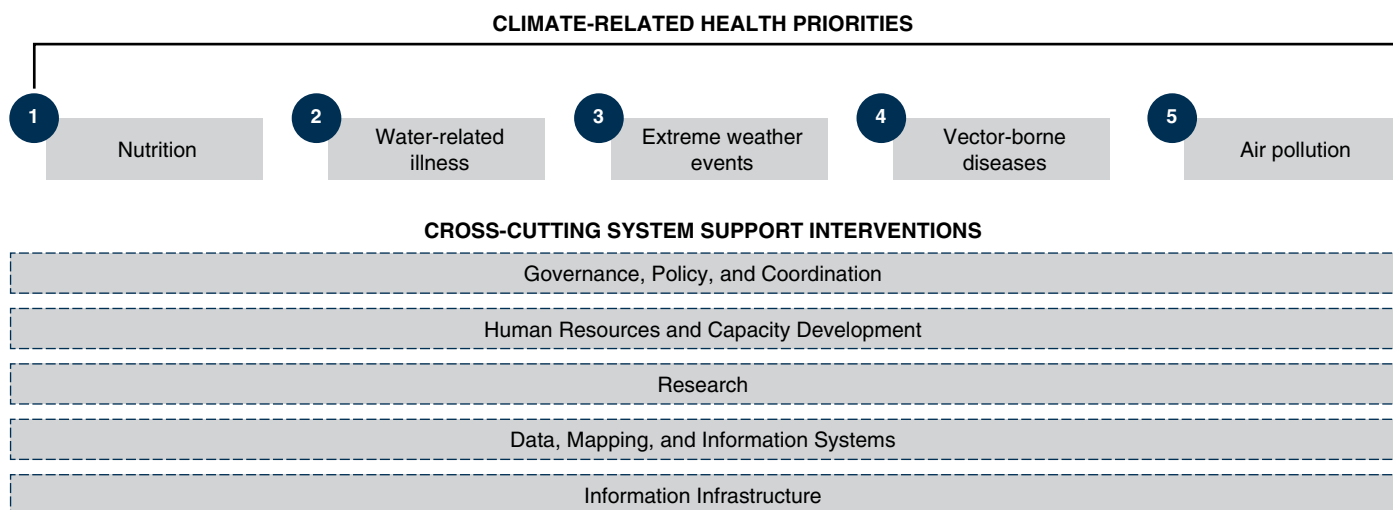
### Nutrition

Undernutrition is widely recognized as the most critical human health issue in Madagascar, and new climate stresses will only worsen outcomes. Close to 50 percent of the population stunted and more than 40 percent of the population anemic, undernutrition is pointedly suspected as being the underlying driver. Inadequate food access and borderline famine conditions in some regions, inaccessible infrastructure to transport food nationally, and very low-input, low-tech agricultural production systems clearly illustrate the entire Malagasy food system’s dependence on climate. Extreme weather events like droughts, flooding, and cyclones will lead to shocks in food production. Increasing temperatures and carbon dioxide will cause crop failure and reduced nutritional quality in food crops in some regions. Maintaining ecological integrity and appropriate land-use planning will enable Malagasy populations that are heavily reliant on natural resources to continue to seek out such a livelihood in the face of climate change. Strategic interventions designed to build resilient and climate-smart food systems will enable sustainable nutrition flows throughout the country. Specifically, these include:

*Education/Communication:*

- Integrate climate considerations into mass media and community awareness campaigns for nutrition and health.

**Figure ES.1:** Climate-related health priorities in Madagascar and areas of investment intervention.



- Promote education and training in meal preparation and choice for balanced and diverse meal consumption.

*Knowledge gaps:*

- Conduct climate- and nutrition-focused research to inform projects and investment and translate research findings for the public (see Section 5 for further elaboration).
- Analyze nutrient value of food products to inform appropriate dietary recommendations.

*Monitoring:*

- Assess dietary intake patterns and establish nutritional surveillance monitoring to pre-empt aid and support for climate-related food shortages and undernutrition.
- Develop a strategy to monitor changing food production, quality, and safety in relation to changing climate conditions.

*Policy/Planning:*

- Align and integrate nutrition sensitive climate-smart agriculture approaches with the development of (i) multi-hazard disaster protocols and risk management protocols for the health sector, and (ii) multi-sector guidance on norms and standards for enhancing nutritional outcomes through sustainable land use, soil conservation, marine spatial planning, and resource management.

## Water and Sanitation

Water- and sanitation-related illnesses are still a major driver of disease in Madagascar; less than 14 percent of the population had access to safe sanitation in 2012 (WSP 2012). Madagascar's economy loses US\$103 million each year due to poor sanitation (World Bank 2012). The precarious water supply and sanitation systems in Madagascar are already highly vulnerable to present-day climate variability and are expected to worsen with climate change. Extended dry periods may deplete water sources or make them intermittent, reduce good hygiene practices, and accelerate airborne fecal dust in open defecation zones, all while reducing the performance of sewers (where they do exist). Extreme weather events may damage water- and sanitation-related infrastructure, while flooding may result in the contamination of water supplies. Sea level rise is expected to compromise water sources in some coastal regions through a range of impact pathways. Strategic interventions designed to build climate-smart water and sanitation infrastructure will minimize the risk of an accelerating burden of diarrheal disease by minimizing contaminant exposures and ensuring sustainable infrastructure. Failure to ensure that services

are resilient will have significant public health consequences. Measures include:

*Capacity/Training:*

- Integrate water and sanitation education into health worker training and activities, including household water treatment and medical waste management.
- Train health and nutrition workers to anticipate and activate prevention measures to minimize increases in diarrheal disease following flooding, drought, and other extreme weather events.

*Education/Communication:*

- Integrate water and sanitation education in primary school education programs.

*Knowledge gaps:*

- Improve the knowledge base and mapping of existing water and sanitation infrastructure and enhance prevailing practices, including location of medical waste facilities.
- Determine risks and susceptibility of water and sanitation infrastructure and practices to sea level rise, cyclonic disruption, etc., and develop appropriate planning that accommodates long-term change.
- Identify major regional gaps in infrastructure and then rank areas most likely to be affected by climate-induced increases in diarrheal disease.
- Conduct anthropological studies on water and sanitation practices in the targeted regions to improve intervention design.

*Monitoring:*

- Develop integrated meteorological and water and sanitation disease surveillance to help predict risk areas and to pre-empt aid and support to at-risk areas.

*Policy/Planning:*

- Develop climate-smart water and sanitation infrastructure in high-risk regions, accompanied by an iterative climate risk management plan to maintain and improve services as the climate changes. Interventions would need to be context specific but should include interventions in 'safe' water and sanitation supply resources, including improved water supply sources, such as hand pumps, or improved latrines (the UNICEF and Global Water Partnership's report *WASH: Climate Resilient Development* provides a useful approach for preparing such interventions).
- Align agricultural, livestock, and forestry land-use planning to minimize downstream water contamination.

## Disasters and Extreme Weather

Madagascar is expected to experience greater variability in precipitation and increases in temperature, sea level, sea surface temperature, and cyclonic activity and intensity. Each of these climate-related environmental changes is expected to magnify direct health impacts (drownings, physical trauma, forced migration), indirect health impacts (diarrheal disease, vector-borne disease, etc.) and direct impacts on health system infrastructure and health-care delivery. Ultimately, all will exacerbate the disease burden in Madagascar. Strategic interventions are needed to link disaster relief operations to health operations and to improve disaster preparedness, to build climate-smart health infrastructure, to develop climate-smart healthcare delivery, and to develop land-use planning protocols that create ecosystem resilience against likely climate change impacts. Targeting should be conducted nationwide but particularly in areas prone to drought, cyclones, and flooding. Interventions should encompass:

### *Capacity/Training:*

- Train and mobilize health workers in climate-related disaster preparedness, response, and case detection for disaster-related outbreaks.

### *Education/Communication:*

- Develop and deploy community awareness campaigns and seasonal disaster preparedness programming for floods, cyclones, and droughts; promote advisory and outreach services (using severe weather forecasting) via risk communication technologies to alert at-risk populations.

### *Knowledge gaps:*

- Map and audit the safety and preparedness of health infrastructures and update flood, drought, and cyclone risk mapping nationally.

### *Monitoring:*

- Create a systematic and coherent registry to track health facility damages, economic costs, and human impacts of extreme weather events.
- Enhance hydrometeorological systems by strengthening and tailoring multi-hazard early warning systems for cyclones, floods, and droughts for health decision making, while creating more direct links to public health surveillance and monitoring systems (including air quality, harmful algal blooms, water quality, etc.).

### *Policy/Planning:*

- Provide operational guidance including norms and standards (i.e., protocols) to guide investments for the construction of

facilities and development of health services that can withstand flood, drought, temperature extremes, and cyclones (including ambulatory and health logistics transport, communication and information and technology infrastructure, and water and sanitation infrastructure). Create government-led mandatory norms.

- Leverage humanitarian aid to raise awareness of specific climate-related health concerns and advocate for inter-sector coordination and risk management.
- Establish a clear partnership with neighboring facilities that will support the sharing of resources in a disaster, including financial recoupment. This is something that can be performed immediately given the existing disaster response work in the country.
- Invest in measures to improve water and energy security of health facilities in regions prone to droughts, cyclones, and floods (e.g., solar/turbines and independent water sources) as well as disaster proof medical waste management facilities.

## Vector-Borne Disease

Madagascar is likely to experience an increase in vector-borne disease for a number of reasons. Climate change is expected to increase temperatures and precipitation, creating conditions that are ripe for the biological proliferation of vector-borne diseases. Climate influences virtually all components of disease systems (Figure 4.4): the pathogen (for instance, influencing the development rate or survival outside the host or vector), the host (through the immune response or changes in host distribution), and the vectors (arthropod vector development is tightly linked to climatic parameters such as temperature and humidity). Key areas of focus include strategic interventions that link weather and disease surveillance to contribute to early warning systems and risk mapping, and aligning the livestock, forestry, agriculture, and land-use sectors for integrated vector management:

### *Knowledge gaps:*

- Create population-based and geographically specific risk maps for vector-borne diseases, and conduct operational and social science research on effective behaviors and control measures.

### *Monitoring:*

- Locate, collate, 'clean', and digitize paper records to improve datasets for disease data, vectors, meteorological conditions, and environmental indicators (e.g., percentage of forest fires, percentage and locations of ecological zones, etc.). Improve ability to access and use remote sensing data of proxy variables for environmental conditions (e.g., land use). Once existing data are understood, invest in hardware and software to carry out skill-based training to improve data collection, management, and analysis.

*Policy/Planning:*

- Develop an integrated health and environmental surveillance system that includes, at a minimum, meteorological and health data for use as an early warning system.
- Strengthen integrated vector management approaches and align timing and location of activities with potential climate-induced shifts in disease burden.
- Align agricultural, livestock, and forestry land-use planning to minimize disease transmission.
- Adopt a government-wide ‘One Health’ approach (see page 4 for more) to manage zoonotic disease risks.

**Air Pollution**

The emissions that drive climate change are largely co-emitted by the same sources that are responsible for air pollution. WHO has recognized the large and significant role that ambient air pollution (AAP) and household air pollution (HAP), particularly in the developing world, play in increasing morbidity and mortality (WHO 2014b). The most recent Global Burden of Disease report estimates suggest that AAP and HAP combined were killing more than 5.5 million people annually by 2013 (GBD 2013; Risk Factors Collaborators 2015), more deaths than those attributable to malaria or tuberculosis. Tens of millions more suffer from related, preventable diseases, including pneumonia (which predominantly affects children), lung cancer, cardiovascular disease, stroke, and chronic obstructive pulmonary disease, which includes emphysema and bronchitis (WHO 2014b). Both AAP and HAP pose significant risks in Madagascar, with the effects of AAP felt in cities and in areas with certain types of industry, and HAP in rural areas where families are reliant upon cookstoves. Specific measures can include:

*Capacity/Training:*

- Train healthcare workers about pollution avoidance techniques that can be communicated to local patient populations.

*Education/Communication:*

- Educate urban populations and rural populations about dangers of prolonged exposure to harmful air, specific to their region.

*Knowledge gaps:*

- Establish a database and registers of pollution sensitive diseases, mapped to case incidences in cities and regions.

*Monitoring:*

- Identify concentration and types of pollutants in major cities using local sensors and satellite remote sensing data.

*Policy/Planning:*

- Scale up clean cookstove programs and coordinate across ministries.
- Develop and adopt a city-wide plan to reduce transport-related air pollution in Antananarivo.

In many ways, sector and health outcome focused interventions are impossible without the necessary crosscutting systemic support and enabling functions of: (i) governance, policy and coordination; (ii) human resources and capacity development; (iii) research; (iv) data, mapping, and information systems; and (v) information infrastructure. Recommendations in each of these areas are described on page 38.

**Low-Carbon Interventions**

Low-Carbon interventions primarily work toward decreasing pollution and limiting greenhouse gas emissions, resulting in health benefits for cardiovascular and respiratory health, while also providing an opportunity to strengthen local economies, employment, and infrastructure provision. Given Madagascar’s progress on the climate and health agenda, it is well positioned to become a leader in the new field of climate-smart healthcare, which combines low-carbon and resilience approaches into a new practice that maximizes benefits for people and the planet. Key elements of low-carbon healthcare include:

- Low carbon health system design and models of care based on climate-smart technology, coordinated care, emphasis on local providers, and driven by public health needs
- Building design and construction based on low-carbon approaches
- Investment programs in renewable energy and energy efficiency
- Waste minimization and sustainable healthcare waste management
- Sustainable transport and water consumption policies
- Low-carbon procurement policies for pharmaceuticals, medical devices, food, and other products
- Resilience strategies to withstand extreme weather events

Using these as high-level principles and in consultation with government partners, specific low-carbon interventions have been recommended for Madagascar that build on current programming and optimize for current capacity within the health system to:

1. Develop a low-carbon strategy for the health sector
2. Scale up community small and medium enterprise (SME) programming and markets around efficient and clean cookstoves, solar lamps, and communal energy charging activities

3. Scale up waste management programs, particularly existing pilot projects using autoclaves
4. Scale up the Green Hospitals initiative
5. Promote water use efficiency through multiple use (i.e., grey water recycling) approaches
6. Establish training programs to educate health policy decision-makers in the value of low-carbon interventions
7. Conduct health system-wide cost-benefit economic analyses to assess the value of decarbonizing the health sector

## Linking with Investment

Informed by this knowledge, these recommendations are useful tools to enhance climate-smart health outcomes in Madagascar. While targeted to a forthcoming World Bank lending program (Improving Nutrition Outcomes using the Multiphase Programmatic Approach Project, see page 4 for further details), the recommendations should be taken as resources for any project type in Madagascar working to improve overall health, environment, or resilience outcomes. They could be introduced at any point during the project cycle—from preparation through implementation and evaluation. The best approach, however, is to align project design with resilience measures (as was the case with Improving Nutrition Outcomes) so that climate and health can be included from an early stage. In short, it is never too early nor too late to enhance project design and implementation by integrating climate change and health considerations.

The Improving Nutrition Outcomes lending program includes a mixture of low-carbon and resilience interventions. Specifically, these are: climate change education for healthcare workers and communities; the scaling up of solar refrigerators in healthcare

facilities and solar batteries in data collection tablets used during surveillance and research. It connects climate and health risks to disaster protocols, highlighting climate change in nutrition mass media campaigns and research. The consideration of climate-sensitive health threats occurs throughout all project phases and as a result of this diagnostic, recommendations have been included in the Project Appraisal Document (PAD).

## Conclusion

This report serves as the first application of the WBG's Climate Change and Health Diagnostic Tool. Madagascar was chosen both due to its susceptibility to climate change and as it provided an opportunity to embed climate considerations in the design of an imminent WBG health investment. During the process, the WBG worked closely with the Government of Madagascar, which exhibited significant leadership in addressing climate and health risks.

Piloting the diagnostic tool in Madagascar demonstrated (i) its usefulness as a tool to collect and catalogue existing climate change and health resources in the chosen country; (ii) its ability to inform the development of a set of concrete recommendations that can be considered in the context of shaping future WBG involvement in the country vis-à-vis the WBG's Climate Action Plan and climate targets; and (iii) its usefulness as a stand-alone project that can shape priorities of the country itself (and other interested stakeholders). Having proved a successful exercise in project quality enhancement, and given that there is now a set of lessons learned from the pilot study, it is expected that its application elsewhere will be able to realize similar value in other countries, particularly those facing accelerated climate risks in the face of already vulnerable health systems.





# Introduction

The World Bank Group (WBG) is committed to pursuing an end to extreme poverty and to build shared prosperity. This commitment includes improving health outcomes and achieving universal health coverage (UHC) while also mitigating and adapting to climate change. The compounded effect of climate change on health will jeopardize these core WBG objectives and undermine the viability of its investments, which rank among the largest of any development institution in the world.

The WBG has recently established an “Approach and Action Plan for Climate Change and Health” delineating institutional targets, geographies, and approaches to mainstreaming climate-smart healthcare and other climate-sensitive health considerations across the institution. One commitment focuses on country-level engagement and, more particularly, on undertaking climate change and health diagnostics. These aim to assess overall health system and health outcome sensitivity to climate and environmental change, while identifying opportunities for investment and intervention to build climate-smart health systems. The team has established a global methodology for conducting such assessments (i.e., an approach that can be applied across countries, regardless of the types of risks and vulnerabilities)<sup>1</sup> and is working with task teams across the institution, as well as engaging with countries to implement the diagnostic.

This report is the first WBG climate and health diagnostic in any country. It aims to provide development lending entry points for enhancing Madagascar’s readiness to manage current and future climate risks to health with particular focus on WBG investments. Although constructed to provide an overview of risks and opportunities for lending, the diagnostic has been conducted to directly inform the development of a new World Bank nutrition investment (Improving Nutrition Outcomes Using the Multiphase Programmatic Approach, P160848 as described on page 4). The aim is to both ensure immediate uptake of climate considerations into a major health investment and maintain ongoing dialogue with a lending task team to guarantee that the approach and recommendations are operationally relevant.

To promote understanding of potential future climate resilience, the Climate Change and Health Diagnostic was developed to help technical staff at the WBG and other development institutions facilitate an action-focused dialogue among stakeholders (e.g., government and civil society) about risks, resilience, and the performance of sectors and systems. The diagnostic identifies priority actions and investments that can enhance a health system’s resilience (and that of other related systems), reduce greenhouse gas emissions, and increase the climate-smart potential of ongoing or future projects.

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<sup>1</sup> World Bank 2017.

### Box I.1: Defining Components of a World Bank Climate Change and Health Diagnostic

- Identifies climate-related events and conditions that stress and shock health systems
- Identifies climate-related events and conditions in non-health sectors that can negatively impact public health or health systems
- Prioritizes interventions that address these shocks and stresses
- Provides information useful in establishing climate-smart, health-related interventions
- Directly links to an active lending portfolio

## Diagnostic Goal

**The overall goal of conducting a climate change and health diagnostic is to link knowledge to investment. It aims to identify events and conditions where climate stresses and shocks undermine the effectiveness of health systems (at local or national scales), increasing morbidity and mortality. The diagnostic uses these insights to prioritize interventions toward establishing climate-smart health systems that both increase resilience and reduce climate forcing emissions. The diagnostic also identifies shocks and stresses in other sectors that could have negative consequences for public health in general or health systems in particular. This diagnostic has been conducted within the context of an active lending portfolio so that recommendations can be directly integrated into investment.**

## Relevance to World Bank

Many WBG client countries—and especially their poor populations—are disproportionately affected by the negative impact of climate on human health. According to a new WBG analysis, 79 percent of countries supported by the International Development Association (IDA) are among the most at-risk countries for negative health outcomes associated with climate change (for either health impacts caused by climate change, health impacts associated with climate change-causing emissions, or both). Half are in Africa (World Bank 2017). Madagascar is categorized as both an IDA and fragile, conflict-affected or violent state.<sup>2</sup> The same analysis indicates that 86 percent of fragile, conflict-affected, or violent

states are most at risk. These significant majorities underscore an absolute need for further engagement on the health and climate agenda and implicate a need for prioritization in future investment.

Addressing climate change and health inherently demands solutions across sectors. The WBG has a comparative advantage in aligning analytic and operational expertise across health, climate, economics, environmental management, and other core areas to address integrated development threats. The WBG's disaster risk management interventions, for example, often implicitly incorporate improvements in health, but do not explicitly measure these. Working at a system level, the WBG is especially well placed to help clients embed an integrated approach in planning. Deep implementation expertise can then support countries in effectively executing programs and interventions, establishing a platform or standard upon which other development institutions can build. WBG research and economic analysis can also help countries establish financial baselines that can be useful in government-wide planning beyond merely the health and environment sectors.

Regionally, climate and health work stands to add considerable value to development investments, with minimal additional effort undertaken by country teams. The case for WBG involvement has been articulated and validated by international experts and partners. WBG has identified key geographies of impact (as well as methods of assessing subnational impact), developed climate-smart health tools that can readily be built into investments, and it can draw on an international community of climate and health experts to perform relevant country- and project-specific analyses.

Integrating climate and health considerations into current and upcoming investments presents a straightforward approach to help development lending teams and countries meet overall climate commitments while aligning with country demands to address climate and environmental impacts on health.

## Structure

One of the first steps in any new climate-smart strategy is the creation of baselines and identification of opportunities. For climate and health considerations, this means conducting a health and climate assessment which explores risks, capacities, and opportunities and which has specific utility for institutions or governments. There are established models for performing climate and health assessments that have primarily been developed by the WHO and partner governments. These assessments are broadly relevant to the development community and have been used to help countries formulate climate and health action plans that are specific to unique geographic and systemic needs. In the context of the WBG, country-specific climate and health diagnostics using the World Bank method (World Bank 2017) expand upon these assessments to make them relevant for development operations and necessary to inform investment. Methods developed here may

<sup>2</sup> Harmonized List of Fragile Situations FY 2017, found at: <http://www.worldbank.org/en/topic/fragilityconflictviolence/brief/harmonized-list-of-fragile-situations>

also be useful for other development institutions and investors endeavoring to undertake similar analyses.

Overall, this work seeks to stimulate and support greater integration of health and climate considerations across the institution; both within the Health, Nutrition, and Population (HNP) Global Practice and in other sectors. As part of corporate climate commitments, the WBG has established a target of ensuring 28 percent of its portfolio generates climate co-benefits by 2020. Individual WBG global practices have their own targets to support this broader goal; for example, HNP aims to ensure 20 percent of new operations are climate considerate by 2020. Doing so requires considerably broader recognition of climate change implications within all departments, particularly HNP where there is at present little climate engagement.

This diagnostic is organized as follows:

**Section 1** presents the methods used in conducting the analysis to (i) ensure transparency of approach and (ii) illustrate the use and adaptation of the approach outlined in *Methodological Guidance, Climate Change and Health Diagnostic: A Country-Based Approach for Assessing Risks and Investing in Climate-Smart Health Systems* (World Bank 2017). The diagnostic guidelines were developed to establish a template for replicability, though with flexibility for country-specific adaptation, as was the case in Madagascar.

**Section 2** provides an overview of climate and health impacts and drivers in Madagascar. This section provides a go-to resource for those wishing to understand the scope and magnitude of climate-related impacts and risks. It includes data on, and discussion of, both climate change and climate health risks. Although

scientific in nature, this section has been prepared with a general policy audience in mind.

**Section 3** serves as an assessment of the health sector in Madagascar, providing relevant facts and figures to inform climate and health decision making, while also exploring dimensions of the sector to determine the degree to which it is climate-smart. This is important to identify pressure points in the health system where interventions may be most useful.

**Section 4** describes the interventions. This includes: what can be done, both in terms of resilience and low-carbon or co-benefit opportunities for the health sector; what can be done in other sectors; and what has previously been recommended by both international and local experts. This information should be broadly useful to anyone working on climate and health in Madagascar.

**Section 5** links these interventions to specific WBG projects and opportunities, identifying entry points and making recommendations for inclusion. In the case of the primary project to which this diagnostic is linked (Improving Nutrition Outcomes Using the Multiphase Programmatic Approach, P160848), an overview of all recommendations has been provided given many of the recommendations are already integrated into project documents.

**Annexes** provide detailed information on certain aspects highlighted in previous sections (such as in-depth climate change projections, listings of relevant partners, reference documents, and other resources) that may be interesting to certain audiences, but that are beyond the immediate scope of this report.

## Why Madagascar?

Madagascar was chosen as the subject of the WBG's first climate change and health diagnostic based on several considerations: (i) Madagascar, geographically, is particularly susceptible to climate change; (ii) there are relevant World Bank health investments in project phases that align with the timing of this project such that they are well positioned to integrate novel climate- and health-related recommendations; (iii) the government of Madagascar has shown significant leadership on the climate and health issue, having maintained an interagency working group on climate and health for 10 years; and (iv) the country has benefited from capacity building of the WHO and WMO in preparing a related national assessment and prioritized action plan. Many living in Madagascar are also poor, with nearly 77 percent of the population living in extreme poverty (World Bank, 2012). Poverty compounds vulnerability and there are many in Madagascar who will likely be impacted by the health impacts of climate change.

Extreme weather conditions have already impacted health and nutrition outcomes in Madagascar. These are expected to worsen in the future with a growing number of infectious diseases, deteriorating mental health, and exacerbated food insecurity and

malnutrition. In the last three years alone, the WBG has prepared two emergency IDA<sup>3</sup> financing operations that include support to delivering WBG HNP interventions as a direct response to climate-related event impacts. Looking to the future, climate change poses a continued, critical threat.

In a country where over 50 percent of children suffer from chronic malnutrition (a figure that is projected to increase without intervention), there is considerable need to develop multi-sector solutions for reliable, affordable, and climate-smart access to food. Conducting a climate change and health diagnostic during preparation of the project Improving Nutrition Outcomes Using the Multiphase Programmatic Approach (P160848, see box below) benefits this project with direct recommendations and climate-smart enhancements, while establishing baseline knowledge and opportunities for intervention in future projects.

<sup>3</sup> International Development Agency (the arm of the WBG focusing on the world's poorest countries, providing concessional finance with low or no interest credits and with repayments of up to 40 years).

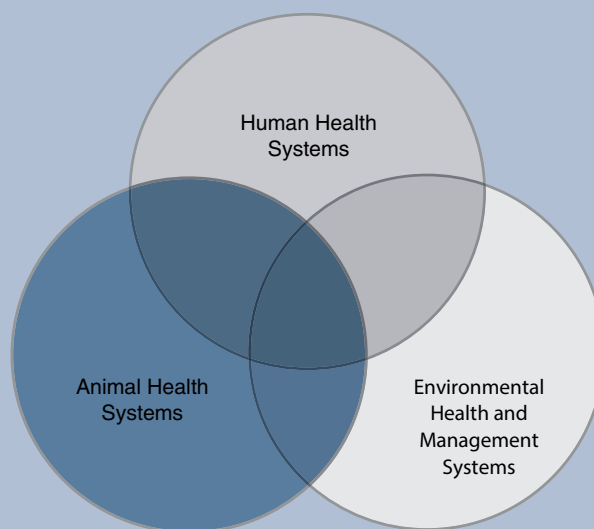
### Improving Nutrition Outcomes Using the Multiphase Programmatic Approach (P160848)

The "Improving Nutrition Outcomes Using the Multiphase Programmatic Approach" Program, approved by the World Bank Board in December 2017, is envisioned as a 10 year, estimated US\$200 million-dollar IDA investment with an overall program development objective "to reduce stunting prevalence in children under 2 years of age in targeted regions." The program includes three phases to be implemented over five, five, and four years, respectively. The first phase is a five-year US\$90 million-dollar investment (including US\$10 million in co-financing from Scaling Up Nutrition) that will be operational in spring 2018. This first phase operation aims "to increase utilization of a package of reproductive, maternal, and child health and nutrition interventions and improve key nutrition behaviors known to reduce stunting in targeted regions." There will also be analytical and technical assistance to inform the government on the more complex and longer-term institutional, financing, and policy reforms required to achieve and sustain results over time.

## Box I.2: Connecting Climate Change and Health with “One Health,” “Planetary Health” and the Sustainable Development Goals

Public health challenges stemming from environmental factors inherently span multiple sectors, and warrant holistic, society-level solutions. “One Health” (humans-environment-animals) and “Planetary Health” (earth systems and health) are related approaches that recognize the connections between humans and environment and that promote coordination to better manage risks and improve health.

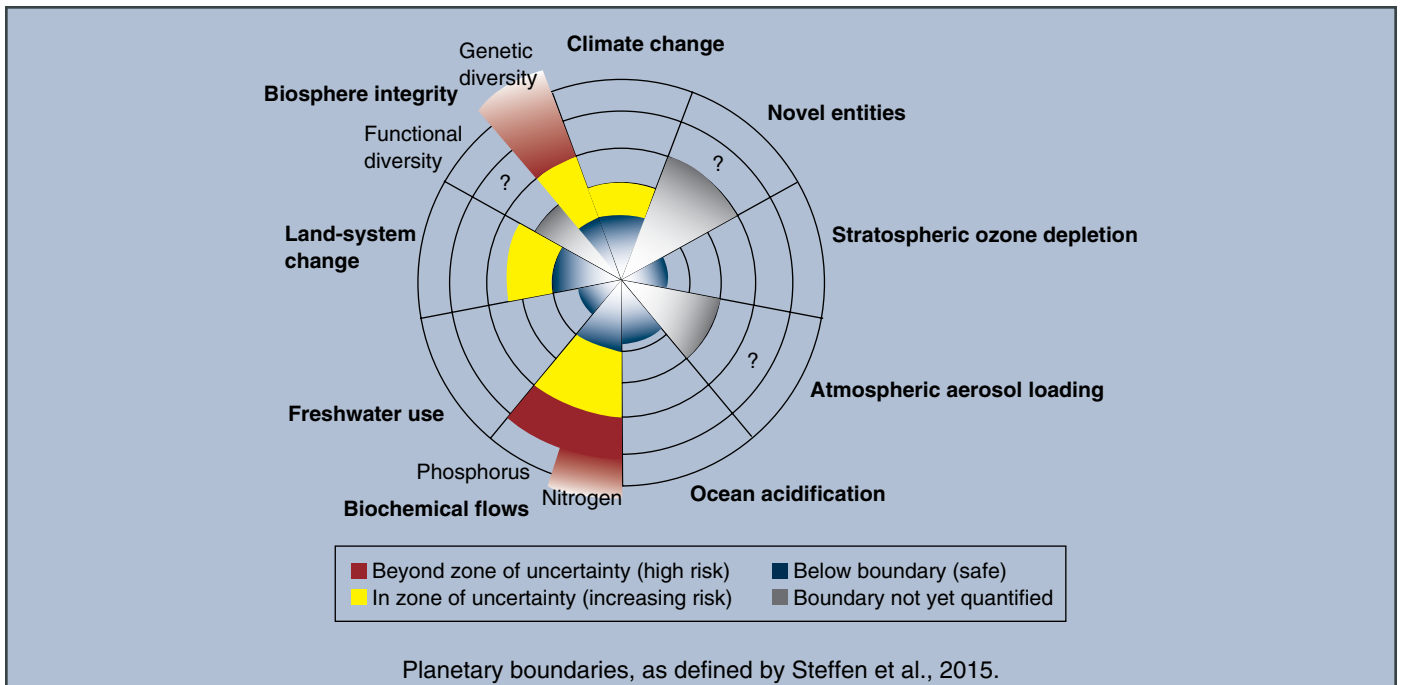
The intention of this climate change and health diagnostic firmly aligns with the goals and ethos of One Health and can be considered a tool employed under the broader One Health umbrella. Climate and health interactions fit clearly within the spheres of “human health systems” and “environmental health and management” below. Utilizing the “One Health” title is important because many countries implementing the legally binding International Health Regulations, including Madagascar, are taking measures to develop One Health coordination mechanisms, particularly for the control of zoonotic diseases.



One Health model, as used within the World Bank

The World Bank has worked for over a decade to promote and operationalize One Health, supported by country partners, technical institutions, international organizations, and other development funders. This has included the generation of a considerable knowledge base on the topic, with reports and studies addressing various One Health dimensions, such as *People, Pathogens, and Our Planet*, *Investing in Climate Change and Health* series, and an extensive portfolio on antimicrobial resistance. This research has underpinned country operations, like the Global Program for Avian Influenza and Human Pandemic Preparedness and Response, and the Regional Disease Surveillance Systems Enhancement program. At present, an *Operational Framework for Strengthening Public Health Systems at the Human-Animal-Environment Interface* (also referred to as the One Health Operational Framework—see Annex 2) is in development and will soon be able to offer further tools toward the achievement of more sustainable health and environmental systems in and among many countries with which the WBG is engaged.

In recent years, support for a related framing has emerged. Planetary Health characterizes public health risks associated with rapidly accelerating, anthropogenic environmental change. There are a range of changes with the potential to significantly impact human health: climate change, biodiversity loss, fishery collapse, land-use change, urbanization, ocean acidification, sea temperature and level increases, and freshwater scarcity. Accordingly, holistic interventions are required to safeguard the future health of both people and planet (Rockefeller Foundation-Lancet Commission Report on Planetary Health 2016). This framework is particularly useful for Madagascar, which has experienced a rapid and massive ecosystem transformation from the time of human settlement several thousand years ago. The trajectories of mass deforestation, biodiversity loss, runoff and soil nutrient leaching, and climate-related impacts all point to the relevance of the Planetary Health framework in Madagascar and are important to understand in the context of this diagnostic.



The post-2015 sustainable development agenda currently includes 17 Sustainable Development Goals (SDGs). Goal 13 calls for urgent action to combat climate change and its impacts, while goal 3 aims to ensure healthy lives and promote well-being. Virtually every other goal includes some dimension that touches upon health and/or climate, underscoring the relevance of integrated systems perspective across environmental and health spheres, which is at the heart of the One Health and Planetary Health approaches. Fundamentally, each of the goals is linked; progress in any one of these areas can lead to collective achievement toward improved development and a more sustainable future.



## Methods

The approach to this diagnostic was modeled on the five-step process described in *Methodological Guidance, Climate Change and Health Diagnostic: A Country-Based Approach for Assessing Risks and Investing in Climate-Smart Health Systems* (World Bank 2017). Each step is detailed below (and in Figure 1.1), including variances and specific dates and duration, so as to be most useful to both previous participants and those who may wish to replicate the process for other countries.

### Stage 1: Pre-Diagnostic Desk and Data Review

*May 16–June 3, 2017 (2.5 weeks)*

This stage focused on collecting information and leveraging efforts already undertaken, particularly health Vulnerability, Capacity, and Adaptation Assessments (V&As) and climate-related planning documents. The latter include works that assess recent climate-related shocks and stresses, and the effectiveness of the health system. Stocktaking was achieved through literature searches, discussions with development partners, researchers, and government contacts. The process identified several dozen relevant studies, reports, and plans developed by the government, WBG, WHO, other development partners, and academics. Each document was then uploaded to a file-sharing site and made available to the diagnostic team. These documents were analyzed for relevant information that was flagged for future use.

Key stakeholders were mapped through a similar process. Contacts and organizations were compiled in a spreadsheet and reviewed by the team to determine if there was appropriate coverage across government agencies and nongovernment entities. In-country relationships and personal contacts proved essential to both the stakeholder mapping process and in achieving buy-in throughout the project. The contact list was then made available for subsequent phases.

The core diagnostic team, as well as the extended HNP lending team to which this project is most closely aligned, met several times during this stage. Discussions focused on three topics: (i) resource sharing, including the latest documents, data, and stakeholder contact details; (ii) briefing one another on new information learned; and (iii) preparing for subsequent work stages.

### Stage 2: Workshops and Meetings

*June 4–June 10, 2017 (1 week)*

The purpose here was to assess and verify the information collected during Stage 1 with in-country partners, confirm initial thinking and directions, and identify additional resources and stakeholders that should be part of the overall assessment. The team found this time useful to listen to partners and learn from in-country experiences after having explained the project's context with stakeholders.

Bilateral meetings were arranged and held with a number of government and nongovernment partners (including WBG staff) drawing upon the previously established contact list. Calling upon the



influence and expertise of the Ministry of Health, an invitation to a one-day consultation was sent to relevant personnel. In parallel, the team prepared the workshop agenda, which was reviewed by the Ministry of Health. More than 75 individuals from across government, civil society, and international institutions attended the workshop (agenda and participant list provided in Annex 3). The day included framing presentations by the WBG climate and health team, technical presentations from country staff, comments and reactions from international partners, and several hours of working sessions with the interagency working group for climate and health, which helped to refine messages from the earlier presentations. Notes were taken and circulated to all participants.

### **Stage 3: Interviews and Site Visits**

*Concurrent with Stage 2*

The purpose of this stage was to better understand the challenges and opportunities of communities and health systems, and to qualitatively assess the extent to which current policies and programs could manage the associated risks. Unfortunately, time constraints did not allow for visits beyond those that were held in relation to Stage 2. The team was reliant upon the first-hand experiences of the experts on the core team with long-standing experience in Madagascar, and those with whom they met in bilateral meetings and those who attended the workshop.

### **Stage 4: Developing Recommendations and Initiating Report Preparation**

*June 11–September 30, 2017 (16 weeks)*

This stage presented an overview of climate and health impacts and opportunities in Madagascar in the format of a five-part report (this document). Additional technical information was supplied in annexes for further reading. This report aims to be a comprehensive account of the latest climate and health information in Madagascar, detailing impacts, opportunities, a systems assessment, and

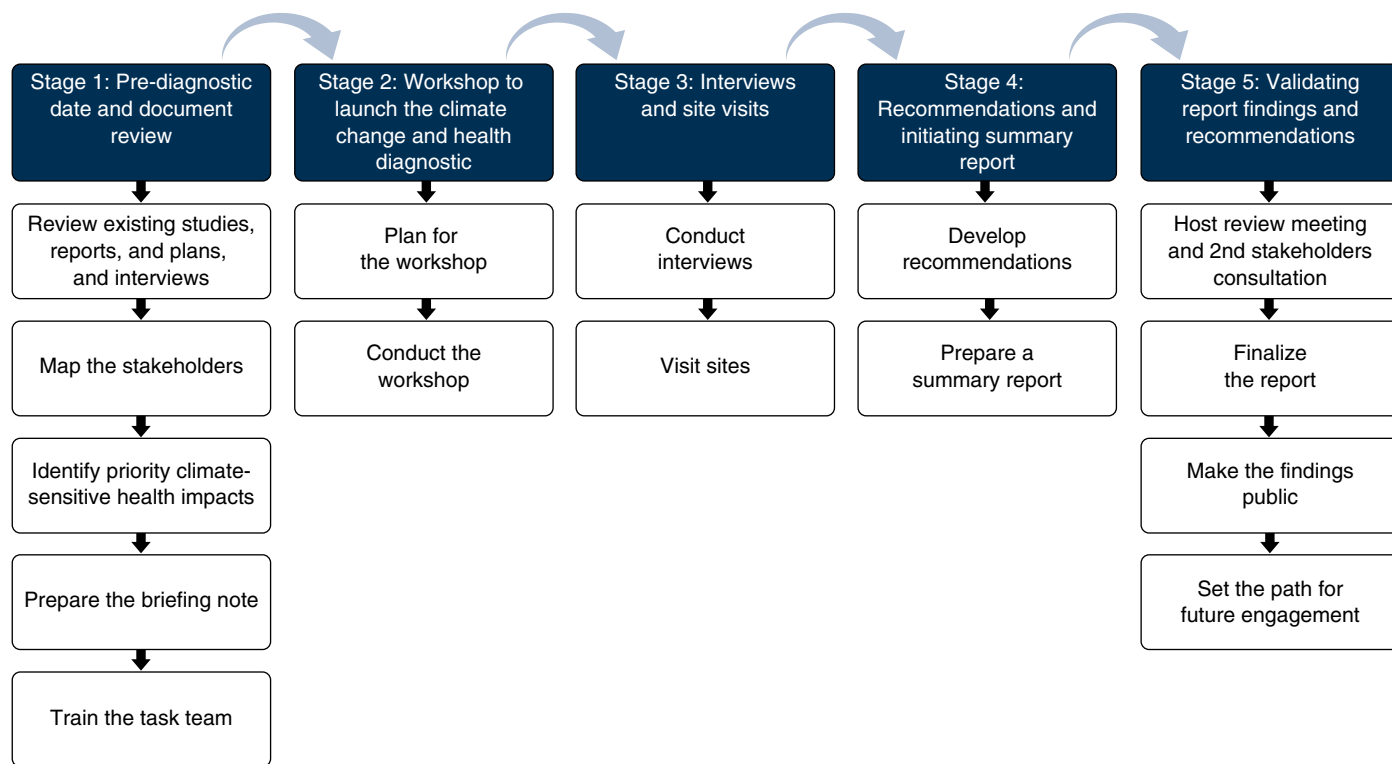
recommendations for actions and investments (or line items in projects). It seeks to incorporate factors such as the eminence of the threats, competing demands, windows of opportunity based on current and planned projects and investments, and stakeholder concerns and preferences. The final draft was prepared for circulation to the consultative group in Madagascar for review and revision. After completion of Stage 5 (final workshop), the report was sent to an international team of reviewers comprising expertise in climate and health, environmental health in Madagascar, and country-level assessments. The report was then finalized and key recommendations delivered to development partners and WBG lending staff (who also maintained an active role incorporating inputs during the development lending project preparation phase).

### **Stage 5: Presenting and Validating Report Findings and Recommendations**

*October 1–October 7, 2017 (1 week)*

To ensure the diagnostic would be valued by WBG lending teams, as well as government and other international partners, in-country staff received the findings and recommendations to provide feedback through bilateral meetings and a workshop. The report was circulated one week in advance of the workshop to ensure time for review and comment. A one-day workshop was held 4 October with more than 25 participants from the Groupe de Travail—Santé et Changement Climatique. Overall report findings were presented and working groups created to discuss and review interventions throughout. At completion, the participants had reviewed all the report's recommended interventions and, based on their feedback, the WBG team discarded some of the original interventions and added new measures, while many others were modified. The final report was amended to include all the day's inputs, and it was circulated for review among country and international partners as well as relevant WBG staff.

Figure 1.1: Climate and health diagnostic staging.





## Climate Drivers, Impacts, and Vulnerable Populations

### Climate in Madagascar

Due to the geography, microhabitats, and weather patterns of the island, the climate of Madagascar varies by region, within region by month, and across region by year. This variability manifests important differences in the types of risks experienced throughout the country, as the climate moves from tropical to temperate to arid. It also drives the need for local-to-regional approaches that are appropriate to the ecological and climatic profile of that particular area.

Microclimates prevail in Madagascar (Figure 2.1), with broad patterns of hot, humid rainforest on the east coast, dry deciduous forest on the west coast, a water-deprived spiny desert in the southwest, and the High Plateau, which is characterized by a mountain chain running down the spine of the country (highest point, nearly 2,900 meters). Rainfall can vary from a few hundred millimeters of rain per year to well over 5 meters of rain per year, depending on the location. Similarly, temperature extremes can range from  $-10^{\circ}\text{C}$  to  $44^{\circ}\text{C}$ , although the average is from  $14^{\circ}\text{C}$  to  $32^{\circ}\text{C}$ , depending on the location and season. The southeastern trade winds originate in the Indian Ocean anticyclone, where high atmospheric pressure builds and can generate cyclones that frequently bombard the eastern coast. As these winds move from east to west, they become drier, explaining the higher frequency of cyclones in the east versus the west.

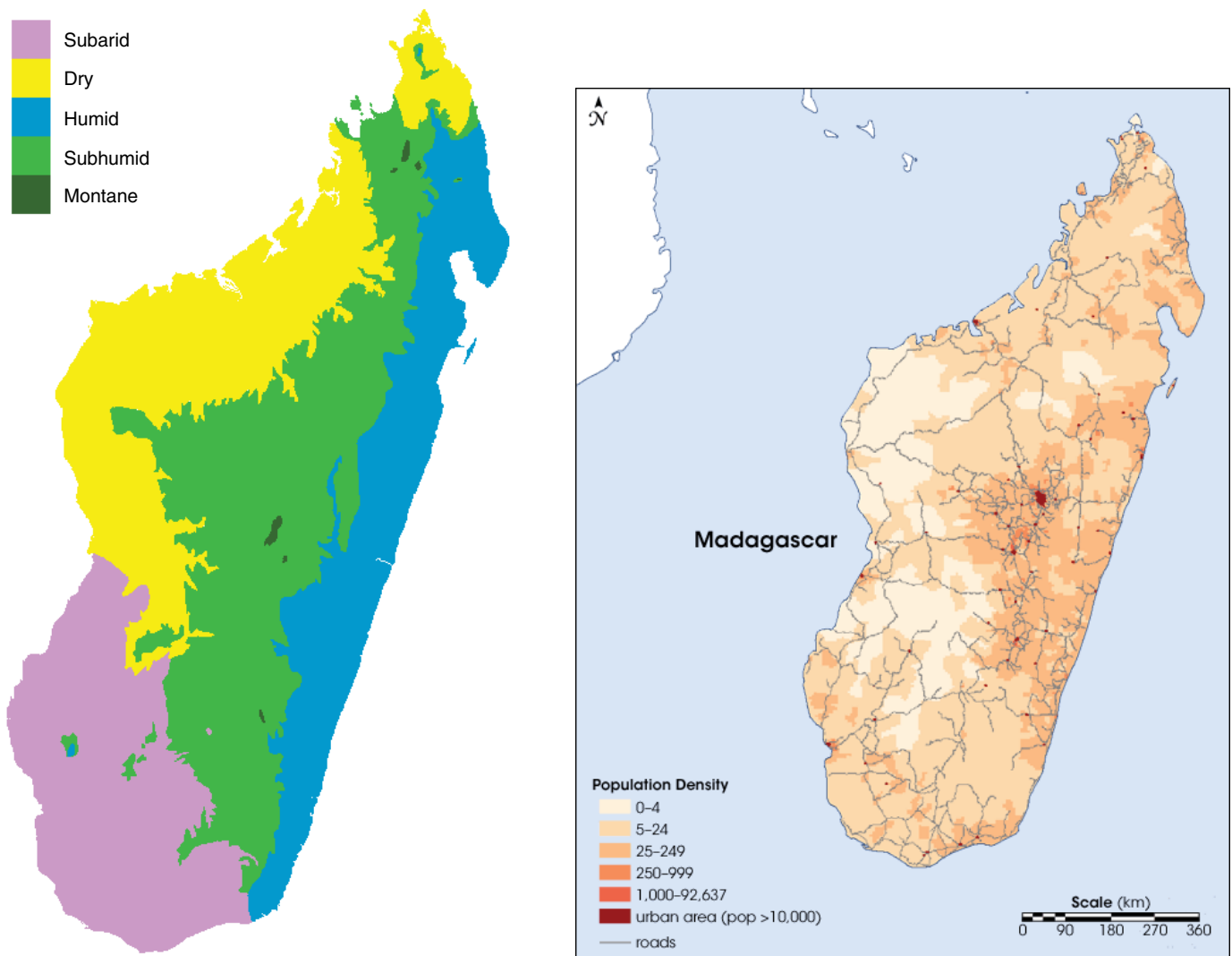
Although there are regional nuances, the dry season lasts from May until October, and the rainy season spans November to April. The east coast is persistently wet throughout the year. In the high plateau, arid south, and west coast, all of the rain falls from November to April. The rest of the country can generally be divided into four seasons: Cold/Wet (June–August, called *Rirignina*), Hot/Dry (September–November, called *Lohataona*), Hot/Wet (November–January, called *Taona*) and Cyclone Season (February–May, called *Fahavaratra*). Climatologically, the cyclone season in the southwestern Indian ocean runs from November 1 until April 30.

### Climate Change in Madagascar

Madagascar is uniquely susceptible to climate impacts and natural disasters, given its extensive coastline and location in the Indian Ocean. The hot, rainy season (November to April) can often bring destructive tropical cyclones. Drought conditions are ever present in certain southern regions. The north and northeast are often affected by flooding and rainfall variability. Climate risks like these are expected to worsen with climate change. Madagascar's mean annual temperature is projected to rise anywhere from  $1\text{--}4^{\circ}\text{C}$  by 2100.

There have been significant temperature increases throughout Madagascar from 1961 to 2005, particularly in the country's south. Average minimum temperature increased across all seasons in 67 percent of the 21 observation stations across Madagascar, and maximum temperatures increased

**Figure 2.1:** Climate zones and population centers in Madagascar.



Source: Socioeconomic Data and Applications Center, Columbia University, accessed at [http://www.efloras.org/web\\_page.aspx?flora\\_id=12&page\\_id=1204](http://www.efloras.org/web_page.aspx?flora_id=12&page_id=1204)

across all seasons at 63 percent of all observation stations, with only one station (Maevatanana, in the Northwest) showing a significant decrease in temperature (Tadross et al., 2007). There do not appear to be significant trends in precipitation based on rainfall records from 1901 to 2000; however, there is a correlation between increasing temperatures in northern Madagascar relating to reduced rainfall, and increasing temperatures in southern Madagascar relating to increased rainfall (Tadross et al., 2008).

Downscaling trends and using global climate models (GCMs), Tadross et al. (2007) produced a series of projections using the scenarios of the International Panel on Climate Change, 5th

Assessment Report (IPCC AR5; Smith et al., 2014). For temperature specifically, depending on whether we model moderately low (Representative Concentration Pathways (RCP) 4.5) or high (RCP 8.5) greenhouse gas emission pathways, the lowest and highest bounds of the temperature envelope could see increases between 2.0–6.5°C by 2100, with higher temperatures projected in the south (Tadross et al., 2008). With regard to projecting the future incidence of cyclones between 2060–2100, Tadross et al., 2008 generated downscaled calculations of the “Genesis Potential” (an approximate measure of frequency of cyclones) and maximum “Potential Intensity” (an approximate measure of the destructive

power of cyclones). The models suggest inconsistent projections for the current cyclone seasons in Madagascar, but a likely reduction in cyclones during the current “non-cyclone season.” Far greater clarity is projected with regard to the potential intensity of future cyclones where all four GCMs predict increases in the destructive power of cyclones by 2–17 percent (Tadross et al., 2008). This has obvious and significant implications for future infrastructure development, as well as health risk management.

## Observed Impacts of Climate Variability and Climate Change in Madagascar

Madagascar’s Nationally Determined Contribution<sup>4</sup> report provides many tangible examples of the impacts of climate change already observed in Madagascar, all of which have indirect but systemic influences on the determinants of public well-being and health (to be discussed in further detail in the next section). It is worth first understanding these before proceeding to health impacts to emphasize

<sup>4</sup> See Box 4.1 in Section 4 for detail regarding the origins and nature of Nationally Determined Contributions.

the connections between climate, environment, and society. Impacts, drawn from the NDC and other sources, can be broadly connected to: (1) increased temperatures; (2) extended drought periods and increased variability of rainfall; (3) intensification of cyclones and floods associated with cyclonic disturbances; and (4) increasing sea level and sea-surface temperatures. A brief outline of each of these follows, and further impacts are contained in Table 2.1.

### 1. *Increased temperatures and carbon dioxide*

- Extreme temperature events will impact plant development and productivity, leading to changes in the flowering, fruiting, and pollination of important food crops. The impact of extreme temperature events will have synergies with water availability and lead to risks to food security.
- Human labor, primarily outdoors in Madagascar (where 74.5 percent of the population works as agriculturalists) will stagnate as heat increases, leading to reduced agricultural productivity and increases in heat stress and stroke.
- Rising levels of carbon dioxide (CO<sub>2</sub>) will lead to reduced micronutrient contents in staple crop foods, thus driving increased micronutrient deficiencies.

**Table 2.1:** Climate changes and associated environmental impacts in Madagascar.

CLIMATE ELEMENT	CURRENT CLIMATE EXPERIENCES	FUTURE IMPACTS
Increased temperatures	Between 1961 and 2005, statistically significant increases in daily minimum temperatures were observed across most of the country	Disruption to unique and critical microclimates lead to significant changes in local farming systems, with implications for food security
Extended drought periods and increased variability of rainfall	Droughts: Between 1980 and 2009, five major droughts occurred, with large impacts on agriculture and food security Floods: Over 30 floods or heavy rainfall events affected Madagascar in the past 30 years, killing hundreds of people and affecting thousands	Decreasing production yields and soil fertility loss; water stress (irregular rainfall patterns, drought, and deficit in some areas)
Intensification of cyclones and floods associated with cyclonic disturbances	Madagascar has one of the highest cyclone risks among African countries, with an average of 3–4 cyclones affecting the country every year	Critical risk to the productive and social sectors of the economy, destroying key infrastructure and livelihoods; there are also indirect costs to the economy for the duration of the time that these assets cannot be used Cyclones threaten life-sustaining ecosystems
Increasing sea level and temperature increase	Shoreline erosion caused by sea level rise poses a significant problem to the coastal ports and beaches of Madagascar; coastal erosion—as measured in 1997—was between 5.7 and 6.5 meters	Threat to coastal infrastructure, including houses, roads, and ports, as well as negatively impacting underground freshwater resources, agriculturally rich areas, changing the ecology of coastal regions, and threatening biodiversity

### Box 2.1: Ocean Health

Ocean impacts are a critical consideration. The ocean is as important to Madagascar as any terrestrial asset and is under at least as much stress—both from climate change and insufficient global environmental management. The Ocean Health Index (<http://www.oceanhealthindex.org/>) ranks Madagascar's ocean health as 162nd out of 221,<sup>5</sup> with declining Ocean Health that is expected to deteriorate by 4% in the near future.<sup>6</sup> According to Smith et al., 2014, global sea surface temperatures are expected to rise by approximately 0.4–1.1°C by 2025. For Madagascar specifically, these increases in sea temperature will be linked to an approximate 1–20 percent decline in catch potential for fish in or near coastal waters as fisheries migrate pole-wards (IPCC 2014). This impact will be compounded by the rising sea temperature also causing coral bleaching events. This large decline in available fish will have significant downstream effects on the local population's ability to obtain adequate animal-source foods for nutrition, especially in the context of limited aquaculture directed for subsistence use (Golden 2016 et al., 2017).

#### 2. *Extended drought periods and increased variability of rainfall*

- In 2016, the El Nino effect caused rainfall to drop 75 percent compared to the past 20-year average in the southern part of the country, causing soil infertility and harvest losses of up to 95 percent, and forcing more than 1 million people to become food insecure.
- At the time of writing, 30–60 percent of the population of southern Madagascar was suffering from food insecurity due to drought periods.
- Water stress attributed to irregular rainfall patterns, drought, and deficits in some areas will lead to inadequate sources for drinking water and challenges to crop irrigation.

#### 3. *Intensification of cyclones and floods associated with cyclonic disturbances*

- From 1976 to 2011, at least 46 national disasters (floods, drought, and cyclones) were reported in Madagascar, affecting more than 11 million people and causing an estimated US\$1 billion in damages (UNHCHR 2011; Clayton 2012).
- Around 14 percent of Madagascar's population is particularly vulnerable to natural disasters, with 10 percent specifically vulnerable to cyclones (UNISDR 2009).

5 According to analysis by Exclusive Economic Zone; a band extending from coastline to 200 miles offshore, for which a country has exclusive rights and domain.

6 The Ocean Health Index is measured as a composite score of biodiversity, clean waters, food provision, artisanal fishing opportunities, natural products, carbon storage, coastal protection, coastal livelihoods and economies, tourism and recreation, and a sense of place.

- Seventy-eight percent of all recorded cyclones have occurred within the last 30 years (OFDA/CRED 2011).
- Social infrastructure (schools, health centers, nurseries) is often destroyed by cyclones.
- Mangrove forests can be destroyed by flooding.
- Coral reefs, habitats, and associated species (fishes, arthropods, sea grass, etc.) can be impacted or destroyed by storm surges, recessions, and debris.
- Crops and fields are susceptible to destruction following heavy rains, floods, and severe winds.

#### 4. *Increasing sea level and rising sea-surface temperature*

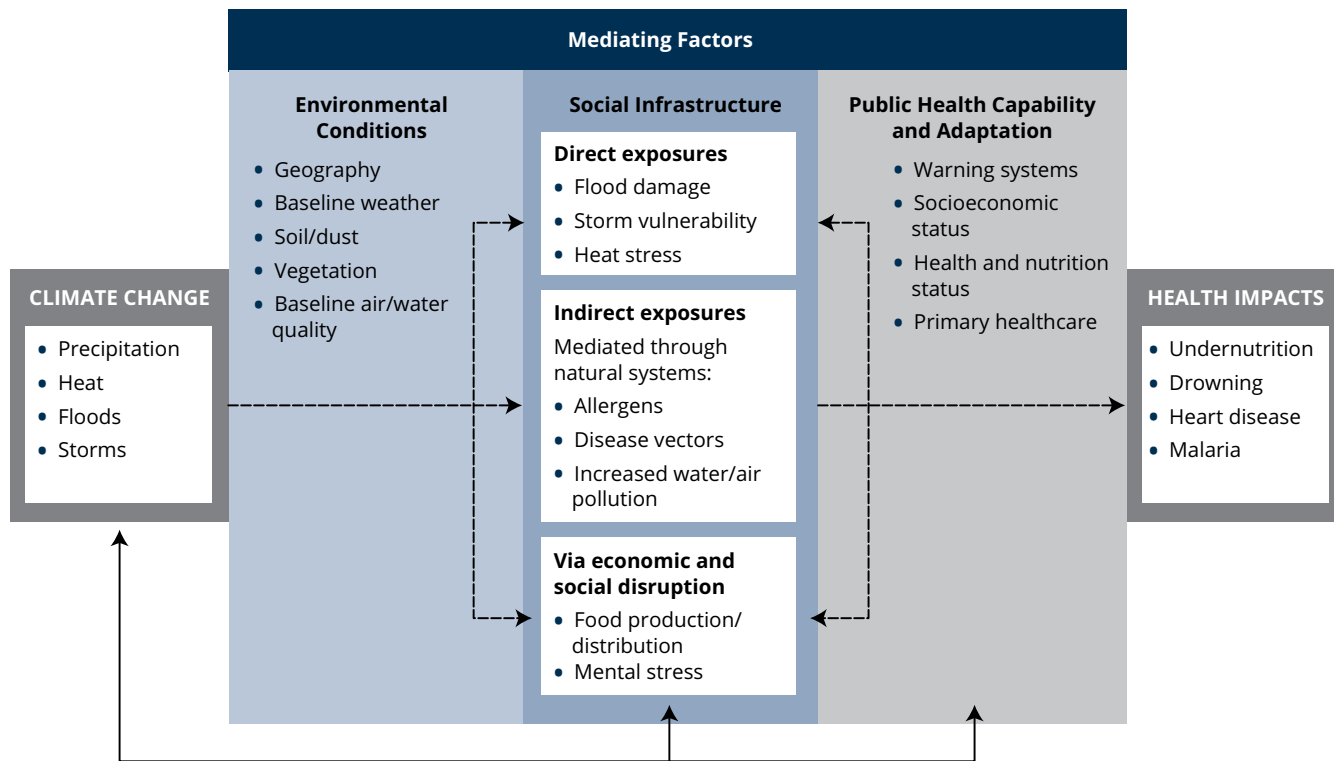
- Average sea level rise of 7–8 mm per year has resulted in significant coastal erosion and the progression of receding shorelines.
- Increasing dinoflagellate algae accumulation in fish, associated with a rise in sea-surface temperature, has resulted in illness and death.
- Reduction in marine life leads to reduction in catch potential that impacts livelihoods and health.

## Climate and Health Risks in Madagascar

This section provides an overview of the key climate-sensitive health risks in Madagascar, as identified by the IPCC, peer-reviewed literature, national evaluations, and expert opinion. This includes health risks exacerbated by extreme weather and longer term climate change, as well as the health and development risks associated with the emission of short-lived climate pollutants.

There are many ways to categorize the health impacts of climate change. One approach focuses on identifying discrete impacts (Figure A1.1), which represents a useful framework in clarifying challenges and conveying the scope of potential risk. Another construct was created by the IPCC to highlight intermediate drivers (Figure 2.2). This is important when thinking about approaches to intervention, and so it is included here as it is particularly relevant for country operations. Three typologies of impact are outlined: (1) direct impacts of climate change on human health; (2) natural system mediated impacts; and (3) human institution mediated impacts (Smith et al., 2014). (Co-emitted air pollution is treated separately to better account for the health impacts associated with the drivers of climate change and is classified in terms of sources that contribute to ambient air pollution versus those that contribute to household air pollution.)

The term “direct impacts” encompasses illness and death due to exposure to extreme weather and climate events in which climate change may play a role. These include effects of high heat (including heat exhaustion and heat waves), floods, storms, air quality, etc. Natural

**Figure 2.2:** Discrete health impacts of climate change.

\*The light blue box indicates the moderating influences of local environmental conditions on climate change exposure pathways in a particular population. The gray box indicates the extent to which factors such as background public health and socioeconomic conditions and adaptation measures moderate the actual health burden produced by the three categories of exposure. The solid black arrows at the bottom indicate that there may be feedback mechanisms—positive or negative—between societal infrastructure, public health, and adaptation measures and climate change itself.

system-mediated impacts applies to illnesses and deaths due to events such as shifts in patterns of disease-carrying mosquitoes and ticks, or increases in waterborne diseases caused by warmer conditions and increased precipitation and runoff. It also includes worsening air quality in general, and increased air pollution in particular, due to temperature increases. Human institution-mediated impacts include morbidity and mortality from altered systems created by humans. Impacts include malnutrition associated with agricultural production losses, diseases and poor health outcomes related to failure of built environments (cities, roads, hospitals), stress and undernutrition following violent conflict, and widespread impacts that result from market and economic losses.

Climate change in Madagascar is anticipated to correlate with health impacts across each of these impact pathways, as described below. Although each has been inserted into a category, health impacts do not exist in a vacuum; being afflicted by a single impact (such as malnutrition) may result in increased vulnerability to another (infectious disease). The categorization simply serves to highlight primary drivers and pathways of impact which may be

useful in discerning interventions. It is important to note that these impacts will play out in a country where the healthcare system is already severely constrained. These constraints, discussed in Section 3 in more detail, include a history of weak health service provision, limited budgets, and low capacity.

#### Direct impacts on health

*Injuries, death and diseases due to extreme weather and climate events*

- The intensity of heavy precipitation events and cyclones has already increased as a result of climate change in Madagascar. Increases in the intensity, duration, and frequency of such events have increasingly severe impacts on human health, and it is expected that as climate change becomes more pronounced, so too will these impacts on health. Cyclones and floods are some of the deadliest of all weather-related hazards, accounting for many deaths per year, mostly due to drowning. In addition



to these immediate health hazards, other hazards can often appear once a storm has passed, as is discussed below under natural system-mediated impacts.

- Drought also poses risks to public health and safety. Drought conditions may increase a range of health impacts, including wildfires, degraded water quality, and reduced quantity.
- While it is hard to estimate the exact number of deaths or public health incidences attributed to direct climate impacts on health, previous estimates give an indication of their potential impact. Between 1990–2011, more than 2,000 deaths were attributed directly to cyclones, not counting the lagged deaths from compromised water sources or changes in vector-borne disease burden or food insecurity.

#### *Heat-related mortality*

- Heat-related mortality, along with other impacts on the general health and productivity of the population, is expected to worsen as temperatures increase in Madagascar. While not specific to Madagascar, under a high greenhouse gas emissions scenario, heat-related deaths among the elderly (65 years and older) are projected to increase to about 50 deaths per 100,000 by 2080 compared to the estimated baseline of just over 1 death per 100,000 annually between 1961 and 1990. A rapid reduction in global emissions could limit heat-related deaths among the elderly to about 10 deaths per 100,000 in 2080 (Honda et al., 2015).

#### **Natural system-mediated impacts**

##### *Infectious and vector-borne diseases, including helminthic, water-borne and hygiene-related diseases*

- Climate change is expected to alter the distribution of diseases borne by vectors such as ticks, fleas, and mosquitoes. Climate is expected to impact these through geographic and seasonal changes, which will influence all parts of a disease lifecycle from incubation through transmission (CDC 2017).
- By 2070, under a high emissions scenario, about 46 million people are projected to be at risk of malaria in country (also partly reflecting population growth). A low emissions scenario could slightly reduce the population at risk toward 2070. Population growth can also cause increases in the population at risk in areas where malaria presence is static in the future (Rocklov et al., 2015).
- Diarrheal deaths are expected to decline due to improvements in Water, Sanitation, and Hygiene (WASH). While not specific to Madagascar, literature suggests that those attributed to climate change will increase by 12 percent (Lloyd, et al., 2015). Urban areas are particularly at risk: current inadequate hygiene, and drainage and waste infrastructure in urban areas are currently leading to outbreaks of various diseases, especially in the

flood season. With anticipated rapid increases in urbanization, coupled with flooding due to climate change, these are likely to put increasing strain on the health system.

- Increases in malaria are anticipated throughout the country in the future (as is the current trend), particularly in the Menabe and Nosy Be regions. This will be driven by a broadening of the temperature envelope which has, historically, limited malaria in these areas, increased flooding (which leads to increased mosquito larvae), and increased human displacement, which also leads to more malaria.

#### *Acute and chronic respiratory infections*

- Climate change is projected to impact human health by increasing ground-level ozone and/or particulate matter air pollution. Such pollutants are associated with a range of health problems and increases in premature deaths (CDC 2017).
- While on the one hand, air pollution—a determinant of climate change—is damaging to human (and ecological) health, climate change, through increasing temperatures, more frequent and intense wildfires, etc., is projected to increase concentrations of air pollution. It is estimated that approximately half of all deaths of ischaemic heart disease are attributed to the use of solid fuels in the country, used by more than 95 percent of the population, and which contribute to approximately 30,000 deaths per year. This type of fuel burning contributes to emissions and is destructive to population health (WHO 2015).

#### **Human system-mediated impacts**

##### *Chronic and acute undernutrition*

- In 2016, the El Nino weather phenomenon caused a 75 percent drop in rainfall compared to a 20-year average. In turn, this prompted harvest losses of up to 95 percent, brought food insecurity to more than 1 million people, forced 35,000 children under 5 to suffer from moderate acute malnutrition and another 12,000 from severe acute malnutrition.
- Given that undernutrition has such a multifactorial etiology, projections of increased risk of undernutrition are difficult. However, it is clear climate change will increase the stress on food systems that are already very vulnerable to shocks. Damage to cropland, collapse of fisheries, CO<sub>2</sub> impacts in reducing the micronutrient content of food crops, deforestation and unsustainable hunting leading to reduced access to wild foods, among other events, will all destabilize food security and increase undernutrition.
- The 2008 cyclone season resulted in damages to an estimated 1,255 community nutrition sites, primarily in the regions of Analanjirofo (where 196 were completely destroyed), Atsinanana, and Atsimo-Atsinanana. Damages were estimated at Ar. 1,314.3 million (US\$800,000). Losses, calculated through

## Box 2.2: Locust Crises in Madagascar

In addition to being prone to natural disasters, Madagascar also faces locust plagues that further threaten food and nutrition security. It was estimated that the food security of 13 million people, or 60 percent of the population, were affected in the locust plague of 2013, of whom 9 million earned a living from agriculture (FAO 2017). Given that extreme weather patterns play a part in creating these swarms, weather conditions and a changing climate can have a direct effect. In 2013, for example, significant flooding from cyclones created a favorable breeding environment for new swarms.

impact on children's nutrition, were estimated at Ar. 1,575 million (US\$1.0 million). Recovery and rehabilitation needs include the reconstruction and equipment of the community nutrition sites to cyclone resistant standards, at an estimated cost of Ar. 5,492 million (US\$3.3 million).

### Poor mental health

- Following climate shocks and stresses, populations are displaced, further impoverished, or affected by other environmentally determined diseases. Mental health also deteriorates. Few studies address mental health impacts of disasters in developing countries, although it is a recognized impact area, drawing from parallel literature in populations that are displaced by other natural disasters or war.

### Any illness that requires professional medical care<sup>7</sup>

- Extreme weather events disrupt and damage health services that are essential in providing regular treatment, medications, or hospital care for both communicable and noncommunicable diseases.

## Vulnerable Populations

The Government of Madagascar recently conducted an extensive climate change and health vulnerability assessment, describing types of vulnerable populations and geographies at risk (GoM, *Evaluation de la vulnérabilité et de l'adaptation du secteur santé au changement climatique* 2015). The WHO has established general categories of vulnerable populations that are largely relevant to Madagascar, particularly considering the overall picture on a demographically targeted, project-by-project basis (such as maternal and child health investments). A brief summary of these

<sup>7</sup> A more detailed overview of climate impacts on the health sector is provided in Section 3.

## Box 2.3: Discerning Climate Change Risks from Environmental Change Risks

In light of the holistic approaches of One Health and Planetary Health, it is necessary to recognize that climate change is not the only environmentally related risk factor to human health. In preparing a national action plan for adapting the health sector to climate change,<sup>8</sup> the government considered cyclones, floods, deforestation, swidden agriculture, freshwater contamination, and drought to be the highest priority health-related environmental issues. This is notable as it includes processes broadly associated with climate change (i.e., cyclones, floods, and droughts) but also includes other processes that are separate from climate impacts, such as deforestation, swidden agriculture, and freshwater contamination.

Understanding climate-health linkages and risk factors is essential to ongoing and pipeline WBG investments given the significant impacts on the success and sustainability of programming in both the immediate and longer terms. The human health effects of climate change, although present now, will become far more challenging in the future. That said, other types of environmental change—such as deforestation, fisheries and wildlife population collapses, and freshwater contamination—have had a much broader and more devastating impact to the present Malagasy population. Recent work has investigated the role of broadscale wildlife population declines (among lemurs, bats, tenrecs, etc.) in an increase of micronutrient deficiencies due to high human reliance on these wildlife for nutrition (Golden et al., 2011). More recent work is establishing baselines of seafood dependency for human nutrition to understand the future role of fishery collapses and coral bleaching on food security and nutrition. Absent climate change, these important ecosystem transformations would still be critical processes driving ill health. Yet, it is likely that climate change will aggravate these impacts in additional ways.

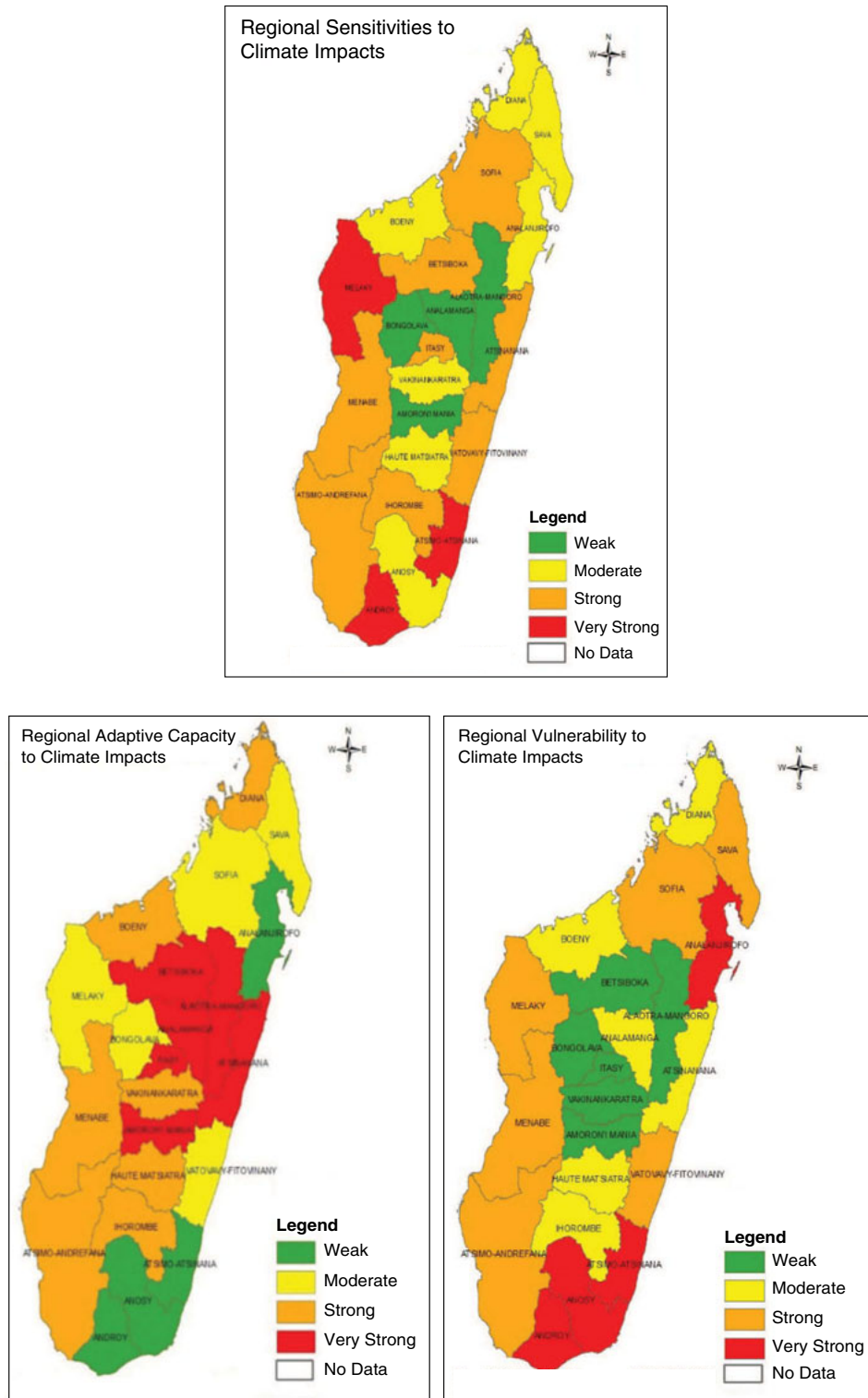
combined results follows, and these results are referenced again in Section 4 in relation to interventions.

## Vulnerability by Region

Overall, Atsimo-Atsinanana, Androy, Analanjirifo, and Anosy are the most vulnerable to the health impacts of climate change. These regions have the weakest adaptive capacity, characterized by isolation, poor access to health services, insufficient health providers per capita, and low incomes.

<sup>8</sup> In 2016, the government published a report outlining adaptation actions for the health sector entitled *Madagascar Plan d'Action National d'Adaptation du Secteur Santé au Changement Climatique*.

Figure 2.3 : Geographic regions of climate vulnerability and adaptive capacity as identified by the Government of Madagascar.



Source: (GoM 2015)

**Table 2.2:** Categories of populations vulnerable to the health impacts of climate change.

CATEGORY	VULNERABILITY FACTOR
Vulnerability due to demographic factors	<ul style="list-style-type: none"> <li>• Age (proportion of young and old)</li> <li>• Gender (proportion of women)</li> <li>• Population density</li> </ul>
Vulnerability due to biological/health factors	<ul style="list-style-type: none"> <li>• Populations with seasonal or chronic malnutrition</li> <li>• Populations with infectious disease burdens</li> <li>• Populations with chronic disease burdens</li> <li>• Immuno-compromised and HIV/AIDS-affected populations</li> <li>• Mental or physical disability</li> </ul>
Behavioural factors	<ul style="list-style-type: none"> <li>• Poor food preparation</li> <li>• Poor hygiene habits and knowledge</li> <li>• Unsafe defecation practices</li> </ul>
Vulnerability due to socio-economic factors	<ul style="list-style-type: none"> <li>• Poverty</li> <li>• Low education and illiteracy</li> <li>• Inadequate access to or use of healthcare</li> <li>• Inadequate safe water and sanitation access and use</li> <li>• Inadequate access to communications and information</li> <li>• Displaced and migrant populations</li> <li>• Marginalized populations (i.e., ethnic minorities, nomadic and seminomadic peoples)</li> </ul>
Vulnerability due to environmental and geographic factors	<ul style="list-style-type: none"> <li>• Exposure to environmental pollutants, livestock, and agricultural wastewater</li> <li>• Fragile ecosystems: dry lands, coastal areas, floodplains, mountains</li> <li>• Populations living in crowded, poor and/or unplanned urban and peri-urban settlements, worker settlements</li> </ul>
Vulnerability due to sociopolitical factors	<ul style="list-style-type: none"> <li>• Political instability</li> <li>• Existence of complex emergencies and conflict</li> <li>• Limited freedom of speech and information</li> <li>• Infringements of civil rights</li> </ul>

Source: Adapted from WHO 2013, and in consultation with the Malagasy Groupe de Travail de Sante et Changement Climatque.

Atsimo-Andrefana, Atsimo-Atsinanana, Atsinanana, and Analamanga are the regions most frequently impacted by cyclones, floods, and drought, Madagascar's most costly natural disasters in both human and economic terms.

Melaky, Androy, and Atsimo-Atsinanana are the most sensitive to the health risks posed by climate hazards, primarily due to high rates of household poverty, dependence on subsistence agriculture, poorly constructed housing, generally poor health status (as evidenced by the low incidence of vaccination), elevated prevalence of pre-existing health conditions, and high rates of malnutrition.

Analamanga, Alaotra-Mangoro, Itasy, Betsiboka, Amoron'i Mania and Atsinanana have greater capacity for adaptation, explained by: (1) better coverage of established health services that can facilitate management of potential epidemics, illnesses, or injuries; (2) a higher level of literacy and adult education; and (3) a higher percentage of households that are not dependent on agriculture—all of which aid in the preparation and recovery from climate extremes.

### **Vulnerability by Population Type**

In addition to geography, local experts have identified vulnerable populations by other typologies. Migrant workers, independent minors, and those working in the informal employment sector (specifically mining and often illegal extractive industries) are high on this list. From an urban perspective, the urban poor were cited as highly vulnerable to nutritional and infectious diseases. Ecologically vulnerable populations were also identified as those dependent on natural resources and those in water-scarce regions. They also recognized remote regions that lack communication

with centralized information networks, and regions that lack transport infrastructure were also noted. These experts offered examples of the nutritional risk and vulnerability associated with this lack of infrastructure, particularly in the context of highly productive agricultural regions that cultivate only a single crop. If an extreme weather event cripples transportation networks, it makes it impossible for regions like these to obtain adequate dietary diversity. Table 2.2 further highlights these correlations and adds categories as defined by WHO, which may be useful for consideration in Madagascar.

## Climate-Smart Healthcare Assessment

Addressing climate change and health risks and opportunities in Madagascar would be impossible without consideration of the current capacity of the health sector. This section provides an assessment of Madagascar's health sector, providing relevant facts and figures to inform climate and health decision making, while also exploring those dimensions of the sector that determine the degree to which it is climate smart. In the areas that it is not, this paper identifies intervention areas and expands upon these in Section 4. Climate-smart healthcare includes both low-carbon and resilience/adaptive dimensions. Both are important for the future and both stand to benefit Madagascar in ways beyond diminishing contributions toward climate change or reducing negative health impacts.

A climate-smart healthcare assessment measures the ability of the health system to manage potentially disruptive climate-related shocks and stresses and, in effect, determines its resilience. This includes managing current and future exposure to climate-related hazards, including risks to the health of the population, as well as risks for the health sector. By overlaying the climate and health risks discussed in Section 2 with an assessment of the current and planned performance of the health system, priority actions can be identified to reduce vulnerabilities and increase resilience before these shocks and stresses occur. The ability of health systems to manage the health risks of climate change is influenced by many factors, including (1) existing infrastructure and assets; (2) potential for expansion/scaling up; (3) social and human capital, including institutional strength of the government (nationally as well as locally) as well as other organizations; and (4) ability and experience in leveraging external support that can support interventions (World Bank 2017). This component of the climate-smart healthcare assessment is critical for a country like Madagascar with its high climate-health vulnerability.

The other dimension of a climate-smart healthcare assessment is to review its low-carbon functionality and potential. This is of lesser importance than assessment of resilience and adaptive capacity in Madagascar given the country's climate-health vulnerability is greater than most countries, while its overall and health sector carbon emissions are much less. Nevertheless, consideration of low-carbon dimensions is both symbolically important for the health sector (showing a capacity for forward thinking) and for a healthier population. Low-carbon technologies are generally less polluting and better for the environment, with ultimately positive impacts on human health, and they offer a compelling business case when compared to traditional infrastructure. Greener technologies are also expected to become more commonplace in the future; establishing them in systems now will place Madagascar at the forefront of the field. In Madagascar, power grids are susceptible to regular outages and blackouts; adoption of local and renewable sources can safeguard against this, while also lowering emissions. An embrace of low-carbon approaches can showcase Madagascar as an early adopter and encourage greater political and financial support for its efforts. Madagascar has the potential to be a leader in the field and attract funding from institutions that focus on climate and environment, such as the Green Climate Fund and Global Environment Facility.

## Health Sector Background

This section provides a brief description of the health sector with the underlying intention of identifying climate change and health interventions.

### Overview

Despite political crisis in 2009–2013, there have been some improvements in the country's public health performance in the past decade, in particular, improved access to drinking water, pre-elimination efforts against malaria, and improved child immunization rates and health outcomes (WHO 2014a; World Bank 2015b). However, health coverage remains limited and the sector has generally suffered from instability and turnover (World Bank 2015a): between 2009 and 2014, there were four different Ministers of Health appointed, while the National Health Strategy, which ended in 2011, was informally extended with no interim strategy put in place. The result has been general fragmentation in the health sector with negative consequences on health sector performance and available funding.

The health sector has suffered from lack of financing, inequitable service delivery, and poor quality of service. In addition to the low overall health financing budget, current health expenditure is highly inequitable. Prevalence of long-term (chronic) malnutrition among children under five is one of the highest in the world: 53 percent are stunted and 5.8 percent are wasted (World Bank 2015b). More than 66 percent of health facilities report missing at least one essential medicine. Since 2014, there has been an effort to address these challenges with the launch of the development of the new health sector strategy, as well as revitalization of the International Health Partnership in Madagascar (World Bank 2015a). Prior to 2014, national spending on health was lower than the Sub-Saharan African average. However, since 2014 this position was reversed. In 2015, national spending as a proportion of GDP was 4.2 percent (WHO 2015; IMF 2015), higher than the Sub-Saharan African average of 2.3 percent (World Bank 2014a).

Medical centers are found throughout Madagascar, although they are concentrated in urban areas, particularly in Antananarivo. As such, access to healthcare is a serious challenge: with a population of nearly 25 million (64 percent living in rural areas) access is beyond the reach of many Malagasy (World Bank 2015a; World Bank 2014b; Lancet 2015; WHO 2008). Additionally, fewer people can afford to access healthcare due in part to the combined effects of increasing poverty levels and growing medical costs (World Bank 2014b; IMF 2015).

### Box 3.1: Lacking Access to Care Is Worse with Climate Change

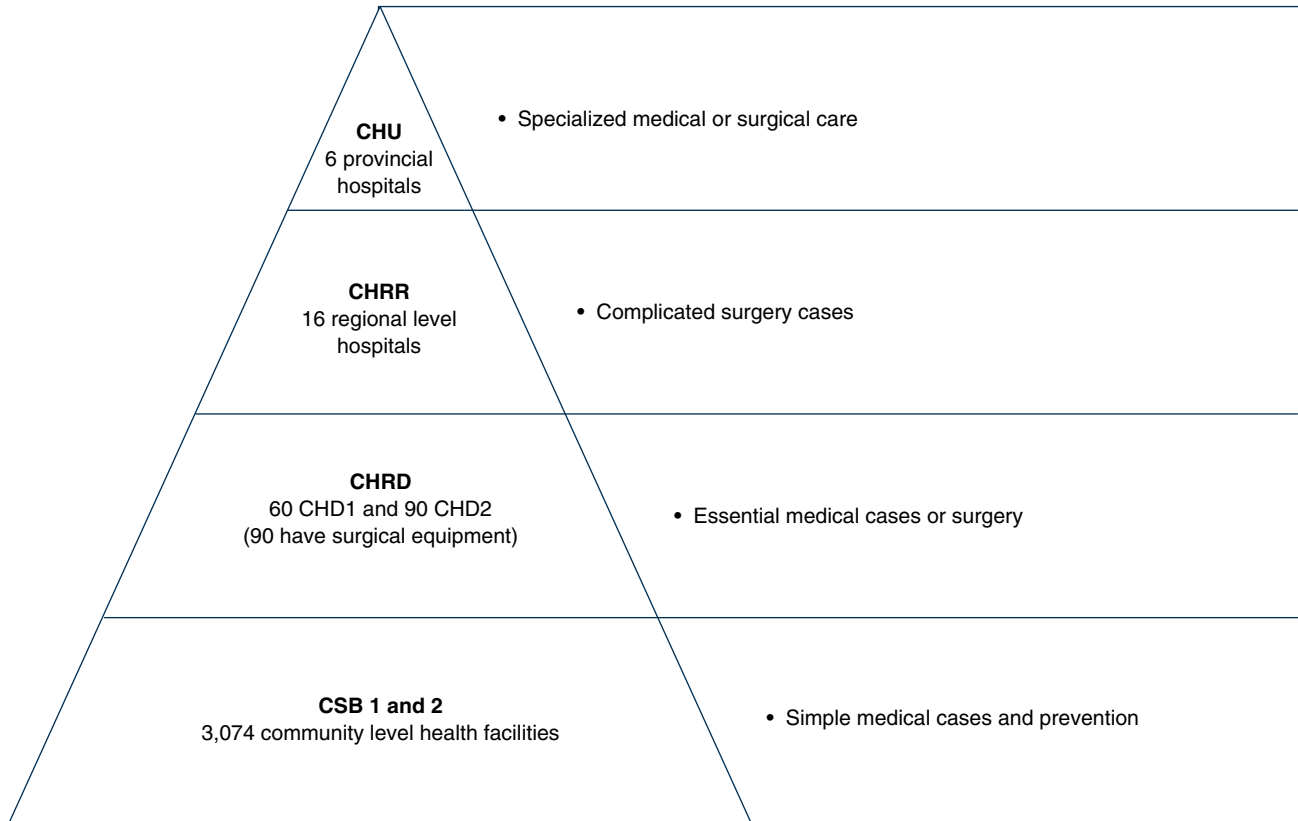
Existing low levels of access are a particular cause for concern with regard to the health system's ability to manage future climate-related stresses, including significant increases in patient numbers as a result of extreme weather events. The low ratio of medical professionals to people suggests that there is very little capacity in the system to treat new patients. Should climate shocks result in a large number of cases, it is unlikely that the current system will be able to respond effectively.

Additionally, the urban concentration of health facilities relative to those available in rural areas, coupled with inadequate transportation infrastructure to reach clinics, indicates a further pressure point regarding potential climate impacts on health: climate change is expected to impact poor people living in rural areas disproportionately and yet the health sector is not currently established to respond to these expected impacts. Scaling up in rural areas will be difficult due to the high cost of such activities, as well as geographic challenges. With communities isolated due to heavy rains, swollen rivers, and other climate-related hazards, access is expected to become an even graver stress on the health sector's ability to meet the growing needs of the country's population.

### Sector Structure

The public health sector is organized in a pyramid structure, with four tiers of access to health services (Figure 3.1). Health services can be accessed at: basic health centers (Centre de Santé de Base, CSB) I and II; district referral hospitals (Centre Hospitalier de Référence de District, CHRDR) without surgery and with surgery; regional referral hospitals (Centre Hospitalier de Référence Régionale, CHRR); and university hospitals (Centres Hospitaliers Universitaires, CHU), including specialized centers.

The system is organized around 112 health districts, which correspond to administrative units referred to as *Fivondronana*. Each health district typically contains 10 to 25 primary care facilities and a hospital. The districts are divided into service areas for community health centers (CSB1 and CSB2). CSB1s are managed only by paramedical staff whereas CSB2s should be managed by a doctor and paramedical staff. In 2012, there were 3,074 functional CSBs and 150 CHRDRs, including approximately 90 with surgical capacity (categorized as CHRDR with surgery) (World Bank 2015a). Across this structure, the prevalence of trained medical

**Figure 3.1:** Structure of Madagascar's health sector.

professionals remains extremely low. There are only 3,150 doctors in Madagascar, which equates to just 1.6 physicians for every 10,000 people (OECD 2006; Our Africa 2010). CSB1s are typically understaffed, and comprise one nurse or midwife and one support staffer. Only five regions had on average more than one staff member per functional CSB1 (World Bank 2015a). Over 40 percent of the population lives more than 5 kilometers from a health center, while only an estimated 50 percent of the population makes use of health facilities of health services due to their distribution or cost.

### Private Healthcare

There has been an increasing reliance on the private sector for the provision of health services over the past decade (World Bank 2015a), both in terms of not-for-profit and for-profit clinics.

Not-for-profit health centers are required to adhere to Ministry of Health norms and regulations and must integrate their work programs into district health planning. As such, between 2001 and 2010, the number of CSB2's in the private sector doubled and the number of private hospitals (CHRD2) almost tripled.

### Healthcare Expenditures

Madagascar's health sector is not adequately funded and has a very constrained budget envelope (World Bank 2015a). The sector is largely reliant on external financing, with domestic financing low and unstable. Public spending on health has increased recently, but has historically fallen well below the levels of Madagascar's peers. Bearing in mind the budget and expenditure inconsistencies in the country, the World Bank (2015a) estimated that, in real terms, public spending on health has not increased since the mid-1990s.



### Box 3.2: Health System Structure Challenges in the Face of Climate Change

The structure of health systems exacerbates the health challenges posed by climate change as, in general, different departments manage specific health outcomes (e.g., malaria or undernutrition) with often limited interactions between departments. The health risks of climate change cut across most of the departments in a ministry of health, requiring crosscutting approaches to adaptation that are not standard practice. Further, programs and activities often make the implicit assumption that the same approach to managing a health risk is appropriate across spatial and temporal scales. This top-down approach has worked well over the past 150 years to significantly increase public health, but may not hold true in the future as the underlying determinants of health may be rapidly affected or altered in some cases. However, the magnitude and pattern of climate-related health risks will depend heavily on the local context, requiring consideration of local vulnerabilities and capacities into program planning. Approaches that have worked in the past may fail to work in the future given broad scale and geographically variable ecosystem and climate changes affecting the determinants of health.

There is also large variation in health system coverage across urban/rural and geographic regions with urban centers better managed than rural centers (World Bank 2015a). Without adequate supervision, it is likely that the health sector will be unable to adequately respond to climate shocks and stresses as the climate signal becomes stronger over time.

Successful interventions will demand a strong grasp of this structure. A large base of CSB implicates the level of healthcare with which most of the at-risk population may interact. Working with local practitioners is critical for reaching into communities, educating the population, and building resilience to impacts.

At approximately US\$20 per capita in 2014, this is far below the average Sub-Saharan African spend of US\$83 (World Bank 2015a). Estimates indicate that public health expenditure increased from 2.9 percent of GDP in 2009 to a peak of 4.6 percent in 2010, with external support comprising a remarkably high amount (roughly 83 percent in 2013). Internal funding at the Ministry of Health constituted 17 percent in 2013 (World Bank 2015a).

The extremely low share of domestic funding to the sector is lower than that of other countries, and very low compared with other sectors in Madagascar. The country's national contribution to education, for example, was approximately 80 percent in this same year (World Bank 2015a). This poses serious concerns for

sustainability, ownership, and efficiency of existing resources. Over 80 percent of health financing comes from external aid. The overreliance on external funding is a serious concern for the sustainability of funding to the sector, and potentially raises issues in terms of alignment, harmonization, and overall efficiency given the high volume of external aid provided off-budget. Expenditure trends in the sector, coupled with historic underfinancing, indicate that this is the third fundamental weakness in the health sector's ability to meet current and future stresses.

### Distribution of Spending

Across the health budget, it is clear that since 2010, labor expenditures have crowded out expenditures on goods, services, and investments managed by the Ministry of Health (World Bank 2015a). The share of regular wages increased from 33 to 78 percent (between 2006 and 2013) of the overall budget (including both internal and external financing) (World Bank 2015a). Regular salary expenditures in Madagascar have reached levels that are much higher than those generally observed in less-developed countries; most other Sub-Saharan Africa countries had labor shares around 50 percent or less (World Bank 2015a).

Expenditures related to the provision of healthcare constitute only a small (and decreasing) share of the budget, with the cost of most medical consumables borne by the patient through cost recovery. A noticeable trend of decreased spending on maintenance and utility costs (from 5.5 percent of the budget in 2008 to less than 1 percent in 2013) indicates a risk to the sector's infrastructure.

In terms of distribution across types of facilities, primary health facilities (CSB1 and CSB2) receive 27 percent of total spending on wages, although they serve 50 percent of the population (World Bank 2015a). Less than 5 percent of total health spending goes to rural communities. Considering that approximately two-thirds of the population live in rural areas, this represents a highly unequal distribution of expenditure shares.

The health sector's systemic risk management capacity is significantly constrained, reflecting a history of political instability and constrained budgets. It is likely that without notable efforts to address the proximate (limited resources, skills and expenditure, etc.) and ultimate (political instability and institutional) causes for its overall poor performance, the health sector will remain vulnerable to any additional pressure, including increasing numbers of patients or declines in the existing capacity of the already constrained system.

### Climate-Related Health Sector Impacts

Madagascar experiences about US\$100 million in economic losses annually from cyclones, earthquakes, and floods (GFDRR 2017).

### Box 3.3: Importance of Reviewing Spending in the Context of Climate Change

Exploration of spending provides important insight into what a system values and prioritizes: that which has been valued in the past is not always that which will, or should, be valued in the future. Priorities and circumstances change and it is critical to adapt spending to prepare for and respond to new threats. Perhaps there is no more immediate threat than climate change.

Given the damage that climate is expected to inflict on the health sector and its associated infrastructure, as well as the increase in climate-related illnesses, there will need to be larger budgets allocated to maintenance, rehabilitation, and expansion of the sector. However, recent history has illustrated the opposite: following Cyclone Enawo in March 2017, 17 of 41 health clinics in the Maroantsetra region were seriously damaged and four were completely destroyed. There is currently no financing or immediate plans to renovate and rebuild these critical structures of health delivery (World Bank 2015b). The potential disruption of services attributed to climate-induced destruction will lead to consequent health challenges.

Another potential threat is posed by the limited spending in rural communities. Climate change provides further incentive for increasing spending in rural areas given as it is the populations here who are most vulnerable to the impacts of climate change, which are anticipated to increase in the future.

A reliance on centralized systems may also pose threats. Between 2006–2013, the central level managed between 50 and 70 percent of current nonwage health-related expenditures with no clear trend toward deconcentration despite a tiered management and service delivery system down to the primary care level. Since 2011, there has been a reduction in the share of nonwage current expenditures managed at the district level. In addition, the share of expenses that could potentially be deconcentrated has gone down sharply, from over 20 percent to 13 percent in 2013. This poses a risk to the adaptive capacity of the system in responding to climate stresses as these are likely to be dispersed across the country, and will require quick disbursement of funds.

These impacts are seen across social and productive sectors, including health. The country is regularly impacted by large-scale climate events: for example, in January 2015, the country was hit by tropical cyclone Chezda. According to preliminary assessments by the Malagasy Red Cross Society (CRM), over 80,000 people were affected, and 68 died (International Federation of Red Cross and Red Crescent Societies 2016). Just one month later, close to 100,000 people were affected by further heavy rainfall and flooding, with 40,000 displaced and with damage across a range of social and productive sectors (International Federation of Red Cross

and Red Crescent Societies 2016). Madagascar's vulnerability to such shocks and their impact on the economy—particularly on infrastructure and health—has been recognized in Madagascar's Nationally Determined Contribution report.

The total economic cost of an extreme weather event can be understood in terms of the immediate impact directly attributable to the damage, plus secondary impacts throughout the economy as a result of decreased production, spending, and consumption. Long-term, chronic conditions also often result following a shock, though they can be difficult to attribute and track. For example, certain infectious diseases can have long-term impacts on organs, and loss of homes and livelihoods can result in years of mental stress and poor nutrition. The extent of the damage to health infrastructure is related to both the intensity of the climate event and the pre-existing condition of buildings.

Climate shocks have impacted the health sector in two ways: directly through damage on healthcare facilities and associated infrastructure (such as power and transport), as well as indirectly through an increase in patients and a rise in disaster-related illnesses, such as infectious disease. Reports of cholera incidences spiked after 2015 floods (Bickton 2016). The rains created favorable conditions for disease outbreaks, which added to the already precarious health situation of the country. The displacement of people after cyclones or droughts poses an additional health risk. Cyclones and droughts often drive large internal population movements, with attendant issues of establishing healthcare providers, sanitation, and coping with the risk of spread of diseases.

While data are limited on the cost of such events on the health system and its ability to recover and manage the increases in climate-related cases, the World Bank and United Nations carried out an assessment of the costs of cyclones in Madagascar (World Bank and United Nations 2008). The report estimated that cyclones imposed economic costs of at least US\$330 million on the country (in 2008 terms), with US\$10.3 million borne by the health sector. An estimated 167 basic health centers and six hospitals in 12 regions were damaged, with additional costs due to outbreaks of diseases. In addition to the constraints imposed on the health sector through physical damage, there were reports of 100 deaths directly attributable to cyclones, with more than 600 people reporting to health facilities to seek help for injuries. Most of this damage was concentrated in the regions of Analanjirifo, Atsinanana, and Haute Matsiara.

The health sector is also affected by slow-onset climate stress, including rising temperatures, changes in freshwater availability, and a rising sea level. As discussed in Section 2, these impacts will be felt through ecosystems and human systems, especially agriculture. Increasingly, access to health services is also challenged by climate change, as numerous communities are seasonally isolated for months at a time (World Bank 2015b). Even those communities

### Box 3.4: Quantifying the Cost of Climate Shocks on the Health Sector

Madagascar experiences about US\$100 million in economic losses annually from cyclones, earthquakes, and floods (GFDRR 2017).

While data is limited on the cost of such events to the health system, an assessment of the 2008 events give an indication of the possible magnitude. Conservatively, and as mentioned earlier in this section, the total cost to the economy was seen at US\$330 million, with health infrastructure representing US\$10.3 million of this amount. Physical assets represented approximately 70 percent of this cost, with around 30 percent of this proportion comprising equipment and furniture, medicines and supplies, and losses of revenues to health facilities.

Damage to health infrastructure, as well as to roads connecting communities with health facilities, closed several health centers, disrupting the country's health services at a time of increased need. This included the treatment of common diseases and diseases covered by control and prevention programs, especially with regard to maternal-child health. Although already significant, the damage estimates show only the quantifiable monetary costs associated with such an event and thus understate the true cost to the economy.

with a health center suffer during the rainy season, since referrals to hospitals are impossible, replenishment of drugs is slower, and supervisory visits are virtually nonexistent. Addressing the impacts of climate variability and change on the health sector requires addressing issues of poverty, sanitation, nutrition, and environmental degradation, all of which significantly hamper a community's resilience and its capacity to adapt.

## Current Low-Carbon and Sustainability Dimensions of the Healthcare Sector

There has yet to be an assessment of the low-carbon dimensions of the health sector. Doing so is important for building climate-smart health systems, and this should be addressed in a detailed assessment.

## Current Status of Health and Climate-Related Activities

### Key Players

The Ministry of Health sits directly under the President's Office and is led by the Minister of Health (World Bank 2015b). The

country has identified a national focal point for climate change in the Ministry of Health and is actively engaged in continuing to build institutional and technical capacities to work on climate change and health (WHO 2015). The focal point plays a coordination role between the Health Ministry and the country's climate change institutions. The Groupe de Travail—Santé et Changement Climatique (GTSCC), established in partnership with the WMO/WHO joint office, is also a key player in advancing work in this field through the Director General of Meteorology in Madagascar. The National Nutrition Office (ONN) is also an important stakeholder given the expected impact of climate on nutrition. ONN, although directly attached to the Prime Minister's Office, is headed by a National Coordinator. This is not a ministerial position but the equivalent to a general director within a ministry. The ONN has administrative and financial autonomy and is tasked with the coordination and the implementation of the National Nutrition Policy and Strategy. However, given the hierarchy within the government, the National Coordinator cannot formally mobilize the Ministers nor sit on the council of ministers. The National Institute for Public and Community Health is the lead organization for ethical review and education, training, and capacity building nationally. It is likely that these coordination issues will become an additional stress point in future climate and health efforts in the country.

In addition to the above key players, there are a series of ministries who will play an important multi-sector role: Ministry of the Environment, Ecology, and Water and Forests; Ministry of Rural Development; Ministry of Agriculture; Ministry of Fisheries; Ministry of Education; Ministry of Transportation; Ministry of Energy; Ministry of Finance and Budget; and Ministry of the Interior. Additionally, the National Office of Catastrophic Risk Management and the National Office of Climate Change Coordination are essential partners given their multi-sector functions. UNICEF is an example of an organization that is implementing key activities and interventions in Madagascar, and it recently issued requests for approaches to biodiversity and human health to begin integrating planetary health approaches. Lastly, civil society and academia are necessary partners to mainstream these climate-health activities.

## Relevant Development Policies, Plans, and Government Priorities

Madagascar is a signatory to the United Nations Framework Convention on Climate Change (UNFCCC), and the Government of Madagascar has taken a number of steps to identify priority activities to build resilience to the anticipated impacts of climate change. Health is a primary pillar of many of these strategies, and will be a fundamental determinant of the ability of the country

### Box 3.5: Interagency Working Group on Climate Change and Health

In 2008, the government established an interagency working group on climate change and health to identify the climate and weather information and service needs of the health sector, including gaps in data, information, and service delivery. It also sought to help the Madagascar meteorological service meet the specific needs of the health sector. It also aimed to help the health sector use climate data and information efficiently for the prevention of epidemics and for guiding response activities for climate-sensitive diseases in the country. The working group has been a catalyst for resource mobilization and climate and health engagement across the government.

The working group (Groupe de Travail—Santé et Changement Climatique) has provided indispensable guidance and insight during the course of this project and has organized two consultations to directly inform this work.

to meet its Sustainable Development Goal targets in the face of increasingly challenging weather conditions.

Its National Adaptation Program of Action (NAPA) laid the groundwork for initiatives on climate change in 2006, identifying health as one of the priority adaptation sectors for the country. The NAPA identified a need to build, strengthen, and decentralize local health services, staff, and infrastructure (GFDRR 2011). It also identified the need for infrastructure that could withstand weather upheavals. Although the NAPA excludes an explicit mention of the negative impact that climate might have on health, it establishes health as a key determinant of climate adaptation for the Malagasy population. Madagascar has an approved national health adaptation plan which serves as a road map for policy action on health adaptation to climate change (WHO 2015).

The Madagascar Action Plan (MAP), a five-year plan covering 2007–2012, established eight national strategies for the country: responsible governance; connected infrastructure; educational transformation; rural development and a ‘Green Revolution’; health, family planning, and the fight against HIV/AIDS; a high-growth economy; cherishing the environment; and national solidarity. While the MAP did not directly address the impacts of climate on the country, climate is embedded in the document, particularly through a disaster lens (GFDRR 2011). Following the change in political leadership, MAP has now transitioned into the National Development Plan (PND).

Madagascar’s First Nationally Determined Contribution (NDC) recognizes that Madagascar is committed to contributing to mitigating climate change, as well as to reduce climate change vulnerability and promote adaptation measures (see Annex 2).

Health is noted as one of the priority areas for adaptation, along with agriculture and coastal zone management. The NDC notes that multi-hazard early warning systems, as well as public health surveillance, are priority adaptation options. The First NDC establishes a focus on adaptation in healthcare and is expected to result in increased efforts from all stakeholders to increase the sector’s ability to respond to potential climate risks. However, there is room for expanded actions with regard to such activities. This Climate and Health Diagnostic is expected to be an important input into future revisions to the NDC and aims to highlight prioritized, high-impact actions for the country that can fulfil both its adaptation and mitigation ambitions. While the health sector is not noted as a mitigation priority sector, large climate co-benefits are likely in the provision of climate-smart health infrastructure construction and operation, as discussed later in Section 4.

Madagascar ratified the Stockholm Convention on persistent organic pollutants in 2005 and in 2015 ratified the Minamata Convention on Mercury. Madagascar is one of four African countries implementing these two conventions in the health sector in a joint project with the UN Development Programme (UNDP), WHO, and Health Care Without Harm (a nongovernmental organization). The aim is develop sustainable healthcare waste management systems and healthcare waste treatment technologies that do not produce persistent organic pollutants, and the substitution of non-mercury containing thermometers and sphygmomanometers.

Madagascar has established a number of other key policy documents aimed to address the development challenges and opportunities in the country, including the Common Country Assessment (2003) and the Poverty Reduction Strategy Paper (2007), among others. While these almost always identify health as a priority sector for the country’s economic development, without clear statements on the impact of climate on health and other important economic sectors, it is likely that the interplay between climate and economic development will be treated as separate. In reality, climate will impact the country’s ability to provide on all of its key objectives across sectors, including agriculture, infrastructure, water, and health.

Given the importance of health on Madagascar’s development outcomes, as well as the increasingly fundamental impact that climate change will likely have on the population (particularly among poor and vulnerable groups), the interplay between climate and health is an obvious priority for future adaptation efforts. Climate-smart healthcare, while encompassing the need to build resilience to climate impacts into the health sector’s ability to anticipate, respond, and recover from climate shocks and stresses, is expected to also assist in the country’s mitigation efforts. Work in this regard is nascent and includes the establishment of this Climate and Health Diagnostic. Madagascar should build on its approved national adaptation plan with regard to this emerging

### Box 3.6: Additional Key Policies and Programs for Consideration

1. National Policy to Combat Climate Change
2. National Action Plan for Nutrition
3. National Nutrition Policy
4. National Health-Environment Policy
5. National Action of Appropriate Attenuation
6. National Medicines Management Policy
7. National Environmental Action Plan
8. Madagascar National Action Plan for Adaptation of Health Sector to Climate Change
9. National Strategy and Action Plan for Biodiversity, 2015–2025

work as a critical component of strengthening its ability to respond to climate impacts across its economy (WHO 2015). In order to do so, the country will need to scale up its efforts on climate and

health following the assessment of the system’s key stress points in this diagnostic.

### Inequities in Coverage and Other Hurdles Impede Improvement

Despite some progress toward building a more climate-smart sector since the political crises of 2009, the country’s health sector still faces acute constraints in addressing public health challenges. Coverage of health and nutrition services is limited and marked by substantial inequities. On the demand side, beneficiaries face a number of financial, geographic, and cultural obstacles to accessing services. The absence of prepayment mechanisms in Madagascar, combined with a cost recovery system that does not have formal fees for all services but requires patients to pay for materials and other small inputs when getting services, makes public health care expensive for the poor and limits their ability to seek help. In short, the health sector’s performance is severely constrained, even without the anticipated increase in climate-related health impacts, as well as constraints imposed across the economy due to climate shocks and stresses.

The government’s expert working group on climate change and health has identified many of these threats and articulated them in the national action plan. Interventions building on these are presented in Section 4, and direct links to investment are given in Section 5.

## SECTION

# 4

## Recommended Interventions

As opposed to most environmental health hazards where exposures can be reduced over time with improved control (e.g., exposure to tobacco smoke, groundwater sources of arsenic), climate change will increase for several decades after emissions are reduced. Further, vulnerabilities will shift because of changes in climate and because of changes in urban form, technology, access to safe water and improved sanitation, and factors associated with development choices. It is also a far more multifactorial process than other types of exposure that public health specialists have tackled in the past. New evidence and knowledge on projections of climate change and vulnerability, and best practices in adaptation will affect options for managing the health risks of climate change. Together, these changes are likely to alter the effectiveness and success of health systems strategies and policies. In some cases, climate change could affect the longer term sustainability and resilience of a program, such as those designed to ensure access to safe water in coastal zones experiencing sea level rise and storm surges.

Given that the health risks of climate variability and climate change are, in general, not new, health systems have policies and programs to manage climate-sensitive health outcomes. As these policies and programs were developed without taking climate into account, they will become increasingly less effective as climate change alters disease risk. Further, because health risks vary over spatial and temporal scales, the extent to which a particular program or intervention could be affected by a particular hazard at a particular time will depend on local vulnerabilities and capacities. What is a low risk in one context could be a high risk in another. Given that climate will continue to change for decades and longer, modifications to environmental and health systems should aim to increase resilience to current and future risks, creating where possible increased flexibility to address future hazards as they arise.

What is needed is a programmatic approach to increasing health sector performance in the face of climate change. Modifying current programs to manage each climate-related hazard separately may lead to inadequate preparation of health systems to manage multiple and synergistic exposures. Instead, a holistic approach that incorporates a range of interconnected climate-smart interventions, as well as those that incorporate interventions outside of the health sector, should be adopted to meet climate-smart health system goals.

In addition to addressing vulnerability and risk, it is worthwhile to also consider low-carbon interventions. Mitigation and adaptation are truly two sides of the same climate change coin; if extensive efforts are to be undertaken to adapt to the health-related impacts of climate change, one should also consider how to improve health-related systems so they contribute less to underlying causes of the threats. The extensive exercise of conducting a climate change and health diagnostic enables considerable generation of knowledge and convening of relevant personnel, and so discussion of greenhouse

gas reducing efforts is timely, appropriate, and necessary if we are to build truly climate-smart health systems.

## Resilience and Low-Carbon Interventions in the Health Sector

New investments in any sector should contribute to building resilience to climate change. This is particularly important for the health sector, which serves on the frontline between human well-being and the environment. The health sector must be built strong to meet changing climate pressures (e.g., higher temperatures, increased precipitation, and stronger storms) and also increasing populations, local environmental degradation, and emerging infectious disease outbreaks. Resilience is particularly important in the context of climate change given the complex, unpredictable, and multifaceted ways in which climate change affects health systems and infrastructure. Vulnerable health systems will simply be unable to cope with threats posed by climate change.

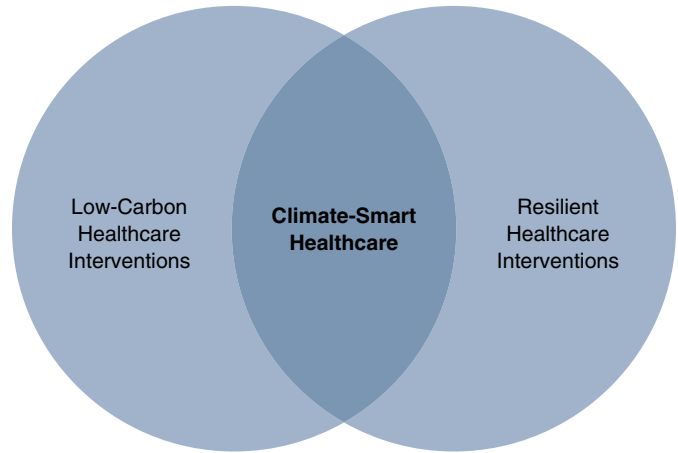
There is also no doubt that health systems in many countries contribute significant greenhouse gas emissions. Although the relative carbon footprint of the health sector in Madagascar is low compared to other countries, it is still important to consider low-carbon interventions, particularly as access to healthcare and service delivery improve as the country develops. Investment in low-carbon healthcare systems can foster clean and independent energy, safe water, clean transport, and clean waste disposal mechanisms. These can help create local capacity and services by strengthening the infrastructure needed for low cost, sustainable, and resilient facilities while strengthening the market viability of low-carbon technologies. Low-carbon healthcare brings added benefits to health and local economies, and it provides financial incentives. It also demonstrates leadership from health systems, providing an example for others to follow. The positive contribution to health is most easily demonstrated through reduced air pollution and its subsequent reduction in the burden of disease.

Given Madagascar's cohesion on the climate and health agenda, it is well positioned to become a leader in the new field of climate-smart healthcare (Figure 4.1), which combines low-carbon and resilience approaches into a new practice that maximizes benefits for people and the planet. In line with the overview presented in Section 3, this section will describe investment opportunities with the greatest potential to safeguard development gains and address health risks and opportunities in a systematic way.

### About the interventions

1. All recommended interventions have been identified as “climate-specific top-ups” that should be considered as additional to existing and planned interventions in evidence-based public health risk management and disease control.

Figure 4.1: Climate smart healthcare.



2. Presented interventions are illustrative of the types of actions that can be taken based on the national consultation process and should not be regarded as exhaustive or comprehensive.
3. Five climate-sensitive health impacts have been chosen as the focus of this diagnostic but do not represent all the potential health impacts of climate change. These include nutrition, waterborne diseases, vector-borne diseases, health impacts of extreme weather events (EWEs), and health impacts of air pollution.
4. Interventions are interrelated and depend on sequencing within existing initiatives in the country. For these reasons, they are not prioritized.
5. Recommended interventions largely aim to improve understanding and monitoring of health vulnerability and the relationship to the environment and climate; to anticipate and prepare for changing risks over different spatial and time frames; to promote multi-dimensional and iterative risk management; and to add flexibility to current public health interventions that can help them perform better under a variety of climates.
6. The interventions point to no regrets investments to strengthen systems to manage health risks regardless of how the climate changes in the future.

## Resilience-Building Priority Interventions

During government consultation, it became clear that resilience interventions specifically applied to the health sector through WBG HNP investments would be insufficient in achieving climate-smart

health outcomes. Climate-smart interventions in many other sectors, like agriculture, water and sanitation, and disaster risk management are key to safeguarding health in the face of climate change. This section therefore describes resilience building interventions across sectors that are needed to achieve these overall best results. Those that fit squarely within the health sector can be thought to be part of *climate-smart healthcare*; those recommended in other sectors are simply directed toward achieving *climate-smart health outcomes*.

They have been categorized by sector for best alignment with ministry work as well as WBG lending. Through the national consultation process, interventions in five key areas were identified: (1) nutrition, (2) water and sanitation, (3) disasters and extreme weather, (4) vector-borne disease, and (5) air pollution (Figure 4.2). While each corresponds to specific areas of investment within the WBG, there are higher level programmatic approaches independent of discipline. As a result, crosscutting systemic support interventions that may be taken at a central level or amongst multiple government departments have also been included to establish an enabling environment for sector work. Some of the recommended intervention themes recur under different sectors; these have been intentionally left in place to ensure that any readers looking only at one section will see the full list.

The interventions here (see Tables 4.1 and 4.2) are illustrative of the types of actions that can be taken, but are not comprehensive, given the expectation that more will emerge with implementation and as the full scope of needs becomes apparent. Broadly, recommended interventions aim to: improve understanding and monitoring of health vulnerability and the relationship between

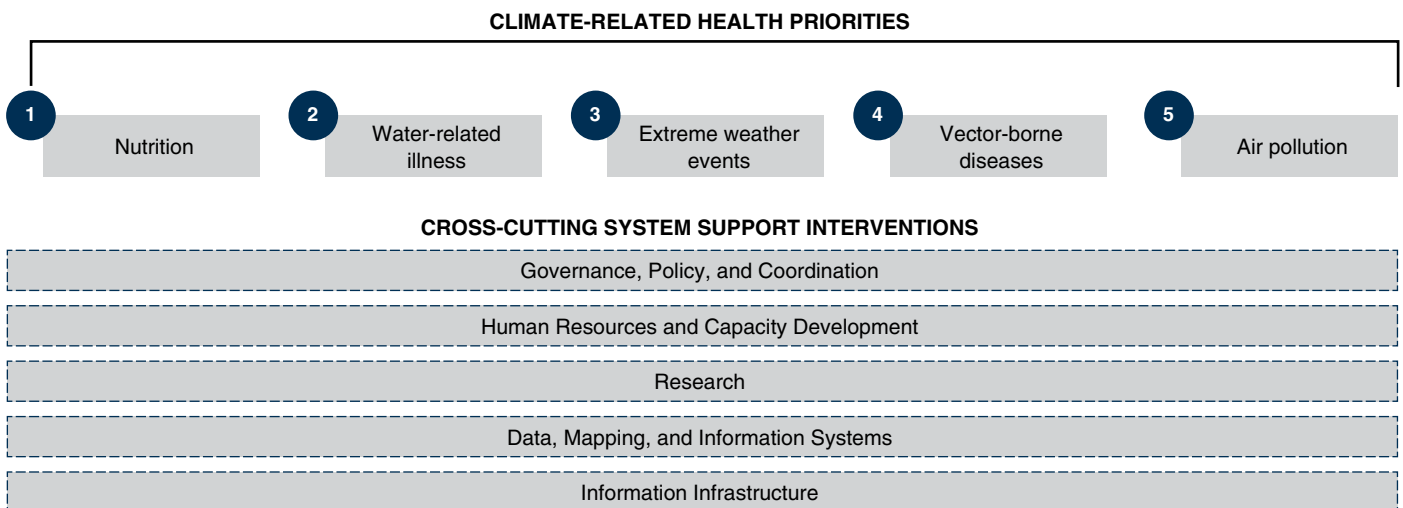
the environment and climate; anticipate and prepare for changing risks over different spatial and temporal scales; promote multi-dimensional and iterative risk management; and add flexibility to current public health interventions, which can help them perform better under a variety of climate scenarios.

## Interventions Focused on Outcomes and Sector

### Nutrition

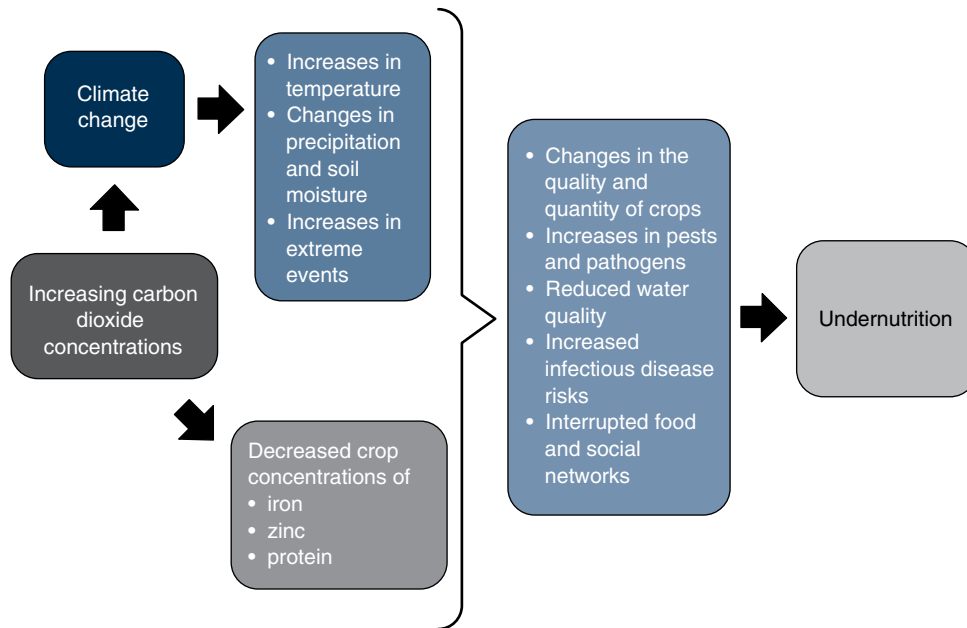
Undernutrition is widely recognized as the most critical human health issue in Madagascar, and new climate stresses will only worsen outcomes. Close to 50 percent of the population stunted and more than 40 percent of the population anemic, undernutrition is pointedly suspected as being the underlying driver. Inadequate food access and borderline famine conditions in some regions, inaccessible infrastructure to transport food nationally, and very low-input, low-tech agricultural production systems clearly illustrate the entire Malagasy food system's dependence on climate. Extreme weather events like droughts, flooding, and cyclones will lead to shocks in food production. Increasing temperatures and CO<sub>2</sub> will cause crop failure and reduced nutritional quality in food crops in some regions. Protein and nutrient content of some cereal crops will decline with rising atmospheric concentrations of CO<sub>2</sub> (Myers et al., 2014). Poor households that are reliant on autarchic food production systems (those that are entirely subsistence in nature) are easily disrupted by climate-related exposures like flooding, extreme heat, or pestilence. Given these systems are not market integrated, there is no trade option to smooth

Figure 4.2: Madagascar climate-related health priorities and intervention areas.





**Figure 4.3:** Connecting climate change to undernutrition.



Source: Ebi 2017.

shocks and stresses, leaving populations highly vulnerable and putting poor nutrition at the top of the list of climate-related health impacts (Figure 4.3).

Maintaining ecological integrity and appropriate agricultural land-use planning will protect Malagasy populations that are heavily reliant on natural resources. Strategic interventions designed to build resilient and climate-smart food systems will enable sustainable nutrition flows throughout the country. With the vast majority of Malagasy being agriculturalists, it is also essential to recognize the role of women in this sector as they represent 60 percent of the production force (INSTAT 2015). Mainstreaming gender sensitivity into agricultural and nutritional interventions will be of the utmost importance in determining the success and efficiency of interventions.

**Climate-Smart Nutrition Interventions**

Target regions: Atsimo-Atsinanana, Anosy, Androy, Amoron'i Mania, Analanjirofo, Morombe

*Education/Communication:*

- Integrate climate considerations into mass media and community awareness campaigns for nutrition and health.

- Promote education and training in meal preparation and choice for balanced and diverse meal consumption.

*Knowledge gaps:*

- Conduct climate and nutrition focused research to inform projects and investment and translate research findings for the public (see Section 5 for further elaboration).
- Analyze nutrient value of food products to inform appropriate dietary recommendations.

*Monitoring:*

- Assess dietary intake patterns and establish nutritional surveillance monitoring to pre-position aid and support for climate-related food shortages and undernutrition.
- Develop a strategy to monitor changing food production, quality, and safety in relation to changing climate conditions.

*Policy/Planning:*

- Align and integrate nutrition sensitive climate-smart agriculture approaches with the development of (i) multi-hazard disaster protocols and risk management protocols for the health

sector, and (ii) multi-sector guidance on norms and standards for enhancing nutritional outcomes through sustainable land use, soil conservation, marine spatial planning, and resource management.

## Water and Sanitation

Water- and sanitation-related illnesses are still a major driver of disease in Madagascar; less than 14 percent of the population had access to safe sanitation in 2012 (WSP 2015). This means that 19.2 million Malagasies did not have access to adequate sanitation in 2012, 8.6 million of whom practice open defecation. Additionally, surface water and shallow wells remain a source of water for many populations (WSP 2012). Madagascar's economy loses US\$103 million each year due to poor sanitation, of which 75 percent reflects annual premature death from diarrheal disease, and 90 percent of that is directly attributable to poor water, sanitation, and hygiene. (World Bank 2012).

The precarious water supply and sanitation systems in Madagascar are already highly vulnerable to present-day climate variability and are expected to worsen with climate change. Extended dry periods may cause water sources to dry up or become intermittent, reduce good hygiene practices, and accelerate airborne fecal dust in open defecation zones, all while reducing the performance of sewers, where they do exist. Extreme weather events may damage water- and sanitation-related infrastructure, while flooding may result in the contamination of water supplies. Sea level rise is expected to compromise water sources in some coastal regions through a range of impact pathways. As a result, it is highly likely that the incidence of diarrheal diseases will rise.

Strategic interventions designed to build climate-smart water and sanitation infrastructure and to align land-use planning across the environmental and rural development sectors will minimize the risk of an accelerating burden of diarrheal disease by minimizing contaminant exposures and ensuring sustainable infrastructure. Failure to ensure that services are resilient will have significant public health consequences. Without taking climate change into account, the limited progress made toward increasing access to drinking water supplies and sanitation is likely to suffer reversals in the near future.

### Climate-Smart Water and Sanitation Interventions

Target regions: Anosy, Androy, Atsimo-Andrefana, and Atsimo-Atsinanana

#### Capacity/Training:

- Integrate water and sanitation education into health worker training and activities, including house-hold water treatment and medical waste management.

- Train health and nutrition workers to anticipate and activate prevention measures to minimize increases in diarrheal disease following flooding, drought, and other extreme weather events.

#### Education/Communication:

- Integrate water and sanitation education in primary school education programs.

#### Knowledge gaps:

- Improve knowledge base and mapping of existing water and sanitation infrastructure and practices including location of medical waste facilities.
- Determine risks and susceptibility of water and sanitation infrastructure and practices to sea level rise, cyclonic disruption from flooding, etc., and develop appropriate planning that accommodates long-term change.
- Identify major regional gaps in infrastructure and then rank areas most likely to be affected by climate-induced increases in diarrheal disease.
- Conduct anthropological studies on water and sanitation practices in the targeted regions to improve intervention design.

#### Monitoring:

- Develop integrated meteorological and water and sanitation disease surveillance to help predict risk areas and to pre-position aid and support to at risk areas.

#### Policy/Planning:

- Develop climate-smart water and sanitation infrastructure in high-risk regions, accompanied by an iterative climate risk management plan to maintain and improve services as the climate changes. Interventions would need to be context specific, but should include interventions in 'safe' water and sanitation supply such as improved water supply sources, for example, hand pumps, or improved latrines (the UNICEF and Global Water Partnership's report *WASH: Climate Resilient Development* provides a useful approach for preparing such interventions).
- Align agricultural, livestock, and forestry land-use planning to minimize downstream water contamination.

## Disaster and Extreme Weather

Madagascar is expected to experience greater variability in precipitation and increases in temperature, sea level, sea surface temperature, and cyclonic activity and intensity. Each of these climate-related environmental changes is expected to magnify direct health impacts (drownings, physical trauma, forced migration),

indirect health impacts (diarrheal disease, vector-borne disease, etc.) and direct impacts on health system infrastructure and health care delivery. Ultimately, all will exacerbate the disease burden in Madagascar. Strategic interventions are needed to link disaster relief operations to health operations and to improve disaster preparedness, to build climate-smart health infrastructure, to develop climate-smart healthcare delivery, and to develop land-use planning protocols that create ecosystem resilience against likely climate change impacts.

### Climate-Smart Disaster and Extreme Weather Interventions

Target region: nationwide, but particularly areas prone to drought, cyclones, and flooding.

#### *Capacity/Training:*

- Train and mobilize health workers in climate-related disaster preparedness, response, and case detection for disaster-related outbreaks.

#### *Education/Communication:*

- Develop and deploy community awareness campaigns and seasonal disaster preparedness programming for floods, cyclones, and droughts; promote advisory and outreach services (using severe weather forecasting) via risk communication technologies to alert at risk populations.

#### *Knowledge gaps:*

- Map and audit the safety and preparedness of health infrastructures and update flood, drought, and cyclone risk mapping nationally.

#### *Monitoring:*

- Create a systematic and coherent registry to track health facility damages, economic costs, and human impacts of extreme weather events.
- Enhance hydrometeorological systems by strengthening and tailoring multi-hazard early warning systems for cyclones, floods, and droughts for health decision making, while creating more direct links to public health surveillance and monitoring systems (including air quality, harmful algal blooms, water quality, etc.).

#### *Policy/Planning:*

- Provide operational guidance including norms and standards (i.e., protocols) to guide investments for the construction of

facilities and development of health services that can withstand flood, drought, temperature extremes, and cyclones (including ambulatory and health logistics transport, communication and information and technology infrastructure, and water and sanitation infrastructure). Create government-led mandatory norms.

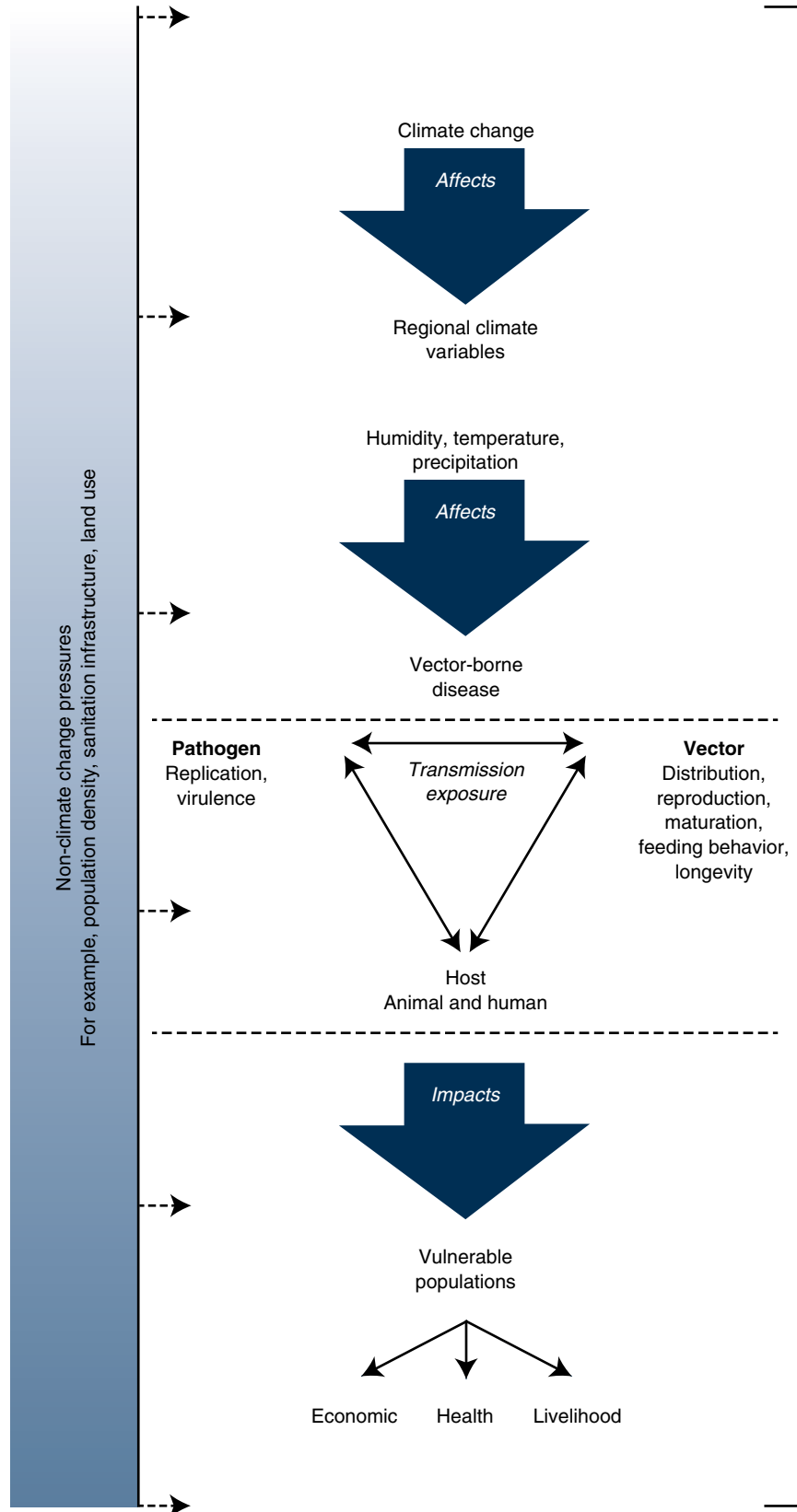
- Leverage humanitarian aid to raise awareness of specific climate-related health concerns and advocate for inter-sector coordination and risk management.
- Establish a clear partnership with neighboring facilities that will support the sharing of resources in a disaster including financial recoupment. This is something that can be performed immediately given the existing disaster response work in the country.
- Invest in measures to improve water and energy security of health facilities in regions prone to droughts, cyclones, and floods (e.g., solar/turbines and independent water sources) as well as disaster-proof medical waste management facilities.

### Vector-Borne Disease

Madagascar is likely to experience an increase in vector-borne disease for a number of reasons. As climate change is expected to increase temperatures and precipitation, this will create conditions that are ripe for the biological proliferation of vector-borne diseases. Climate influences virtually all components of disease systems (Figure 4.4): the pathogen (for instance, influencing the development rate or survival outside the host or vector), the host (through the immune response or changes in host distribution), and the vectors (arthropod vector development is tightly linked to climatic parameters such as temperature and humidity). Temperature affects arthropod vector development at embryonic, larval, and pupal stages, it influences adult feeding behavior, and it affects adult life spans. Similarly, aquatic or moist environments are often needed for breeding stages; high precipitation can create more reservoirs and thus amplify the number of breeding sites. Physically, storms that create debris establish breeding grounds for urban disease outbreaks, enabling further proliferation of disease carrying species, while drought can also lead to increased vector abundance. Vectors and hosts may also move as a result of climate impacts, such as floods or heat waves bringing the diseases to new areas.

Careful assessment and prediction in some regions and disease systems remain possible, as demonstrated by the numerous studies that have used statistical modeling to forecast the future distribution of species or disease (Rogers, Hay, and Packer 1996; McDermott et al., 2002; Purse et al., 2008). Even if other mechanistic causes

Figure 4.4: Pathways by which climate change may influence vector-borne diseases.



are implicated, addressing and mitigating the potential effects of climate change and climate variability on vector-borne disease promises significant benefits in Madagascar where humans live so closely in contact with livestock and other animals that are part of many vector-borne disease transmission life cycles. Key areas of focus include strategic interventions that link weather and disease surveillance to contribute to early warning systems and risk mapping, and aligning the livestock, forestry, agriculture, and land-use sectors for integrated vector management.

### Climate-Smart Vector-Borne Disease Interventions

Target regions (as defined by three important diseases identified by the interagency climate change and health working group):

- Malaria: Southeast, Analanjirifo, Atsimo-Andrefana, Vato Vavy, Melaky, Morombe
- Filariasis: Southeast and Vato Vavy
- Schistosomiasis: Southeast, Vato Vavy, Androy

#### *Knowledge gaps:*

- Create population-based and geographically specific risk maps for vector-borne diseases, and conduct operational and social science research on effective behaviors and control measures.

#### *Monitoring:*

- Locate, collate, clean, and digitize paper records to improve datasets for disease data, vectors, meteorological conditions, and environmental indicators (percentage of forest fires, percentage and locations of ecological zones). Improve ability to access and use remote sensing data of proxy variables environmental conditions (e.g., land use). Once existing data are understood, invest in hardware and software to carry out skill-based training to improve data collection, management, and analysis.

#### *Policy/Planning:*

- Develop an integrated health and environmental surveillance system that includes, at a minimum, meteorological and health data for use as an early warning system.
- Strengthen integrated vector management approaches and align timing and location of activities with potential climate-induced shifts in disease burden.
- Align agricultural, livestock, and forestry land-use planning to minimize disease transmission.
- Adopt a government-wide One Health approach to manage zoonotic disease risks.

### Air Pollution

The emissions that drive climate change are largely co-emitted by the same sources that are responsible for air pollution. WHO has recognized the large and significant role that ambient air pollution (AAP) and household air pollution (HAP), particularly in the developing world, play in increasing morbidity and mortality (WHO 2014b). The most recent Global Burden of Disease report estimates suggest that AAP and HAP combined were killing more than 5.5 million people annually by 2013 (IHME 2016; Risk Factors Collaborators 2015), more deaths than those attributable to malaria or tuberculosis. Of these, 2.9 million were due to exposure to household smoke from cooking, which constitutes the fourth-ranked risk factor for disease in developing countries (WHO 2014b). This is also a major source of black carbon, a short-lived but powerful driver of a warmer atmosphere. Tens of millions more suffer from related, preventable diseases, including pneumonia (which predominantly affects children), lung cancer, cardiovascular disease, stroke, and chronic obstructive pulmonary disease, which includes emphysema and bronchitis (WHO 2014b). Both AAP and HAP pose significant risks in Madagascar, with the effects of AAP felt in cities and in areas with certain types of industry, and HAP in rural areas where families are reliant upon cook-stoves.

Target regions include Antananarivo (AAP) and nationwide in rural areas (HAP).

### Climate-Smart Air Pollution Interventions

#### *Capacity/Training:*

- Train healthcare workers about pollution avoidance techniques that can be communicated to local patient populations.

#### *Education/Communication:*

- Educate urban populations and rural populations about dangers of prolonged exposure to harmful air, specific to their region.

#### *Knowledge gaps:*

- Establish a database and registers of pollution sensitive diseases, mapped to case incidences in cities and regions.

#### *Monitoring:*

- Identify concentration and types of pollutants in major cities using local sensors and satellite remote sensing data.

#### *Policy/Planning:*

- Scale up clean cookstove programs and coordinate across ministries.
- Develop and adopt city-wide plan to reduce transport-related air pollution in Antananarivo.

**Table 4.1:** Overview of climate and health interventions by impact category.

IMPACT CATEGORY	INTERVENTION	TARGETED REGIONS
Nutrition	<ul style="list-style-type: none"> <li>Align and integrate nutrition sensitive and climate-smart agriculture with the development of multi-hazard disaster protocols and guidance protocols for enhancing nutrition through sustainable land use, soil conservation, marine spatial planning, and resource management</li> <li>Assess dietary intake patterns and analyze nutrient composition of foods to inform dietary recommendations</li> <li>Establish nutritional surveillance and the monitoring of food system production, food safety, and food quality</li> <li>Develop mass media and community awareness messaging that embeds climate change into health and nutrition programs</li> <li>Promote education and training in meal preparation for optimal nutrition</li> </ul>	Atsimo-Atsinanana, Androy, Amoron'i Mania, Analanjorofo, Morombe
Water and sanitation	<ul style="list-style-type: none"> <li>Develop climate-smart water and sanitation infrastructure in high risk regions</li> <li>Map locations of existing water and sanitation infrastructure as well as health and waste management facilities</li> <li>Identify major regional gaps in infrastructure and triage according to climate-induced risk</li> <li>Conduct anthropological studies on water and sanitation practices in regions selected for intervention</li> <li>Integrate water and sanitation education and training into both community health worker training, as well as primary school education</li> <li>Train health and nutrition workers to anticipate and activate prevention measures to minimize disease risk following flooding and drought</li> <li>Align agricultural, livestock, and forestry land-use planning to minimize downstream water contamination</li> </ul>	Anosy, Androy, Atsimo-Andrefana, Atsimo-Atsinanana, Analanjorofo, Sava
Disaster and extreme weather	<ul style="list-style-type: none"> <li>Provide operational guidance—including norms and standards—for the construction of health facilities and healthcare delivery systems that will resist floods, droughts, temperature extremes, and cyclones. Generate government-led norms and standards</li> <li>Leverage aid to raise awareness of specific climate-health concerns and advocate for inter-sector management</li> <li>Map and audit health infrastructures and update flood, drought, and cyclone risk mapping nationally</li> <li>Invest in measures to improve water and energy security of health facilities</li> <li>Create a systematic and coherent registry to track health facility damages, economic costs, and human impacts of EWEs</li> <li>Develop and deploy community awareness campaigns and seasonal disaster preparedness for EWEs; provide advisory and outreach services via risk communication technologies to alert at-risk populations</li> <li>Train and mobilize health workers in climate-related disaster preparedness</li> <li>Strengthen and tailor multi-hazard early warning systems for EWEs, deteriorating air quality, and algal blooms and link them to human health surveillance</li> </ul>	Nation-wide, but particularly flood, drought, and cyclone prone regions

*(continued)*

Table 4.1: Continued

IMPACT CATEGORY	INTERVENTION	TARGETED REGIONS
Vector-borne disease	<ul style="list-style-type: none"> <li>• Create population-based and geographically specific risk maps for vector-borne diseases, and conduct operational and social science research on effective behavior and control mechanisms</li> <li>• Improve the understanding of relationships between weather variables, land-use patterns, and infectious diseases, and how climate change will affect them</li> <li>• Create a disease forecasting, early warning initiative</li> <li>• Develop an integrated health and environmental surveillance system that includes meteorological and health data</li> <li>• Strengthen integrated vector management approaches and align activities to with potential climate-induced burden shifts</li> <li>• Align agricultural, livestock, and forestry land use planning to minimize disease transmission</li> <li>• Adopt a government-wide “One Health” approach to manage zoonotic disease risks</li> </ul>	<p>Malaria: Atsimo-Atsinanana, Analanjirifo, Vatovavy, Melaky, Morombe</p> <p>Filariasis: Atsimo-Atsinanana, Vatovavy</p> <p>Schistosomiasis: Atsimo-Atsinanana, Vatovavy</p>
Air pollution	<ul style="list-style-type: none"> <li>• Identify types and concentrations of pollutants in major cities using local sensors and satellite remote sensing data</li> <li>• Establish database and registers of pollution sensitive diseases, mapped to case incidences in cities and regions</li> <li>• Scale up clean cookstove programs and coordinate across ministries</li> <li>• Develop and adopt a citywide plan to reduce transport-related air pollution in Antananarivo</li> <li>• Educate urban and rural populations about the dangers of prolonged exposure to harmful air, specific to their region</li> <li>• Train healthcare workers in pollution avoidance techniques that can be communicated to local patient populations</li> </ul>	<p>Ambient air pollution: Antananarivo</p> <p>Household air pollution: rural areas nationwide</p>

## Crosscutting Systemic Support to Build Resilience

In many ways, sector and health outcome focused interventions are impossible without the necessary crosscutting systemic support and enabling functions of: (i) governance, policy and coordination; (ii) human resources and capacity development; (iii) research; (iv) data, mapping, and information systems; and (v) information infrastructure. These primary crosscutting interventions—upon which all of the recommended interventions rest—are described below.

### I. Governance, policy, and coordination

1. Strengthen the health sector’s general performance through policies and interventions to reduce out-of-pocket expenditure on health for the poor, as well as healthcare provisions across the country, particularly in rural areas

that are highly vulnerable to climate impacts on health (World Bank 2015b).

2. Strengthen the existing working group on health and climate change, and mobilize resources for the implementation of the National Adaptation Plan on health and climate change.
3. Improve coordination between the country’s health sector and broader development and humanitarian actors to ensure climate change and health considerations are mainstreamed into development activities.
4. Reinforce action on drivers and impacts of other environmental degradations and develop synergies with relevant initiatives that also require an integrated approach, such as national action plans and implementation efforts for health security, disaster risk reduction, and ecosystem and biodiversity conservation.

5. Strengthen health services through rapid response capacity for climate sensitive outcomes, including surveillance and monitoring and raising awareness. An integrated surveillance system that includes health and environmental data is the foundation for developing early warning and response systems to improve current and future resilience to climate change.

## II. *Human resources and capacity development*

1. Assess environmental health human resources and institutional capacities in health and relevant multi-sector programming.
2. Establish subject- and competency-based training programs on health and climate, as well as disaster preparedness, that are appropriate for specific actors and their professional functions. This includes:
  - Health Ministry technical and planning staff (especially GTSCC members)
  - Health workers
  - Laboratory workers
  - University faculty and researchers
  - Staff at relevant partner institutions and ministries.
3. Conduct a comprehensive environmental health human resource development program that includes both training and job placement.
4. Support national academic and research community (Université d'Antananarivo, IPM, Institut Merieux) to (1) develop higher education curriculum in environmental health and climate; competency-based modules integrated in professional training programs (2) sponsor faculty to be trained in this; (3) provide training scholarships; and (4) facilitate job creation and on-the-job placement opportunities.
5. Monitor and evaluate efficacy of training programs and skill base in associated programming

## III. *Research*

1. Support research and the capacity of research institutions to generate evidence and relevant skills to identify, anticipate, and manage the health risks of climate variability at national and local levels.

2. Establish a climate and health research program that is accompanied by higher education and a specialized skill training programming.

## IV. *Data, mapping, and information systems*

1. Improve coordination and joint efforts between the Ministry of the Interior and Institut National de la Statistique (INSTAT) to improve the interoperability of their databases, and update statistics more effectively between the two entities for alignment of political boundaries, name changes, and population-based statistics.
2. Train staff, update technology, and support improved health and related risk factor data collection and management.
3. Establish a system for integrated surveillance to enable monitoring of key climate-sensitive diseases, as highlighted and articulated in *Climate Change and Health Diagnostic: A Country-Based Approach for Assessing Risks and Investing in Climate-Smart Health Systems* (World Bank 2017).
4. Reinforce sentinel systems and community-based surveillance for climate-sensitive health outcomes and disaster-related impacts.
5. Establish indicators of adaptation, losses, and damages, and the burden of climate-sensitive health outcomes to track progress.
6. Include climate and disaster risk screening in health system risk assessments and planning.
7. Conduct social and anthropological research on behaviors for waterborne and vector-borne disease risk.
8. Establish dynamic mapping of climate related health risks, updated seasonally or periodically

## V. *Information Infrastructure*

1. Improve information and communications technologies, coordination, and openness to improving infrastructure for real-time risk communication, including expansion of cellular networks and wireless connectivity.
2. Invest in hardware and software necessary for collecting, managing, and analyzing new environmental health data.
3. Build new—or increase access to—facilities that are capable of housing servers and information and communication technology (ICT) hardware.



### Box 4.1: Madagascar's Nationally Determined Contributions

In anticipation of an historic international climate agreement at the December 2015 United Nations Framework Convention on Climate Change Conference (UNFCCC) of Parties in Paris, many countries described climate actions they intended to take after 2020. Such statements came to be known as Intended Nationally Determined Contributions, pairing national policy with the global framework. The use of "intended" ceased following ratification of the Paris Agreement, and these declarations are now called Nationally Determined Contributions (NDCs). So far, 121 of 184 countries (66 percent) highlighted health in their NDCs; Madagascar was one of these.

Three of Madagascar's 13 priority actions (specifically, 3, 4, and 10) explicitly include health and sanitation, highlighting a recognized need for climate and health action. Others (6 and 7) deal with food security and agriculture, providing recognition of the link between climate and health, and by extrapolation, to nutrition.

There are new financial facilities that have been established to assist countries in achieving their contributions, and so it is important to highlight these here as consideration of NDC priorities may point to opportunities for further investment. Priority actions from the Madagascar NDC are included in Annex 3.

### Box 4.2: Madagascar National Health Sector Adaptation Plan

WHO recommends that Health National Adaptation Plans (HNAP) follow an assessment of climate and health vulnerability and adaptation needs as a means to plan and deliver necessary changes. In Madagascar, the Plan d'Action National d'Adaptation du Secteur Sante au Changement Climatique or PNASS was conducted in 2016, and represents a strong commitment of the government to take action in this area. It is an important unifying framework for climate change and health issues and highlights Malagasy priority areas. The list of recommendations is also relatively exhaustive and includes interventions that span multiple sectors, although the primary focus is within the health field. Many of the recommendations listed in the PNASS overlap with the interventions described in Table 4.1, which is anticipated since the PNASS recommendations were the basis for the government discussions on interventions.

Though PNASS recommendations are not largely different from WBG-suggested interventions, there are some points of departure. For example, PNASS interventions are presented in a series, beginning with risk evaluation and moving through program evaluation and management, whereas WBG interventions are delineated by category of health impact according to lending need. PNASS interventions are also more comprehensive in scope than the actions suggested by WBG, which were narrowed to focus on specific lending needs. Nevertheless, highlighting linkages to the PNASS is critical because it ensures the work that went into the multiyear process of preparation is preserved and the recommendations acknowledged, even if they must be narrowed in scope to be most useful to the WBG and other investors. For example, while "mobilizing all healthcare and related actors in the event of disasters" or "advocating with public and private partners to provide nutritious food to disaster victims" are important activities, they are difficult to itemize in investment and so have not been included in our list of interventions and should instead be used to inform the development of plans among different ministries. Nevertheless, the PNASS was a critical resource in the development of these interventions and the full list of recommendations is included in Annex 3.

## Low-Carbon Priority Interventions

While the above section describes resilience interventions across sectors toward achievement of climate-smart health outcomes, this section focuses on low-carbon interventions specifically for the health sector. The reason being that the list of recommended low-carbon interventions to improve health outcomes in any sector would simply include all low-carbon interventions. As low-carbon interventions primarily work toward decreasing pollution and limiting GHG emission, there are clear health benefits for cardiovascular and respiratory health regardless of the sector in which they are undertaken.

Recent WBG work has detailed key elements of low-carbon healthcare. These include:

- Low-carbon health system design and models of care based on climate-smart technology, coordinated care, emphasis on local providers, and driven by public health needs
- Building design and construction based on low-carbon approaches
- Investment programs in renewable energy and energy efficiency
- Waste minimization and sustainable healthcare waste management
- Sustainable transport and water consumption policies

- Low-carbon procurement policies for pharmaceuticals, medical devices, food, and other products
- Resilience strategies to withstand extreme weather events

Using these as high-level principles and in consultation with government partners, specific low-carbon interventions have been recommended for Madagascar that build on current programming and optimize for current capacity within the health system:

1. Develop a low-carbon strategy for the health sector.
2. Scale up community SME programming and markets around efficient and clean cookstoves, solar lamps, and communal energy charging activities.

**Table 4.2:** Low-carbon health sector interventions toward achieving climate-smart healthcare.

INTERVENTION	ACTIVITIES
Develop a low-carbon strategy for the health sector	<ul style="list-style-type: none"> <li>• Conduct an assessment of current capacities and needs</li> <li>• Meet with partners in the infrastructure and energy sectors toward establishing a plan</li> <li>• Support countries in gaining a deeper understanding of their energy vulnerabilities and in identifying opportunities for cost saving now and in the future</li> <li>• Map out a plan for the design of new facilities as well as retrofitting existing facilities</li> <li>• Work with international partners, such as Health Care Without Harm, that specialize in low-carbon health facility development</li> </ul>
Scale up community SME programming and markets for energy efficiency	<ul style="list-style-type: none"> <li>• Take stock of current small and medium enterprise (SME) activities in low-carbon energy that might be available to the health sector</li> <li>• Develop on-site renewable energy sources and storage capacity for resilience</li> <li>• Install reduced energy devices (e.g., lighting etc.)</li> <li>• Install passive cooling, heating, and ventilation</li> <li>• Use cold water detergents</li> </ul>
Scale up waste management programs, particularly existing pilot projects that use autoclaves	<ul style="list-style-type: none"> <li>• Reduce waste through reusable instruments and medical supplies in accordance with relevant hygiene and safety standards</li> <li>• Implement waste segregation programs to reduce the amount of waste that must be treated</li> <li>• Implement ecologically sustainable, low-carbon solutions for healthcare waste management, such as bio-digestion and autoclaving of infectious waste</li> <li>• Develop food waste biogas pilot projects that generate energy for health facilities on-site for potential scaling</li> <li>• Identify local landfills for medical waste recycling</li> <li>• Scale up existing autoclave programs for sterilizing pathogenic healthcare waste as an alternative to incineration</li> </ul>
Scale up the Green Hospital initiative	<ul style="list-style-type: none"> <li>• Conduct an analysis to determine those facilities that could be included in the Green Hospital Initiative</li> <li>• Develop a plan for expansion that includes a range of healthcare facilities</li> </ul>
Promote water use efficiency through multiple use	<ul style="list-style-type: none"> <li>• Conduct a system-wide readiness assessment for health facility efficient water programs</li> <li>• Establish a plan to introduce rainwater harvesting</li> <li>• Install low flow devices</li> <li>• Install recycling devices in appropriate facilities</li> </ul>
Establish training programs	<ul style="list-style-type: none"> <li>• Develop training curricula to train developers and health system facility managers in the value of low-carbon health sector interventions</li> <li>• Conduct training aligned with international standards to influence the construction of future facilities and the retrofitting of existing facilities</li> </ul>
Conduct health system-wide cost-benefit analyses	<ul style="list-style-type: none"> <li>• Conduct long-term cost-benefit analyses of the low-carbon interventions described in this document at the level of health system facilities</li> <li>• Integrate cost-benefit analyses into a low-carbon strategy</li> <li>• Present findings to health and finance ministries</li> </ul>

See *Climate Smart Healthcare: Low-Carbon and Resilience Strategies for the Health Sector* (WBG 2017) report for further details.

3. Scale up waste management programs, particularly existing pilot projects using autoclaves.
4. Scale up the Green Hospitals initiative.
5. Promote water use efficiency through multiple-use (i.e., grey water recycling) approaches.
6. Establish training programs to educate health policy decision makers in the value of low-carbon interventions.
7. Conduct health system-wide cost-benefit economic analyses to assess the value of decarbonizing the health sector.

Further details are provided in Table 4.2.

### Box 4.3: Global Green and Healthy Hospitals

The Global Green and Healthy Hospitals network (GGHH) is a worldwide network of more than 900 institutional members representing the interests of over 29,000 hospitals and health centers in 50 countries, including Madagascar. GGHH works with health facilities, health systems, ministries of health, international organizations (including WBG and WHO and health professional organizations) to help foster sustainable and climate-smart healthcare. Based on a 10-goal framework, the network offers a series of tools and resources, including case studies from hospitals around the world, guidance documents on energy, waste, water, buildings, procurement, and more. It also hosts an online data center and tool (Hippocrates) for managing and reducing the environmental footprint and GGHH Connect, a social media platform for members to communicate and collaborate with one another. It has launched the Green Health Challenges, which is an initiative to encourage sector-wide collaboration on waste, energy, and climate.

GGHH held a workshop in Madagascar in August 2017 at the request of UNDP and the Ministry of Health to build capacity for a comprehensive sustainability program.

## Relevant WBG Tools and Resources

This section describes several existing tools within the WBG that may be useful in helping task teams address the recommendations and implement the interventions.

### Climate Change and Health Website

The World Bank has been working to address climate change and health risks and opportunities for several years. As a result, there are a number of reports and knowledge resources generated that can assist in the operationalization of climate change and health project interventions. For example, *The World Bank Approach and Action Plan for Climate Change and Health* offers guidance on framing climate change and health. *Climate Smart Healthcare: Low-Carbon and Resilience Strategies for the Health Sector* offers a comprehensive list of tools and resources for climate-smart health programming. *Geographic Hotspots for World Bank Action on Climate Change and Health* provides a methodology for determining regions that are susceptible to climate change and health risks. Each of these, as well as other reports, training segments, factsheets, and links to non-WBG climate change and health work can be found at: <http://www.worldbank.org/en/topic/climatechange>.

## Climate and Disaster Risk Screening Tools

WBG's Climate and Disaster Risk Screening Tools developed provide a systematic means to considering short- and long-term climate and disaster risks in project and national/sector planning processes. Screening is an initial, but essential, step to ensure these risks are assessed and managed to support mainstreaming of climate and disaster resilience into key development policies, programs, and projects.

These self-paced tools provide high-level screening at an early stage of program and/or project development. The tools do not provide a detailed risk analysis, nor do they suggest specific options for increasing the project's resilience. They are intended to help determine the need for further studies, consultation, and dialogue in the course of program or project design.

These tools can be applied to a range of development sectors in support of national plans and strategies, and also project-level investments. The national/policy level tool targets national plans, sector-wide strategies, and development policy and institutional strengthening and reforms (<https://climatescreeningtools.worldbank.org>).

## Environmental Health Capacity Assessment Tool

WBG, in partnership with EcoHealth Alliance, has developed a tool for the country assessment of environmental health services. The tool aims to assist countries in: prioritizing and tracking capacity development; optimizing the use of existing infrastructure; and reinforcing progress in addressing other goals and action plans (e.g., climate adaptation, biodiversity conservation, tackling antimicrobial resistance, disaster risk reduction, and health security). Structured around core components of governance, technical, and focal (alien species) components, the tool establishes standardized criteria for environmental health capacity, while noting that the participation of multiple sectors is likely required for effective operations.

The tool is designed to highlight relevant areas that can reinforce overall ecosystem resilience, intending to build directly on existing climate and disaster risk screening tools and risk reduction resources. It also supports country capacity to anticipate how weather and climate change-related risks interact with other changing environmental factors. The tool's development originated from the WBG Operational Framework for Strengthening Public Health Systems at the Human-Animal-Environment Interface (aka. One Health Operational Framework), which emphasizes value-added application of One Health and the benefits of environment sector involvement in the public health system.

The assessment tool establishes an approach toward collecting and analyzing available data sources to produce a qualitative assessment report (modeling the assessment mission and report after the format used for the WHO's Joint External Evaluations). Application of the tool includes the convening of a stakeholder meeting with participating ministries to present the pilot assessment findings while verifying capacity strengths and gaps with country partners. The stakeholder meeting also serves to review possible opportunities to leverage existing capacity and initiate discussion on prioritization of capacity building needs and areas of alignment and/or reinforcement of existing goals. This is also an opportunity to seek feedback on the tool's overall utility and establish a possible scoring structure. Overall, this assessment tool will highlight country leadership, experience, and expertise while advocating for capacity support to strengthen areas within environmental health services.

### Global Facility for Disaster Risk Reduction Resources

The Global Facility for Disaster Reduction and Recovery (GFDRR) is a global partnership that helps developing countries better understand and reduce their vulnerability to natural hazards and climate change. GFDRR is a grant funding mechanism, managed by the WBG, that supports disaster risk management projects worldwide. Working with over 400 local, national, regional, and international partners, GFDRR provides knowledge, funding, and technical assistance.

In recent months, GFDRR has developed two tools that may be of use to the climate and health community: guidance material on post-disaster health sector recovery, and a knowledge hub concentrating on recovery operations.

In partnership with the International Recovery Platform (IRP) and Pan-American Health Organization (PAHO), WBG (through GFDRR) has developed a guidance note for post-disaster health sector recovery. The note is intended to provide action-oriented advice and interventions for local and central government health sector officials who face post-disaster challenges. Milestones are categorized by phases of recovery (immediate, short-term, and medium- to long-term) and specify policy, planning, financial, and implementation decisions that go into developing and implementing a health sector recovery plan.

This guidance is available on the GFDRR website in English and French (<https://www.gfdr.org/sites/default/files/2017-09/Health%20Guidance%20Note.pdf>).

WBG has also developed the 'Recovery Hub', a 'one-stop shop' for disaster recovery operations of which health is one of five featured sectors. The hub will feature knowledge resources,

case studies and project documents<sup>9</sup> (<https://www.gfdr.org/recovery-hub>).

### Operational Framework for Strengthening Public Health Systems at the Human-Animal-Environment Interface

The One Health concept recognizes the connections between humans, animals, and the environment and promotes coordination to better understand and manage risks. For over a decade, the WBG has worked to promote and operationalize One Health approaches, supported by country partners, technical institutions, international organizations, and development funders. There has been a considerable evidence base established on the topic, with reports and studies addressing various One Health dimensions, such as *People, Pathogens, and Our Planet*, the *Investing in Climate Change and Health* series, and *Drug-Resistant Infections: A Threat to Our Economic Future*. This analytical work has underpinned country operations like the Global Program for Avian Influenza and Human Pandemic Preparedness and Response, and the Regional Disease Surveillance Systems Enhancement program. An Operational Framework for Strengthening Public Health Systems at the Human-Animal-Environment Interface (or One Health Operational Framework) now builds on this experience and provides guidance to help optimize One Health operations.

The One Health Operational Framework supports country lending programs and establishes a step-by-step, how-to methodology for applying One Health in development operations. It outlines activities and interventions to target disease threats at the human-animal-environment (climate) interface, highlighting mechanisms for institutional and technical implementation to build more collaborative public health systems. It emphasizes elements that are critical to include in projects, including specific country requests for national priority issues. The approach presents steps and provides technical guidance for actions and capacity that can be taken at the country level along the 'prevent-detect-respond-recover' spectrum. It also provides examples of successful One Health projects to draw upon and replicate, while creating a platform for engagement among international organizations, development lending institutions, and national governments. See Annex 2 for further details of the One Health Operational Framework.

<sup>9</sup> Other related, publicly available disaster preparedness tools include ThinkHazard, which provides a general view of the threats, for a given location, that should be considered in project design and implementation to promote disaster and climate resilience, and the INFORM Risk Index, an open-source risk assessment for humanitarian crises and disasters. INFORM Risk Index can support decisions about prevention, preparedness, and response.



## SECTION

# 5

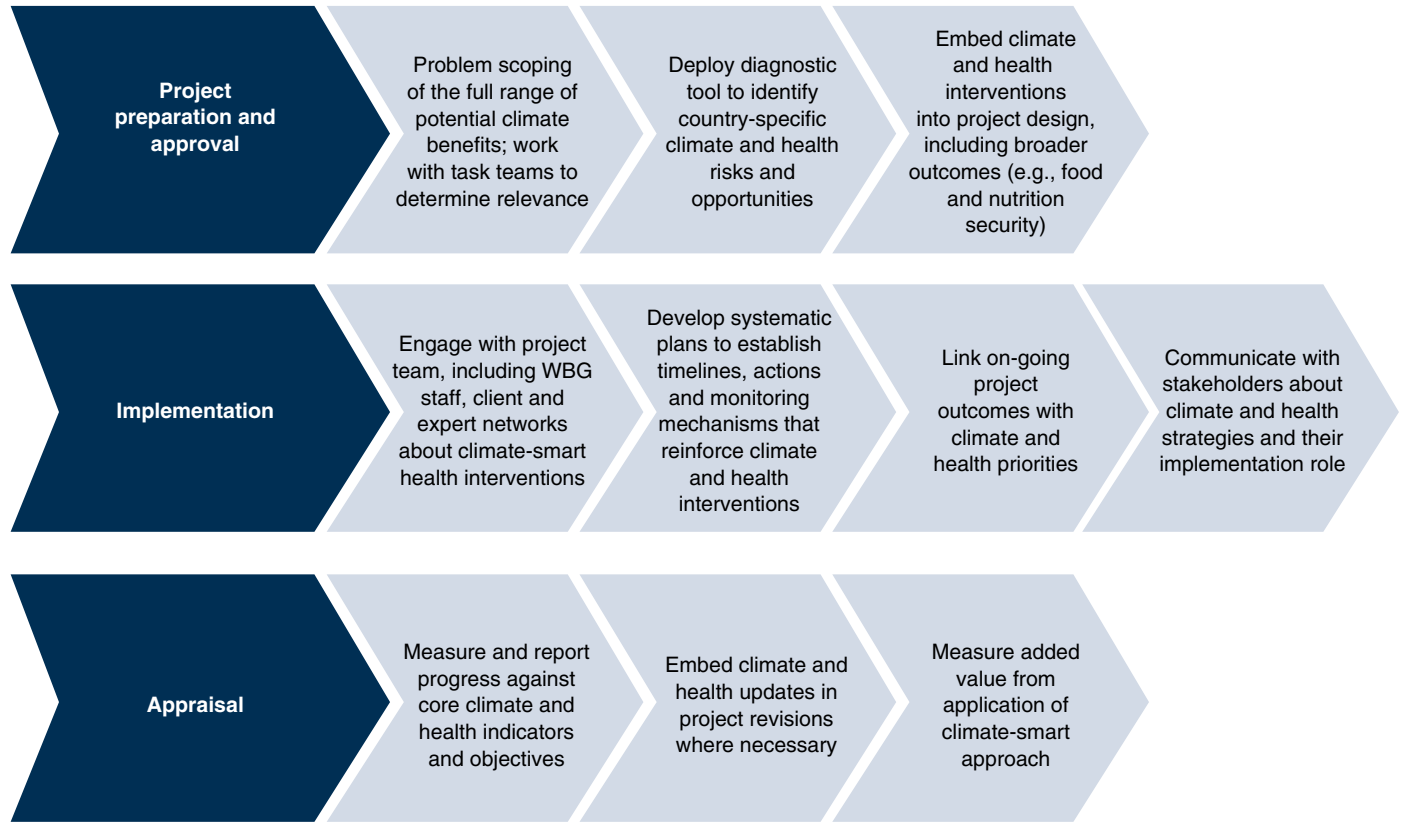
## Linking to Investment

As is clear from the previous sections of this report, there are considerable health risks associated with environmental degradation and climate change in Madagascar. In several respects, over centuries and decades, many of these impacts have already become apparent: undernutrition, diarrheal disease, vector-borne disease, disaster-related disease, and respiratory disease; not one is new to the island, yet each stands to expand geographically and among populations in our new era of climate reality. Section 2 outlined the effect of climate change in Madagascar and highlighted known and potential health risks in attempt to catalogue what is known and to establish a basis for action. Section 3 then provided an overview of the health system in country, spotlighting areas of potential weakness so that we may work toward making health systems more climate smart, and in effect strengthen institutions on the front lines of human protection and well-being. Section 4 offered interventions, both for the health sector and others, and sought to ensure that practitioners have resources and examples at their fingertips in designing programs.

Informed by this knowledge, Section 5 defines direct connections to WBG sectors and projects, describing interventions that could align with work on the ground. The aim is to provide a resource useful to WBG task teams working in each of the areas that follow. This does not preclude others at non-WBG organizations from using the above analysis and interventions for their own projects.

Climate interventions can be made at any point during the project cycle, from preparation through implementation, and appraisal. This is important as it suggests that no project is too early nor late to be considered for enhancement by integrating climate change and health considerations. Optimally, projects will be aligned during the design and preparation phase so that climate and health can be included from an early stage.

Figure 5.1: Interventions throughout the project cycle.



## Overview of WBG Lending in Madagascar

The bank’s current portfolio in Madagascar consists of 13 investments totaling US\$758 million. New funding of US\$1.3 billion has been announced for 2017–2020. This finance represents an opportunity to bring climate and health considerations into current future projects.

The interventions below are categorized by lending program. Particular focus has been paid to the Improving Nutrition Outcomes using the Multiphase Programmatic Approach Project (P160848), as this was the primary entry point for conducting this diagnostic and is the project most closely aligned with the assessment (results are presented in Table 5.1). A review of the Madagascar portfolio (both active and pipeline) was conducted, and three programs were identified for which climate and health interventions would be particularly relevant. Other Madagascar programs with lighter touch intervention options are listed in Table 5.2. There are additional global trust

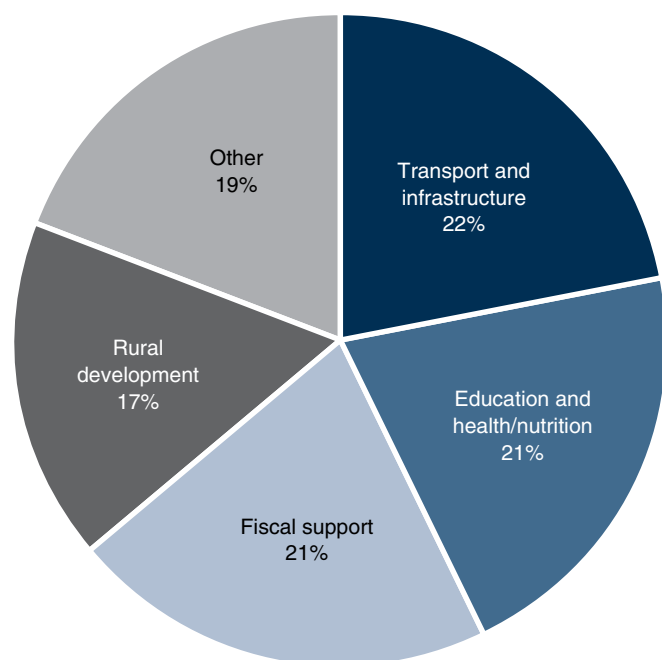
fund-related activities that could also benefit from climate change and health interventions; these are described in the subsequent subsection regarding trust fund activities.

## Madagascar Projects and Recommended Interventions

### Improving Nutrition Outcomes Using the Multiphase Programmatic Approach Project (P160848)

#### WBG GP: HNP

The Improving Nutrition Outcomes using the Multiphase Programmatic Approach project aims to increase utilization of a package of reproductive, maternal, and child health and nutrition interventions and improve key nutrition behaviors known to reduce stunting in targeted regions. This operation is a contribution to the first phase of the government’s longer term vision in achieving greater

**Figure 5.2:** Sector focus of active WBG projects, by value.

### Box 5.1: Working with the Government of Madagascar on Climate Change and Health

As described in Section 3, there are many potential government collaborators on climate change and health. Depending on intervention type and WBG project, the implementation partner will vary. However, an important first step in the preparation of any climate change and health intervention is discussion with the interagency working group on climate change and health (Groupe de Travail—Santé et Changement Climatique). The working group has been a catalyst for resource mobilization and climate and health engagement across the government since 2008 and has provided considerable guidance and support during the development of this report. First contact with this group will support the development of appropriate investments, frame subsequent government interactions, and ensure work builds on that which has already been undertaken.

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human capital. In this context, this project will aim to increase the utilization of a defined minimum package of maternal and child health and nutrition services and improve key nutrition behaviors known to reduce stunting by addressing a focused set of bottlenecks. Necessarily, the operation will focus on improving coordination between the nutrition and health sectors to jointly deliver the package. The project will also provide the necessary analytic and technical assistance support to inform the government on the more complex and longer-term institutional, financing, and policy reforms required to achieve and sustain results over time.

The Improving Nutrition Outcomes using the Multiphase Programmatic Approach project is envisioned as a 10-year estimated \$US200 million investment. The first phase was World Bank Board approved in December 2017 as a US\$90 million-dollar investment (including US\$10 million in cofinancing from Scaling Up Nutrition), and is expected to be facilitated during 2018–2022.

Not all of the climate change and health interventions presented in Section 4 are relevant to this project given the focus on maternal and childhood health and nutrition and the geographic focus in the central highlands (as they are not susceptible to all climate impacts). The interventions that follow are those that specifically align with project intentions.

## Interventions

Throughout the diagnostic process, consultations have been held with the HNP task team to inform the development of this project. As a result, many climate and health linkages and recommendations have been embedded within the Project Appraisal Document (PAD). The following section describes in detail the climate and health interventions associated with each PAD reference, as well as additional interventions that have been identified during country consultations. These interventions have also been reviewed and discussed with government and can be integrated during the project implementation phase. (High level recommendations are presented below, with further details presented in Table 5.1)

### *Low-carbon interventions:*

- Integrate climate-smart health education, inclusive of resilience dimensions, into healthcare worker and community training (PAD Section 3; para 37; page 25)
- Scale up the use of solar refrigerators used in healthcare facilities and solar batteries in data collection tablets used during surveillance and research (PAD Section 3; para 37; page 25)



*Resilience interventions:*

- Ensure supported Neglected Tropical Disease (NTD) interventions include consideration of climate-sensitive threats (PAD Section 1.A; para 5; page 11)
- Develop guidance that links climate-smart healthcare to climate-smart agriculture (PAD section 1.A.5; para 11)
- Integrate climate-smart health education, inclusive of resilience dimensions, into healthcare worker and community training (PAD Section 3; para 37; page 25)

- Contribute to disaster protocols that consider climate and health risks (PAD Section II.A; Component 4; para 49; page 29)
- Embed climate change in health and nutrition mass media campaigns (PAD Section III.A; para 40 and annex 5, Component 4; para 18; page 68)

*Research:*

- Conduct climate and health-relevant research to inform project implementation (PAD annex 3, para 4 and annex 5, para 16)

**Table 5.1:** Descriptions of climate-smart health interventions for Improving Nutrition Outcomes using the Multiphase Programmatic Approach project.

ACTIVITY	ACTIVITY DESCRIPTION	CLIMATE CHANGE AND HEALTH REFERENCE IN PAD
<b>Low carbon</b>		
Integrate climate-smart health education, inclusive of low-carbon dimensions, into healthcare worker and community training	This involves developing training courses and materials for health professionals, teachers, and the general public. The process will take several months as training materials need to be developed, translated, and courses conducted.	Section 3; para 37; page 25
Scale up use of solar refrigerators used in healthcare facilities and solar batteries in all data collection tablets used during research and surveillance	Switching to solar refrigeration units is advantageous for multiple reasons: it decreases grid dependency in regions prone to blackouts and it diminishes the overall carbon footprint of healthcare facilities. Use of solar batteries, in addition to being more climate smart, are also rechargeable and better for field research and surveillance.	Section 3; para 37; page 25
<b>Resilience</b>		
Ensure supported NTD interventions include consideration of climate-sensitive threats	There are a number of NTD-related interventions described in section 4. As this project works with the NTD community, climate-smart approaches to managing NTD risks should be advocated for.	Section 1.A; para 5; page 11
Develop guidance that links climate-smart healthcare to climate-smart agriculture	Both are of critical importance in Madagascar where the threat is shared. The known terminology around agriculture can perhaps make implementation of climate-smart healthcare more acceptable and efficient. Embedding climate-smart healthcare in this program will place it well ahead of the curve for when it becomes the norm for health systems to include low-carbon and resilience considerations.	Section 1.A; para 5; page 11

ACTIVITY	ACTIVITY DESCRIPTION	CLIMATE CHANGE AND HEALTH REFERENCE IN PAD
Integrate climate-smart health education, inclusive of resilience dimensions, into healthcare worker and community training	This involves developing training courses and materials for health professionals, teachers, and the general public. The process take several months as training materials need to be developed, translated, and courses conducted.	Section 3; para 37; page 25
Develop disaster protocols that consider climate and health risks	Health sector disaster and emergency response protocols, which are inclusive of climate change.	Section II.A. Component 4; para 49; page 29 Annex 5 Component 4; para 18; page 68
<b>Research</b>		
Conduct climate and health relevant research to inform project implementation	Research options presented below.	Annex 3; para 4; page 56 Annex 5; para 16; page 67
Embed climate change into health and nutrition mass media campaigns	Add climate considerations into ongoing and future campaigns and awareness raising initiatives that are focused on health and nutrition.	Section III.A; para 40
<b>RESEARCH OPTIONS</b> (To be explored through multiple World Bank lending programs in Madagascar)		
Research Area	Description	Approach and Estimated Cost
Assessment of dietary habits	What are people eating and when in different parts of Madagascar? The aim is to evaluate the food system-related vulnerability to climate change. It is essential to establish an understanding of existing problems, potential future problems, and appropriate interventions according to geography. There are a few possibilities for this research, all with different costs.	1) US\$40,000. Create a task force to synthesize and integrate existing research data from separate regions of Madagascar. This will be sparse and unlikely to have broad national coverage. It will also be collected in different ways so inter-regional comparison would be difficult. 2) US\$250,000–US\$300,000. Work jointly with INSTAT and Ministry of Health to launch a series of enumerators across the varying regions of Madagascar to collect prospective 24-hour recall data at low and high food seasons. This would involve the hiring and training of large teams of enumerators but would result in systematically collected data.
Baseline data collection on nutritional deficiency types	This is to include both anthropometry and micronutrient evaluation and link to infectious disease and noncommunicable disease emergence (through community-based epidemiological surveillance programs). Identification and analysis of baselines will facilitate data integration with environmental and climate parameters to project climate vulnerability. This is essentially two separate activities with the surveillance being most important to move the climate-smart health infrastructure forward: (i) estimation of nutritional deficiency types and (ii) development of epidemiological surveillance programs at the community level.	1) US\$800,000–US\$900,000 for comprehensive testing of all forms of micronutrients, vitamins, and fatty acids for all subjects, though the cost could be reduced based on a focus on certain subpopulations or forms of nutrition. 2) Current cost is US\$75,000 for 2 years of work for 8,000 people. This would reduce with scale. Perhaps US\$1 million total.

(continued)

Table 5.1: Continued

ACTIVITY	ACTIVITY DESCRIPTION	CLIMATE CHANGE AND HEALTH REFERENCE IN PAD
Drivers of maternal mortality	This is to include (1) down-eating during pregnancy for fear of difficult births; (2) nutritional choices during pregnancy; (3) use of uterotonics during and after delivery; (4) challenges in accessing prenatal care and a secure and safe and staffed place for delivery; and (5) ways in which climate change will affect healthcare infrastructures. Some are climate related, others are not. From a ministry perspective, maternal mortality is a priority. This would only need to be done on subsets, small focus groups, and limited surveys across different regions of Madagascar.	US\$10,000–US\$15,000. This work could be included in the dietary intake surveys. Cost would be the addition of a team of slightly different skilled enumerators. If done alone without the dietary intake surveys, then all of the travel and other costs would need to be embedded; likely near US\$50,000.
Influence of seasonal weather patterns and climate change on health and disease	Uses all of the other data being collected with collaborators from across Madagascar and beyond to run analyses, projections, etc. Would require some North–South partnership funding, student exchange, workshop costs, etc.	US\$100,000–US\$200,000 at low end and US\$500,000 at high end, if inclusive of new modeling.
Population microbiomes to understand the etiology of stunting	Determine underlying drivers. Is stunting diet related, absorptive, intestinal parasites, etc.? Important to ensure dietary interventions are appropriately targeted. Anecdotally, many believe that there are diverse dynamics driving the very high rates of stunting in Madagascar.	Most microbiome analyses are roughly US\$100–US\$150 per sample and microscopic analysis of fecal samples would be approximately US\$10 per sample. Therefore, US\$150 x “X” for a meaningful study.

## Integrated Urban Development and Resilience Project for Greater Antananarivo (P159756)

### WBG GPs and Programs: GPSURR, Water, GFDRR

The Integrated Urban Development and Resilience Project for Greater Antananarivo aims to improve the living conditions of the poor in selected low-income neighborhoods of Greater Antananarivo (GA). The focus is on enhancing basic service delivery and flood resilience and strengthening the government’s capacity for integrated urban management and effective response to eligible crises and emergencies.

The overall design of the project would represent the first phase of a series of projects under a long-term programmatic approach around improving integrated urban development and resilience for GA. Using a two-pronged approach, the project design would focus on: (i) targeting selected neighborhoods that are highly prone to flooding for upgrading basic services and flood resilience; and (ii) initiating key activities that would help the institutions tackle systemic issues of integrated urban development at the metropolitan level. It would thereby finance both corrective and preventive actions at both the neighborhood and GA levels. Corrective activities would include remedial interventions, mostly infrastructure and urban upgrading/improved service delivery

for existing low-income and highly vulnerable neighborhoods. Preventive actions would cover urban management processes, including planning, strategy, inter-communal and multi-stakeholder coordination, and municipal finance. The project would also help improve institutional arrangements (including potential reforms for solid waste management systems, storm water drainage, and flood protection) and capacities for service delivery at a metropolitan level. This US\$70-million investment is expected to be implemented 2018–2021.

### Climate Change and Health Entry Points

Climate-related events are a key consideration in the design of the current project, particularly extreme weather events and flooding. While investment in management capacity and flood infrastructure will go some way toward addressing health challenges associated with current and future climate risks, further linking the project with findings from this diagnostic would improve its overall impact on resilience.

Of particular relevance to this investment are recommendations relating to water and sanitation and disasters and extreme weather (see Section 4).

Capacity development with regard to urban planning should account in particular for climate risks associated with water supply,

sanitation, and hygiene. Specifically, there is the opportunity to create guidance that integrates water and sanitation infrastructure with health outcomes and urban planning. The development of climate-smart water and sanitation facilitates should be incorporated with specific reference to the fact that climate poses a considerable future burden on the city through its negative impact on water-related illness. Additionally, any further infrastructure development should include targeted climate-smart water and sanitation infrastructure in priority areas and develop a plan for how to maintain and improve services as the climate changes in the context of urban development. Integrating water and sanitation education should also be included into any training or capacity building the project provides. Lastly, where early warning systems are implemented or improved, these can easily be extended to include health warnings, and training should be given to build the capacity of urban planners and health providers to activate prevention measures to minimize increases in diarrheal disease following floods. Health risks should be included in any disaster preparedness training. All project investments should be low carbon and integrate climate-smart health education, inclusive of resilience dimensions, into community training.

### **Resiliency in the South (FY '19)**

#### ***WBG GPs and Programs: Social Inclusion and Labor, HNP***

The Social Safety Net Project (SSNP) for Madagascar aims to support the government in increasing the access of extremely poor households to safety net services and in laying the foundations for a social protection system. Cash transfers and community nutrition services would scale up existing safety nets to address urgent needs of the poorest populations in the five most affected districts (Tsihombe, Beloha, Ambovombe, Amboasary, and Bekily) suffering from the severe drought in the south of Madagascar. The drought has been exacerbated by climate-related factors, such as El Niño. The US\$35-million grant was approved in 2016 in response to the government's declaration of a humanitarian emergency for the region. As a result of El Niño, rainfall has been about 75 percent lower than the average of the last 20 years, causing harvest losses of up to 95 percent. Additionally, more than 1 million people have become food insecure, 35,000 children under 5 suffer from moderate acute malnutrition, and another 12,000 from severe acute malnutrition. The future climate-related implications are considerable, as impacts seen here closely align with climate change expected in the future.

#### ***Climate Change and Health Entry Points***

The project aligns closely with the findings in this diagnostic, particularly those regarding nutrition. Identification of vulnerable populations in this report further underline the impacted populations of this project. To be most effective and considerate

of climate change, cash transfers should include consideration of climate-sensitive threats, while including education and sensitization as to growing climate and health and nutrition concerns. In order to do this, it is suggested that cash transfer interventions are aligned with the climate-smart healthcare and nutrition sensitive climate-smart agriculture interventions described in Section 4. It is also recommended that communication campaigns include an awareness of seasonal nutrition needs and how these could be exacerbated by climate change. Efforts should also be made to promote education and training in meal preparation and choice for balanced and diverse meal consumption. Developing multi-sector guidance on norms and standards for enhancing nutritional outcomes through sustainable land use, soil conservation, marine spatial planning, and resource management would also enhance the climate resilience of this portfolio of work.

### **Trust Fund-Related Activities in Madagascar and Recommended Interventions**

In addition to discrete sectoral-focused projects, WBG operates a number of global goods-focused initiatives linked to centrally managed trust funds that have some relevance to climate change and health (and importantly, have relevance to work under way in Madagascar). Several of these are described below, as are connections to climate change and health work and opportunities for engagement with in-country lending.

#### **Pilot Program for Climate Resilience and Scaling Up Renewable Energy in Low-Income Countries Program**

The US\$1.2-billion Pilot Program for Climate Resilience (PPCR) is a funding window of the Climate Investment Funds (CIF) for climate change adaptation and resilience building. Using a two-phase, programmatic approach, the PPCR assists national governments in integrating climate resilience into development planning across sectors and stakeholder groups. It also provides additional funding to put the plan into action and pilot innovative public and private sector solutions to pressing climate-related risks. PPCR has been supporting Madagascar in better understanding overall climate vulnerability across sectors, identifying investments to strengthen institutional capacity and channeling public investments toward infrastructure and improved climate services. The country is developing a Strategic Program for Climate Resilience under the PPCR, aligned to five principles (spatial resilience; sector resilience; community resilience; infrastructure resilience; and fiscal resilience) as well as utilizing funds for the Scaling Up Renewable Energy in Low Income Countries Program under the CIF.

**Table 5.2:** Other World Bank projects in preparation in Madagascar and links to climate-smart health-related interventions

PROJECT	INTERVENTION	DESCRIPTION
Madagascar Basic Education Support Project (P160442)	Support the implementation of key elements of the government's sector plan to improve learning and completion of primary education, particularly access and quality of preschool/early childhood education.	Embed climate and health education in primary schools, particularly regarding water-related illness (and the expected negative impact of climate on these) as well as on changing vector-borne disease distribution and seasonality. Doing so will establish the basis for a well-informed, environmentally, and health aware public, while potentially inspiring young people toward future careers in public health and environment to address some of the capacity issues outlined in Section 3.
Private sector development: agriculture and tourism (FY '18)	Support private sector growth through small-scale agriculture and tourism development.	Include low-carbon development in tourism-related infrastructure; include health in development of climate-smart programs to address challenges in agriculture, such as worsening nutritional outcomes due to climate change (increasing temperatures, water scarcity and extreme weather events). Many of the interventions described in the Section 3 nutrition section may be applicable; e.g., early warning system development, education, syncing of climate-smart health and agriculture agendas.
Madagascar Inclusive and Resilient Growth (P162279)	Improve financial inclusion in Madagascar and increase access to credit for micro, small and medium enterprises.	Consider populations vulnerable to climate change and health issues in early assessments of target populations; incorporate projections to determine who will also be impacted in the future.
Agricultural support to the south (FY '18)	Build on current WBG agricultural projects that support market development and land rights by targeting vulnerable populations in the south of the country as identified in the current Country Partnership Framework (CPF).	Align climate-smart healthcare and nutrition-sensitive climate-smart agriculture approaches that address the negative outcomes of climate change on crop yield as well as nutritional content of crops. Inclusion of disaster protocols to build resilience to droughts and floods should also be included. Many of the interventions described in the Section 3 nutrition section may be applicable; e.g., early warning system development, education, syncing of climate-smart health and agriculture agendas.
Lead-cost Electricity Access Development (FY '18)	Improve electricity sector planning and financial sustainability, strengthen operational performance and governance of the state-run utility company, JIRAMA, and facilitate investments to enhance reliability of electricity transmission and distribution.	Consider low-carbon health facility assessment and planning in the development of electricity sector planning. Support the health sector to conduct a low-carbon (and energy access) study that could serve as a sentinel for other sectors in projecting future energy needs and opportunities. For more details see low-carbon interventions 1, 2, and 7 in Section 4.

### ***Climate Change and Health Entry Points***

Health is a fundamental component of climate change adaptation and resilience building, particularly in Madagascar where health and nutrition is identified in the Systemic Country Diagnostic (SCD) as a major area of concern for the country. There are significant areas of alignment between the Strategic Program for Climate

Resilience (SPCR), Pilot Program for Climate Resilience (PPCR) and the interventions highlighted in this diagnostic. The recommended initiatives outlined in this diagnostic, particularly regarding national health adaptation strategies, should be drawn on, while aligning with all four themes of the interventions described in Section 4.

## Madagascar Ethanol Clean Cooking Climate Finance Program

The Madagascar Ethanol Clean Cooking Climate Finance Program aims to increase household use of ethanol in cookstoves as a means of addressing the high incidence of acute respiratory infections due to household air pollution (HAP) and decrease the market demand for charcoal. Nearly 12,000 deaths per year in Madagascar are attributed to respiratory infections caused by inhalation of HAP from traditional cooking with biomass, of which over 10,000 involve children under five. The program makes use of results-based climate finance payments that are to be generated from Malagasy households adopting ethanol cooking solutions. Each household participating in this program is expected to consume 220 liters of ethanol, which replaces 2 tons of charcoal consumption and eliminates 5 tons of GHG emissions.

### *Climate Change and Health Entry Points*

There are obvious health benefits to be achieved through the use of cleaner cookstoves and clear climate benefits to switching away highly polluting sources that also compound local environmental degradation. Aligning climate change and health messaging and interventions with this work is critical because the project has similar endpoints (toward improving health and environmental impacts). Convening the cookstove community with the health and climate community will serve to cross-pollinate ideas amongst leaders in health, energy, and rural development. Of the interventions described in Section 4, there are clear synergies around education, capacity building, training, low-carbon development plans, household interventions, research, and risk assessment.

## Global Facility for Disaster Risk Reduction

This facility (GFDRR) has supported disaster risk management efforts in Madagascar since 2008, with a focus on identifying risks, mainstreaming climate and disaster resilience in economic development, and fostering disaster risk financing strategies.

With GFDRR assistance, Madagascar became the first country in Africa to conduct a joint damage, loss, and needs assessment. The assessment, conducted in collaboration with the European Union and the UN after the 2008 cyclones, estimated the damage caused to infrastructure, changes in economic flows, and impacts on social sectors. It also helped identify needs for post-disaster reconstruction and recovery.

GFDRR enabled the development and dissemination of risk atlases for high-risk regions and of construction codes for buildings and infrastructure. The construction codes provide climate proof standards for agriculture, irrigation systems, public health centers, roads, and schools in areas highly vulnerable to cyclones, droughts, and other climate shocks. Enforced construction codes are expected to stimulate economic development by improving building performance and reducing reconstruction and repair costs. The risk atlases are expected to strengthen regional and national decision making.

GFDRR supported an initiative in the southwest Indian Ocean region to help countries better identify risks and strengthen financial resilience to disasters. Activities have supported hazard data collection and developed country-specific risk profiles. This will assist Madagascar in assessing regional and national risk financing options.

Currently, GFDRR is facilitating a study to identify policy actions that have high potential to increase urban resilience and improve the quality of life of the poor in Antananarivo. This study will analyze household-level surveys; the study helps inform the national government and municipal authorities on how to better target and finance poverty reduction programs.

GFDRR anticipates demand from the Government of Madagascar to support:

- Preparing risk atlases and regional disaster response plans for priority regions
- Mainstreaming disaster risk management in urban and land-use planning and other priority sectors
- Strengthening urban resilience in the capital and other cities
- Modeling contingency funds at central and decentralized levels
- Expanding the risk assessment and financing initiative

### *Climate Change and Health Entry Points*

The links between climate change, health, and disasters are well described in Section 4. Many of these disaster risk management interventions will implicitly incorporate improvements in health, but may not measure health outcomes explicitly, or lead to projects with a health focus. The methods proposed in this report could be helpful for the preparation of most of these projects.



## Global Context of Climate Change and Health Impacts

Climate impacts health and this is likely to be greater in low- and middle-income countries. These are often most vulnerable to climate shifts and have the least capacity to take adaptation or mitigation measures given their weak health infrastructure and capacity. The threat posed by climate to health outcomes has been extensively discussed for some years and is seen to be growing.

Climate change impacts could drag more than 100 million people back into extreme poverty by 2030 (Hallegate et al., 2016), with a significant part of this reversal attributable to negative impacts on health outcomes. There is clear and mounting evidence that health outcomes will—in large part—be negatively impacted by rising sea levels and temperatures and weather extremes due to climate change. Several of the emissions that drive climate change also affect health directly. These impacts will be greatest in the poorest countries and regions where the population is densest, most vulnerable, and least equipped to adapt (World Bank 2012, 2013, and 2014a; Smith et al. 2014).

Given the complexity of social and environmental factors that influence disease and health outcomes, the precise extent of this impact is difficult to establish. WHO, for example, estimated in the early 2000s that climate change was already accounting for an additional 150,000 annual deaths (WHO 2004). Forecasts suggest that by 2030 an additional 250,000 deaths per year will occur from heat exposure, undernutrition, malaria, and diarrheal disease due to climate change. These estimates are regarded as conservative and do not include all climate-sensitive health impacts, such as pollution, injuries, non-malaria infectious disease, and others for which projection data are lacking (WHO 2014a).

This additional burden of disease comes with a significant economic global and local impact. One study (Ebi 2008) estimates the global additional costs associated with climate change-related cases of just three sets of diseases—malaria, diarrheal diseases, and malnutrition—to be US\$4–12 billion in 2030 under the business-as-usual scenario. A significant part of this burden is borne by poor countries where those three conditions are already persistent.

Separate work suggests there are also significant costs associated with disaster-related health impacts. Although little research has been undertaken for the developing world, it was estimated that climate-related disasters have already caused US\$14 billion in health-related costs over a 10-year period in the United States alone (Knowlton et al. 2011). Other research has estimated that impacts associated with labor productivity losses due to excess heat (correlating to health stress) may be as much as 11–20 percent in heat-prone regions such as Asia and the Caribbean by 2080 (Kjellstrom 2009). If avoided, these aggregate health costs—along with other benefits of limiting warming to 2°C—can amount to economic savings that exceed US\$1.5–2 billion per year for health sector adaptation and start to approach the estimated US\$70–100 billion per year of overall adaptation investment needed by 2050 (World Bank 2009).

Not all climate-related health impacts of concern will occur in the future. Along with some direct impacts, the emissions that drive climate change are largely co-emitted by the same sources that are responsible for air pollution. The Global Burden of Disease suggests that ambient air pollution (AAP) and, in the developing world, household air pollution (HAP) already kill more than 5.5 million people



annually (IHME 2016). Tens of millions more suffer from related diseases, including pneumonia (particularly affecting children), lung cancer, cardiovascular disease, stroke, and chronic obstructive pulmonary diseases (WHO 2015). As such, reducing emissions of greenhouse gases through better transport, food, and energy use choices can result in improved health, especially through the reduction of air pollution.

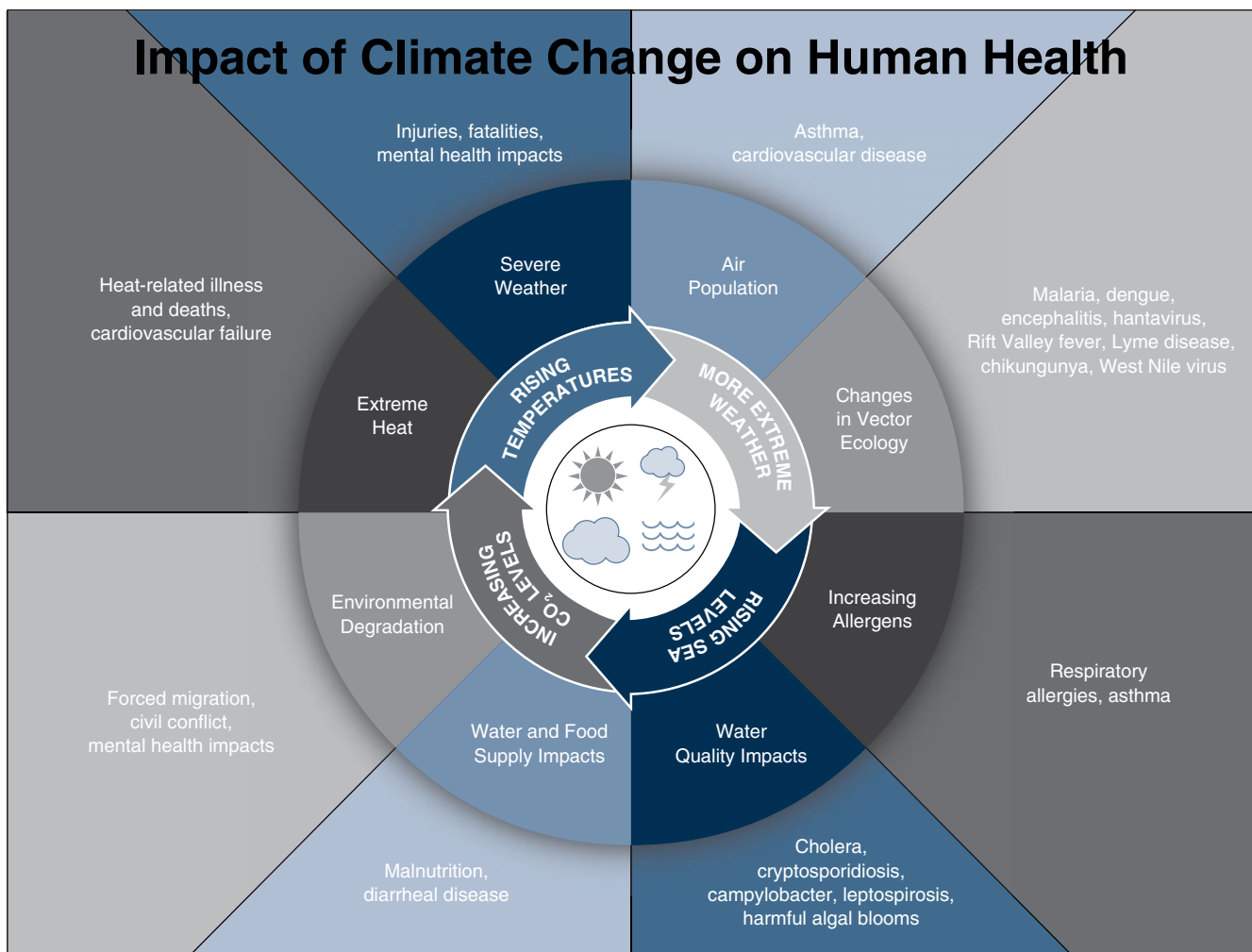
The economic costs associated with the air pollution-related burden of disease are also considerable. A study by the Organisation for Economic Co-operation and Development (OECD 2014) found that air pollution illnesses and mortalities correspond to US\$1.7 trillion of lost output annually in OECD countries, US\$1.4 trillion in China, and US\$500 billion in India.

### Climate Change Impacts on Human Health

There are many ways to categorize the health impacts of climate change. One way is through drivers (Figure 2.2), another is by visualizing impacts (Figure A1.1).

A significant percentage of the impacts of climate change and its drivers is preventable through a range of proven health and nonhealth interventions and adaptation measures that help increase a population’s resilience. According to the IPCC, there is substantial potential to reduce climate impacts on health across eight dimensions by shifting to higher levels of adaptation than

Figure A1.1: Exposure pathways by which climate change affects health.\*



Source: Dr. George Luber, CDC.

those currently proposed. Whether in infectious disease, heat waves, or natural disasters, history has shown that preparedness and response to threats can greatly limit the losses to health, human life, and economies. For example, in 1970 a Category 3 hurricane battered East Pakistan (present day Bangladesh) resulting in 500,000 deaths. Similar storms hit Bangladesh again in 1991 and 2007, causing 140,000 and 3,400 deaths, respectively. Collaborative adaptation over the intervening decades led to these dramatic improvements in lives lost (Smith et al. 2014) by increasing Bangladesh's resilience to natural disasters. The country shifted to a higher level of adaptation that included improving general disaster education (greatly assisted by rising literacy rates, especially among women), deployment of early warning systems (which included community mobilization), building a network of cyclone shelters, relocation efforts, and increasing connectivity of health facilities in high-risk areas.

Mitigation, in addition to delivering long-term health effects by reducing the level of GHG emission, would also have an immediate impact on health outcomes due to lower pollution levels. A significant proportion of potential deaths could be avoided with stringent climate mitigation, given air pollution's role as a co-emitted byproduct of fossil-fuel combustion. However, the remaining deaths are also avoidable through mitigation of black carbon and methane, the so-called short-lived climate pollutants or SLCPs (Rogelj et al., 2014).

Importantly, the present health status of a population may be the single most important predictor of both the future health impacts of climate change and the costs of adaptation (Smith et al., 2014). A population's health status is a function of both access to health services and general development, the latter measured through access to other basic goods and services such as food, education, clean water and energy, clean air, and disaster preparedness and protection. Currently, universal health coverage (UHC) is the ultimate goal of the health community as reflected in the new Sustainable Development Goals (SDGs), national health policies, and strategies at development institutions. Achieving UHC—that is, ensuring that 100 percent of the population has access to equitable and affordable basic health promotion, prevention, and treatment and rehabilitation services—would significantly contribute to increases in a population's resilience to both climate change impacts and the impacts of pollution.

Despite evidence both of the problems and their potential solutions, there has been little effort in most low- and low-middle income countries to increase the levels of community resilience through interventions in health and other sectors to improve health outcomes. This historic trend is currently changing, and we may be at a “tipping point” for health and climate change.



## Country-Identified Priority Actions for Climate Change and Health

The following sections present excerpts from two country prioritizations. They have been translated into English, but are otherwise transcriptions of what is found in each document.

### **A. Madagascar Nationally Determined Contributions (NDCs) (2016)**

Priority actions before 2020

1. Finalization and implementation of the National Adaptation Plan
2. Strengthen climate change adaptation mainstreaming in all strategic/framework documents
3. Multi-hazard early warning systems that mainly consider cyclones, floods, drought, and public health surveillance
4. Effective application of existing or newly established sectoral policies: flood and cyclone-resistant hydro-agricultural infrastructure standards, cyclone resistant building standards, flood-resistant terrestrial transport infrastructure standards, local climate hazard community guideline for water-sanitation-hygiene
5. Intensive awareness raising campaigns concerning the adverse effects of climate change and environmental degradation
6. Development of Resilient Agriculture Integrated Model pilot projects/programs (combination of watershed management, selected/adapted varieties, locally produced compost, rehabilitation of hydro-agricultural infrastructures, input access facilitation system, conservation agriculture, and agroforestry) or “climate-smart agriculture”
7. Promotion of intensive/improved rice farming system and rain-fed rice farming technique
8. Formulation and implementation of the national policy of the maritime territory of Malagasy, considering climate change
9. Formulation and implementation of the National Strategy for Integrated Water Resources Management
10. Evaluation of links between climate change and the migration of vector-borne diseases, malaria, and other emerging diseases as well as the evolution of acute respiratory infections, in order to identify remedial and/or corrective measures
11. Restoration of natural forests and reinforcement of habitat connectivity
12. Identification and sustainable management of climate refuge areas inside and outside protected areas
13. Contribution to the finalization of the “National Framework for Meteorological Services” for which Madagascar has committed itself to the World Meteorological Organization

## B. Madagascar PNAASS Recommendations (2016)

### I. Risk and Capacity Evaluation

Desired outcome: Risk factors for climate change are identified

1. Conduct assessments of sensitive risk factors including levels of risk to climate change for human health
2. Conduct descriptive modeling approaches to understand the pertinent health risks, with a view to setting up a surveillance and early warning system
3. Evaluate existing structures and programs by identifying capacity and gaps including technological needs for climate change

### II. Capacity Building

Desired outcome: Capacity for the effective management of public health risks related to climate change are made available

1. Prepare capacity-building plans specific to climate change adaptation to address identified weaknesses as a result of capacity assessment
2. Train members of the GTSCC on assessment and management of public health impacts resulting from climate change
3. Train national experts and civil society members in the adaptation of the health sector to climate change
4. Provide laboratories and research institutions with equipment and products: acquisition and deployment of appropriate technologies (satellite imagery, monitoring, health and environmental monitoring, laboratory and research activities, etc.)
5. Train technicians at the level of the inter-sector institutions in terms of response at all levels (event management of public health significance, epidemiology of interventions, etc.)
6. Create specific expertise on the links between health and the environment
7. Expand anticyclonic health facilities
8. Expand “FS” with WASH infrastructure
9. Strengthen the capacity of local communication stakeholders in “GRC”
10. Strengthen the institutional capacity of the health system

### III. Integrated Health and Environmental Surveillance

Desired outcome: Rapid, evidence-based decisions are made for the sound management of public health risks related to climate change

1. Establish a baseline of health and nutritional status to triage relevant issues
2. Establish an integrated health and environment surveillance system
3. Reinvigorate local early warning systems in the face of climate change
4. Early detection of events related to climate change
5. Use new technologies to strengthen the epidemiological surveillance system using satellite imagery
6. Conduct countrywide integrated surveillance of all climate-sensitive diseases (malaria, acute respiratory infections, diarrhea, plague, conjunctivitis, skin infection, malnutrition, etc.)
7. Create a platform at all levels to validate and disseminate data resulting from environmental and disease surveillance for decision making
8. Establish and operationalize early warning systems to control climate change sensitive diseases including data management
9. Implement the Global Framework for Climate Services
10. Expand sentinel surveillance sites for fevers, including climate observation stations
11. Develop and update the risk and vulnerability mapping and distribution of climate change-related diseases.
12. Collect and analyze data related to climate change

### IV. Response

Desired outcome: The critical situation of facing climate change is monitored

1. Inform the population in time of any type of danger related to the climate catastrophes
2. Taking care of climate change victims through treatment and prevention of target diseases
3. Implement communication activities related to prevention, preparedness, and early warning of disasters

4. Mobilize all healthcare and related actors in the event of disasters
5. Advocate with public and private partners to provide nutritious food to disaster victims
6. Evaluate response activities

## V. Research

Desired outcome: Local knowledge on health risk factors sensitive to climate change fuel decision making

1. For all relevant institutions, integrate health and environmental research and action programming together
2. Develop and implement a climate change and health research program
3. Disseminate research findings
4. Disseminate the PNASS and the Vulnerability Assessment and Health Sector Adaptation Study
5. Review the research already undertaken on the adaptation of public health to climate change
6. Use new technologies for the collection, transmission, processing, and analysis of data
7. Integrate data and information related to climate change and health into existing information systems
8. Organize inter-sector information exchange between research institutes and health practitioners
9. Advocate for the creation of a scientific discipline formed around health and meteorology (biometeorology)

## VI. Monitoring and Evaluation

Desired outcome: PNASS monitoring and evaluation activities are carried out

1. Identify the process, output, impact, and indicators for the program
2. Monitor and evaluate PNASS activities
3. Strengthen existing monitoring and evaluation systems to integrate climate change and health
4. Supervise stakeholders
5. Incorporate information from follow-up activities
6. Organize periodic reviews of the program
7. Conduct community outreach regarding communication

## VII. Coordination and Program Management

Desired outcome: Cross-sectoral coordination is effective at all levels

1. Integrate climate-sensitive health risks into national disaster risk reduction strategies and plans
2. Develop and implement climate change and health regulations
3. Incorporate environmental and sanitary standards into urban planning
4. Institutionalize the “GTSCC” for the implementation of the PNASS
5. Integrate the climate change and health framework into the GRC, and the National Contingency Plan for Pandemics and Major Epidemics
6. Advocate for a continuing government allocation of resources for the adaptation of public health to climate change
7. Integrate climate, health, and environmental linkages into curricula at all levels
8. Implement the interministerial convention to facilitate access to and improve the availability of climate change data
9. Carry out working information sessions with stakeholders: Department of Health, other departments
10. Advocate at the four institutions and at the level of the ministerial departments
11. Create a partnership platform for the exchange of experiences in climate change adaptation planning processes
12. Mobilize resources for the implementation of activities related to climate change
13. Advocate with local authorities for the creation of income-generating activities to reduce inequality in access to basic social services, especially at the expense of vulnerable groups such as the poorest strata, the elderly and the disabled, pregnant women and children under five, malnourished children, people without health centers and WASH infrastructure, people living in areas exposed to hazards during periods of crisis (post-epidemic and post-cyclone)
14. Keep all stakeholders informed on issues of change climate and health



# Climate Change and Health Stakeholder Consultation Agendas and Participant Lists

## Consultation 1

### CHANGEMENT CLIMATIQUE ET SANTÉ À MADAGASCAR

Consultation Technique 1

Hotel Carleton, Antananarivo, 9 June 2017, 8h30–13h00

#### PROGRAMME

0800–0830	<b>Accueil des participants</b>	
0830–0915	<b>Introductions</b>	
5m	Bienvenue	Dr. Voahirana Rajoela, Banque Mondiale
20m	Contexte Auto-présentation des participants	Madame DGS Dr. Ihanta, Ministère de la Santé
5m	L'approche du climat et la santé à la Banque Mondiale Les objectifs de la réunion	Dr. Timothy Bouley, Banque Mondiale
5m	Vue d'ensemble de l'investissement santé à la Banque Mondiale à Madagascar	Ms. Jumana Qamruddin, Banque Mondiale
5m	Contribution du Madagascar à l'expérience internationale en santé et climat	Dr. Joy Guillemot, OMS/OMM
5m	L'importance de l'environnement et les approches écosystémique pour la santé et le nutrition	Dr. Christopher Golden, Harvard School of Public Health
0915–1030	<b>Session Technique: Risques Climatique à Madagascar</b>	
10m	Les tendances climatiques observées et les futurs changements climatiques à Madagascar	Dr. Zo Andrianina Rakotomavo, Direction Général de la Météorologie
10m	Questions et réponses	
10m	Les impacts et priorités pour la gestion des risques catastrophes liées au climat	BNGRC
10m	Questions et réponses	
1030–1045	<b>Pause-Café</b>	



<b>1045–1130</b>	<b>Session Technique: Sante et climat à Madagascar – aléas, actions, et priorités</b>	
15m	Résultats de l'étude: Evaluation de la vulnérabilité et de l'adaptation du secteur santé au changement climatique à Madagascar	Dr. Norohasina Rakotoarison, Service de Santé et Environnement, Ministère de la Santé Publique
15m	Plan d'action national d'adaptation du secteur santé au changement climatique à Madagascar (PNASS)	Dr. Norohasina Rakotoarison, Service de Santé et Environnement, Ministère de la Santé Publique
15m	Questions et réponses	
<b>1130–1245</b>	<b>Les perspectives multisectorielles</b>	
15m	Interventions et recommandations des autres secteurs et ministères	Les participants du gouvernement
30m	Discussion avec les représentants internationaux	Les participants des organisations internationaux
30m	Discussion et recommandations des participants sur 3 thèmes: 1. Les vulnérabilités prioritaires et opportunités de l'investissement qui adresse le climat, environnement, et sante 2. Les lacunes dans les connaissances et les actions 3. Les connections entre les organisations et les partenaires à Madagascar qui travaillent sur le climat, environnement, et sante	
<b>1245–1300</b>	<b>Résumé et prochaines étapes</b>	
<b>1300–1400</b>	<b>Déjeuner</b>	
<b>1400–1600</b>	<b>Séance technique avec le groupe de travail en santé et changement climatique</b>	

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## CLIMATE CHANGE AND HEALTH STAKEHOLDER CONSULTATION AGENDAS AND PARTICIPANT LISTS

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## Consultation 2

**CHANGEMENT CLIMATIQUE ET SANTÉ À MADAGASCAR**

Consultation Technique 2

Hotel Carlton, Antananarivo, Mercredi 4 Octobre, 8h30–16h30

**Les objectifs de la réunion**

Présenter et valider le rapport de diagnostic de Madagascar, y compris ses recommandations pour appuyer le gouvernement de Madagascar à améliorer la résilience face aux impacts sanitaires du changement climatique.

**Résultats attendu**

Finaliser la conception des interventions de la Banque mondiale sur le climat et la santé décrites dans le rapport.

0830–0900	<b>Accueil des participants</b>	
900–0915	<b>Introduction</b> Bienvenue Tour de table des participants	Madame DGS Dr. Ihanta, Ministère de la Santé
0915–930	Progrès sur la diagnostic du climat et la santé à la Banque Mondiale Les objectifs de la réunion et processus	Dr. Timothy Bouley, Banque mondiale
930–1000	Diagnostic Global—une approche pour l'évaluation des risques et l'investissement dans des systèmes de santé adaptés au changement climatique.	Dr. Kris Ebi, University of Washington
1000–1015	<i>Questions et réponses sur les 2 présentations</i>	
1015–1030	<b>Pause-Café</b>	
	<b>Session Technique 1: Aperçu des Risques Climatique à Madagascar</b>	
1030–1130	Résultats de l'étude: Aperçu de la vulnérabilité et le secteur santé à Madagascar  Questions et réponses	Dr. Chris Golden, Harvard University
1130–1230	<b>Session Technique 2: Interventions bas-carbon dans le secteur de la santé</b>	
	<b>Présentation de les interventions recommandées</b>  Questions et réponses	Dr. Timothy Bouley, Banque mondiale
1230–1330	<b>Déjeuner</b>	
1330–1445	<b>Session Technique 3: Approches résilientes dans le secteur de la santé</b>  Présentation des approches recommandées pour la résilience  Groupes de travail: <ul style="list-style-type: none"> <li>• Nutrition</li> <li>• WASH</li> <li>• Maladies Vectorielles</li> <li>• Catastrophes</li> <li>• Capacité du Système Sanitaire</li> </ul> Questions et réponses	Dr. Joy Guillemot, OMS/OMM
1445–1500	<b>Pause-Café</b>	

<b>1500–1600</b>	<b>Session Technique: Interventions Multi-sectorielle</b>	
	Présentation des interventions recommandées pour les autres secteurs Groupes de travail: <ul style="list-style-type: none"> <li>• Agriculture</li> <li>• Assainissement et eau</li> <li>• Infrastructure, Energie, Transport</li> <li>• Gestion des catastrophes naturelles</li> </ul>	Dr. Joy Guillemot, OMS/OMM
	Questions et réponses	
<b>1600–1630</b>	Conclusion	Dr. Timothy Bouley, Banque mondiale

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## Overview of New World Bank Framework for Strengthening Systems at the Human-Animal-Environment Interface (One Health Operational Framework)

Health disasters like Ebola in West Africa, H5N1 Avian Influenza in Asia and Europe, and Zika virus in Latin America have significantly harmed both health and economies. Many of these countries afflicted by diseases of pandemic potential also face a persistent burden of endemic diseases such as rabies, Lassa virus, and brucellosis, and are challenged by bacteria increasingly resistant to antibiotics. These disease threats compound poverty and obstruct development. Ecosystem alteration, climate change, and inadequate biosecurity are also disproportionately present in the developing world, and exacerbate existing and emergent disease risk.

Strong, environmentally considerate, public health systems are needed to prevent, reduce, and manage risks to humans, animals, and the environment and are critical to achieving the World Bank twin goals of ending extreme poverty and boosting shared prosperity. The “One Health” concept recognizes these connections and promotes coordination to better understand and manage risks. This approach can help countries achieve progress on national and global priorities including poverty alleviation, economic growth, food security, health, and well-being toward achievement of the SDGs.

### One Health: What It Is and Why It Matters

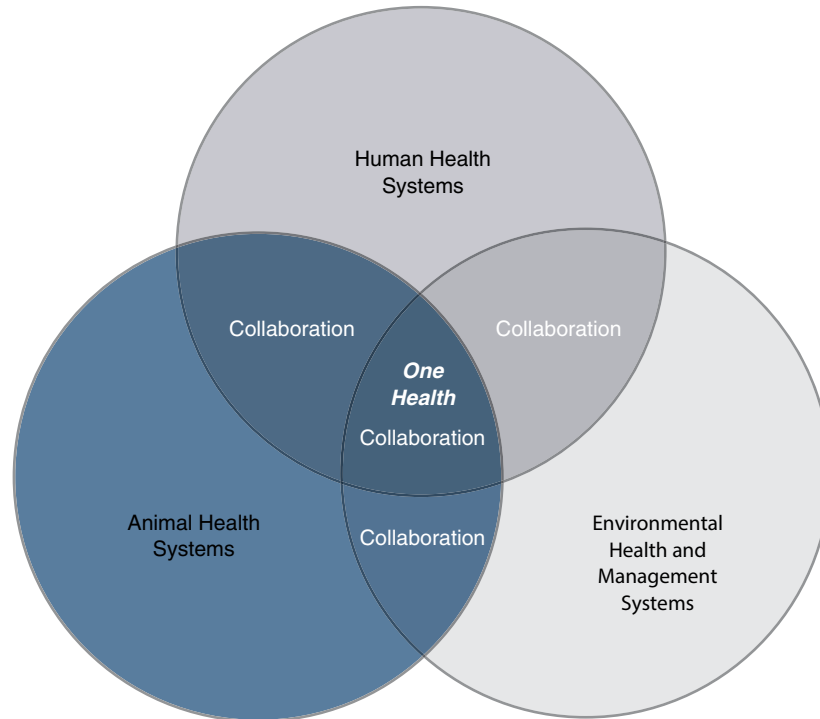
Public health challenges at the human-animal-environment interface are inherently multi-sectoral, and therefore warrant whole-of-society solutions.

The One Health concept recognizes the connections between humans, animals, and the environment and promotes coordination to better understand and manage risks. By improving understanding

#### Box A4.1: Humans, Animals and the Environment: What Are the Connections?

- *Pandemic and epidemic threats:* Over 60 percent of infectious diseases in humans are of animal origin; e.g., Avian Influenza, Ebola, MERS-CoV, and Rift Valley fever viruses, even HIV/AIDS. Changes in land use, climate, food production, trade, and travel are among the drivers of disease emergence and spread.
- *Antimicrobial resistance:* There is evidence of adverse human health consequences due to resistant microorganisms resulting from nonhuman usage of antimicrobials, including in animal agriculture. Improper waste management from manufacturing and application may also enable environmental dissemination of residues and resistant strains.
- *Loss of ecosystem services:* Land degradation often results in loss of ecosystem services that support human health and agriculture (e.g., safe water and food, pest control, disaster resilience).



**Figure A4.1:** One Health model, as used by the World Bank.

of animals and/or ecology, it informs risk management and can prevent disease threats. Its application can also reinforce other health objectives, such as maternal and child health, food and nutrition security, pollution management, and sanitation.

An increasing number of countries are taking measures to develop One Health coordination mechanisms to support multi-sectoral surveillance, laboratories, risk assessment, communication, and policy development activities.

### Why Invest in One Health?

In addition to direct health benefits, the economic argument for investing in One Health is compelling (Figure A4.2).

While economic impacts are considerable, investments in capacity to mitigate risk are still very limited.<sup>10</sup> One Health strategies

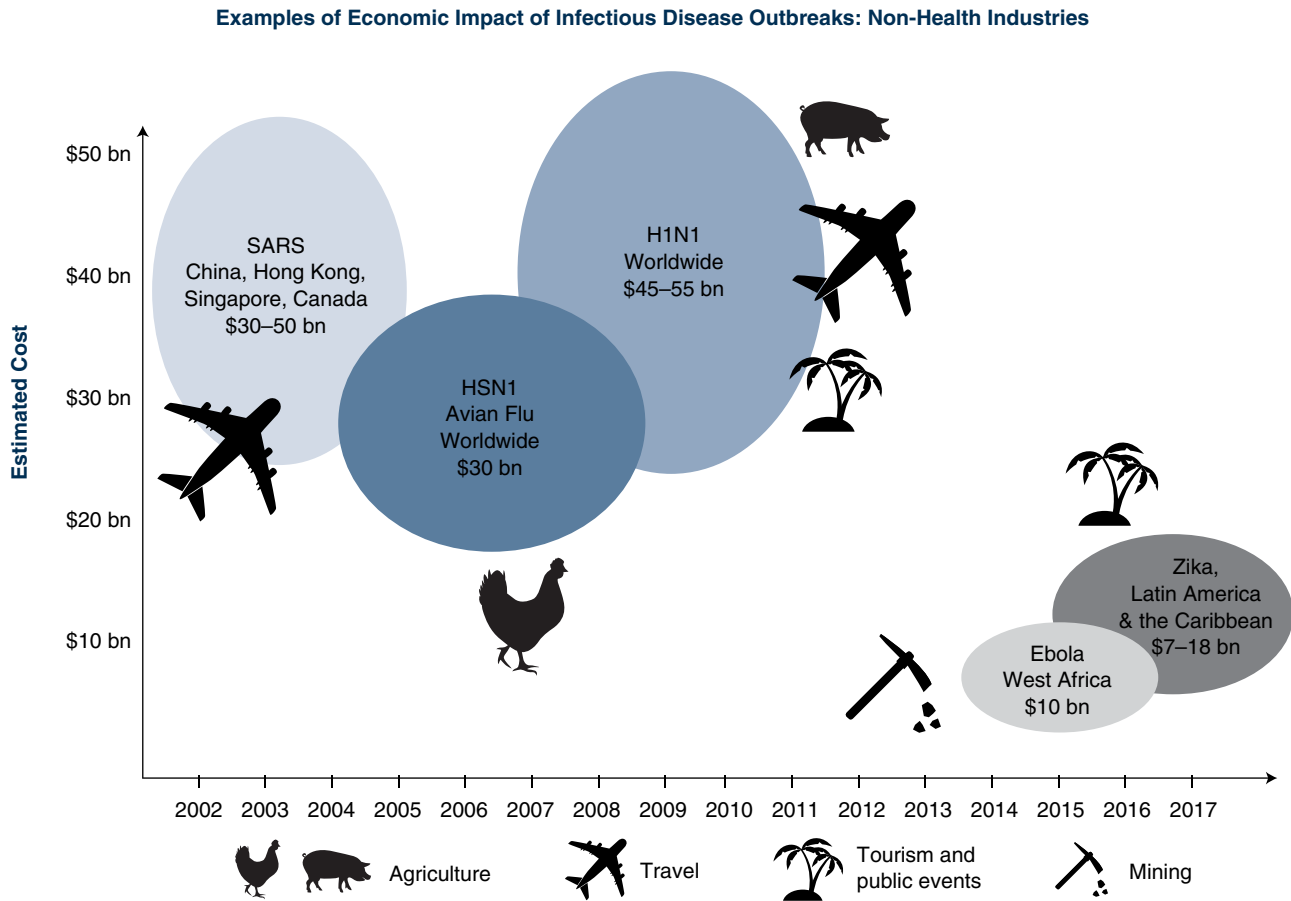
are highly cost-effective not only for reducing pandemic and antimicrobial resistance risks, but also endemic diseases.

### One Health Can Help Advance Other Development Priorities

Strengthening public health systems for the benefit of humans, animals, and environmental health can also help protect agricultural production and ecosystem services, ranging from food and nutrition security to disaster resilience and ecotourism; all of which contribute to economic development and are critical foundations for growth. One Health is integral to the success of multi-sector national action plans for health security, to address antimicrobial resistance, and for disaster risk reduction. It can optimize pandemic preparedness planning and enhance climate change vulnerability assessments. This multi-sector approach is endorsed by international agencies (e.g., the WHO-World Organization for Animal Health-Food and Agriculture Organization tripartite agreement and recent decisions on health and biodiversity by the UN Biodiversity Convention that specifically recognize the value of One Health for mainstreaming biodiversity to help protect species and ecosystems).

<sup>10</sup> Annual investment of approximately US\$1.9–3.4 billion to raise human and animal health system capacity in World Bank client countries is expected to return upward of \$30 billion per year in avoided losses. This is a high return on investment even if only a portion of pandemics are prevented, while also generating gains for agricultural production and control of endemic diseases (World Bank 2012).

**Figure A4.2:** Examples of economic impacts of infectious disease outbreaks in nonhealth industries. Estimates represent medical and nonmedical costs; icons depict highly affected industries.



Figures are estimates and are presented as relative size. Based upon BioEra, World Bank, and UNDP data. Chart updated by EcoHealth Alliance.

## One Health Operations at the World Bank

The World Bank has worked for over a decade to promote and operationalize One Health approaches, supported by country partners, technical institutions, international organizations, and development funders. The World Bank has established a considerable knowledge base on the topic, with reports and studies addressing various One Health dimensions, such as *People, Pathogens, and Our Planet*, the *Investing in Climate Change and Health* series, and *Drug-Resistant Infections: A Threat to Our Economic Future*. This analytical work has underpinned country operations like the Global Program for Avian Influenza and Human Pandemic Preparedness and Response, and the Regional Disease Surveillance Systems Enhancement program. The Operational Framework for Strengthening Public Health Systems at the Human-Animal-Environment

Interface (“One Health Operational Framework”) now builds on this experience and provides guidance to help optimize One Health operations.

## How to Invest in One Health

Defining the scope, identifying entry points, and mapping stakeholders are key first steps to understanding relevant actors and identifying gaps to address hazards. Each sector has its own contributive tools and guidance resources; stronger multi-sector coordination can better harness existing efforts and generate knowledge that could otherwise not be yielded from single sectoral approaches. As public health systems are dynamic and require continuous feedback loops, implementation may occur at different stages based on resources and priorities, but should reinforce

overall public health systems strengthening to reduce resource intensive responses.

### Tips for One Health Operations

- ***Starting points for One Health vary by context, disease, and objectives.*** Public health systems must be agile enough to address all hazards; to do this, countries need strong human, animal, environmental health/management systems and coordination between them to even determine which sectors are relevant to understand and manage risk.
- ***One Health approaches should be built into project design from the onset.*** Engaging all relevant stakeholders early on helps optimize project success by developing a common understanding of issues and joint solutions to address them, anticipating risks, targeting key gaps and reducing duplication, and facilitating relevant coordination channels.
- ***Wildlife and environmental health services should be systematically included when considering national investments in public health systems.***
- ***There is a growing body of operational experience and tools*** among the World Bank and key technical partners that provide solid grounds to develop sound One Health operations.
- ***Communication is a key priority for One Health approach understanding and implementation.*** Planning ahead for disease events and maintaining strong multi-sector coordination channels at all times helps ensure consistent and effective messaging to manage risk, enhance efficiency, and promote credibility of all sectors.

### One Health Operational Framework Comparative Advantage

1. Supports this process and establishes a stepwise, how-to methodology for applying One Health in development operations. It outlines activities and interventions to target disease threats at the human-animal-environment interface, highlighting mechanisms for institutional and technical implementation to build more collaborative public health systems. It emphasizes elements that are critical to include in projects, including specific country requests for national priority issues. It presents steps and provides technical guidance for actions and capacity that can be taken at the country level along the prevent-detect-respond-recover spectrum.
2. Embeds One Health economic and development considerations into an applied approach to policy and lending.
3. Provides examples of successful One Health projects that can be borrowed from and replicated.
4. Creates a platform for engagement amongst international organizations, development lending institutions, and national governments.
5. Finally, the One Health Operational Framework encourages greater technical engagement and high-level political support to mainstream One Health considerations into development policy and lending.

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