

Climate and Health Vulnerability Assessment

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HAITI

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

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Cover image: Dajaban Haiti - July 15, 2011: Haitian woman carries a bucket of goods on her head while men carry a poultry crate and sack of grains at Haitian Dominican Republic border market.

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March 2024



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ACKNOWLEDGMENTS

This Climate and Health Vulnerability Assessment (CHVA) for Haiti was produced by the Health- Climate, Environment and Disasters (HCED) program in the Health, Nutrition and Population (HNP) Global Practice of the World Bank, which is led by Tamer Rabie. It is authored by April Frake, Christopher Boyer, Mikhael Iglesias, Claire Bayntun, Stephen Dorey, and Tamer Rabie. The authors sincerely appreciate the valuable contributions provided by Ana Lucrecia Rivera-Rivera, Muloongo Simuzingili, and Loreta Rufo.

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

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

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

LIST OF ABBREVIATIONS

AAP	Ambient Air Pollution
AIDS	Acquired Immunodeficiency Syndrome
AR6	Assessment Report 6 [of the IPCC]
CKKP	Climate Change Knowledge Portal [of World Bank]
CFP	Ciguatera Fish Poisoning
CHVA	Climate and Health Vulnerability Assessment
CHE	Current Health Expenditure
CHEVT	Climate and Health Economic Valuation Tool
CMIP5	Coupled Model Intercomparison Project Phase 5
COPD	Chronic Obstructive Pulmonary Disease
COVID-19	Coronavirus 2019
CRU	Climatic Research Unit [University of East Anglia, UK]
CVD	Cardiovascular Disease
DALYs	Disability Adjusted Life Years
DCC	Direction des Changements Climatique
DRM	Disaster Risk Management
EU	European Union
FCV	Fragility, Conflict, and Violence
GBS	Guillain-Barré Syndrome
GCCA	Global Climate Change Alliance
GCM	General Circulation Model
GDP	Gross Domestic Product
GHG	Greenhouse Gas [emissions]
GWP	Global Warming Potential
HAP	Household Air Pollution
HFG	Health Finance and Governance
HIS	Health Information System(s)
HIV	Human Immunodeficiency Virus
HNAP	Haiti National Adaptation Plan
HNP	Health, Nutrition and Population
HRH	Human Resources for Health
HSS	Health Systems Strengthening
ICU	Intensive Care Unit
IHME	Institute for Health Metrics and Evaluation
IHR	International Health Regulation
INDC	Intended Nationally Determined Contribution(s)
IPC	Integrated Food Security Phase Classification
IPCC	Intergovernmental Panel on Climate Change
LAC	Latin America and the Caribbean
LULC	Land Use and Land Cover
MDE	Ministère de L'Environnement
MSPP	Ministère de la Santé Publique et la Population
NAP	National Adaptation Plan
NAPA	National Adaptation Plan of Action
NCD	Noncommunicable Disease

NDC	Nationally Determined Contribution(s)
NOAA	National Oceanic and Atmospheric Administration
NGO	Nongovernmental Organization
OFATMA	Office d'Assurance Accident du Travail, Maladie et Maternité
ONA	Office National d'Assurance Vieillesse
OOP	Out-of-Pocket (spending on health)
PAHO	Pan American Health Organization
PES	Essential Service Package
PHC	Primary Health Care
PIH	Partners in Health
PM2.5	Fine Particulate Matter
PSDH	Strategic Development Plan of Haiti
PSP	Paralytic Shellfish Poisoning
PTG	Post-Traumatic Growth
RCP	Representative Concentration Pathway
SIDS	Small Island Developing State
SLCP	Short-Lived Climate Pollutant
SLR	Sea-Level Rise
SOPs	Standard Operating Procedures
SPEI	Standardized Precipitation Evapotranspiration Index
SPCR	Strategic Program for Climate Resilience
SDGs	Sustainable Development Goals
STMM	Short-Term Medical Mission
UHC	Universal Health Coverage
USAID	United States Agency for International Development
VBD	Vector-Borne Disease
WaSH	Water, Sanitation, and Hygiene
WBD	Waterborne Disease
WHO	World Health Organization



EXECUTIVE SUMMARY

Haiti is highly vulnerable to the impacts of climate change due to its geographic location, low economic development, and limited resources. The country's geographical location — characterized by its presence on the Atlantic hurricane belt and on a low-lying coastal plain — makes it particularly susceptible to sea-level rises (SLRs), rising temperatures, hurricanes, and heavy rainfalls — all of which are projected to become more frequent and intense due to global warming. Over the past 30 years, Haiti has experienced 34 flooding events, 35 significant storms, and 31 hurricanes including Hurricane Matthew in 2016. Haiti also experiences periodic droughts that have impacted its agricultural production and exacerbated food insecurity.

Climatic hazards are also exacerbating Haiti's vulnerability to fragility, conflicts, and violence (FCV), further stressing the need for immediate action. Climate-related hazards — such as hurricanes, droughts, and floods — have destroyed crops, disrupted food production, and led to food insecurity and malnutrition. This can contribute to further social unrest and conflicts, especially among vulnerable communities. Severe weather events impacting the country have also caused significant damage to infrastructure, homes, and communities, forcing people to flee their homes and seek refuge elsewhere. Climate hazards in Haiti have also disrupted economic activity and caused significant losses to agriculture, fisheries, and other livelihoods, thereby exacerbating poverty and unemployment, and likely contributing to social instability and conflict. These factors highlight the importance of addressing the underlying vulnerabilities that make Haiti susceptible to FCV and of taking effective measures to mitigate and adapt to the impacts of climate change.

Climate-related health risks in Haiti are significant; they are projected to increase the disease burden of the country. Identified climate-related health risks include (1) increased injuries and fatalities due to extreme weather events, (2) increased heat-related morbidity and mortality, (3) increased nutritional risks, (4) increases in water-related diseases, (5) increases in vector-borne diseases (VBDs), (6) exacerbation of respiratory risks, and (7) decline of physical / mental health and well-being.

While the government of Haiti is committed to addressing climate change through multiple national plans, further efforts are required to strengthen the adaptive capacity of the country's health system to address its growing needs. Notably, the country still lacks adequate funding for climate-health programming and infrastructure, as well as adequate integration of climate-informed interventions such as early-warning monitoring systems.

Five key recommendations are proposed in this CHVA to improve the health system's adaptive capacity to growing climate-related health risks:

1. Incorporate climate change into health plans and strategies, thus creating a governance and policy landscape that would contribute to strengthening the country's health system resiliency.
2. Provide budget lines to channel funding for implementing climate-health interventions.
3. Strengthen health service delivery amid extreme weather events and prioritize support for frontline communities.
4. Expand information systems that are already in place, such as Haiti Data, thus enabling the collection and analysis of climate and health data.
5. Develop building codes that are aimed at strengthening the existing health facilities' resiliency to climate hazards.

INTRODUCTION

COUNTRY CONTEXT

1. Haiti is highly vulnerable to the impacts of climate change — due to its geographic location, low economic development, and limited resources. Haiti's geographical location — characterized by its presence on the Atlantic hurricane belt and a low-lying coastal plain — makes the country particularly susceptible to sea-level rises (SLRs), rising temperatures, hurricanes, and heavy rainfalls, which are projected to become more frequent and intense due to global warming. Over the past 30 years, Haiti has experienced 34 flooding events, 35 significant storms, and 31 hurricanes including Hurricane Matthew in 2016. Haiti is also affected by periodic droughts that have impacted its agricultural production and exacerbated food insecurity.

2. Climatic hazards are also exacerbating Haiti's vulnerability to fragility, conflict, and violence (FCV), further magnifying the need for immediate action. Climate-related hazards, such as hurricanes, droughts, and floods, have destroyed crops, disrupted food production, and led to food insecurity and malnutrition. This can contribute to further social unrest and conflicts, especially among vulnerable communities. Severe weather events impacting the country have also caused significant damage to infrastructure, homes, and communities, forcing people to flee their homes and seek refuge elsewhere. Climate hazards in Haiti have also disrupted economic activity and caused significant losses to agriculture, fisheries, and other livelihoods, thereby exacerbating poverty and unemployment, and likely contributing to social instability and conflicts. These factors highlight the importance of addressing the underlying vulnerabilities that make Haiti susceptible to FCV and of taking effective measures to mitigate and adapt to the impacts of climate change.

AIMS OF ASSESSMENT AND CONCEPTUAL FRAMEWORK

3. The objective of this Climate and Health Vulnerability Assessment (CHVA) is to assist decision-makers with planning effective adaptation measures to deal with climate-related health risks. Where available, these measures are also provided at the subnational level to assist regional health planners. The recommendations of this CHVA are primarily aimed at the health sector; however, related sectors influencing health risks that stem from climate changes, such as DRM, are also included. The target audience includes, but is not limited to, the country's Ministry of Health, Ministry of Environment, and any other ministry involved in addressing climate-related health risks, as well as nongovernmental organizations (NGOs) that are involved in supporting projects and programs for the health system in Haiti.

4. Adaptation priorities need to run alongside fundamental and urgent action to mitigate

climate change. It is important to stress how complex the climate challenge is and how hard it is to predict with accuracy how severe climate exposures facing populations will become. There are many factors that could slightly slow or significantly speed up the rates of change, including positive feedback effects and, most worrying of all, cascading climatological tipping points. For this reason, mitigating existing greenhouse gas emissions (GHGs), as well as developing and implementing measures to protect human development from the changing climate, is of paramount importance.

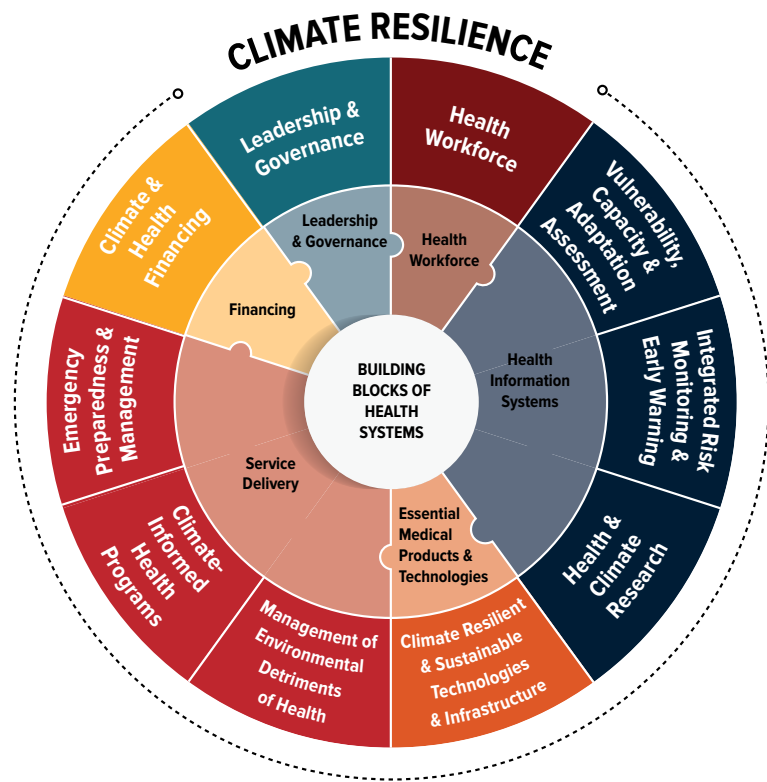
5. Investing in adaptation strategies to proactively address the effects of climate change on health outcomes is critical. This assessment is focused on the climate risks to health and health systems, the adaptive capacities in place to deal with these risks, and the recommendations to meet identified gaps. The primary focus of this assessment is, therefore, on climate adaptation and resilience measures. However, as the Assessment Report Six (AR6)¹ of the Intergovernmental Panel on Climate Change (IPCC) makes clear, “Global surface temperature will continue to increase until at least the mid-century under all emissions scenarios considered.” Mitigation is no longer a sufficient strategy, regardless of the pace of the response of governments and communities around the world. Adaptation is now as critical a part of climate action as mitigation. Therefore, although this report is focused on adaptation measures, it also includes recommendations on reducing the healthcare sector’s carbon footprint.

6. The World Health Organization’s (WHO) operational framework for building climate-resilient health systems is adopted to analyze the adaptive capacity to adequately deal with current and future identified risks. Based on this framework (Figure 1), the assessment is structured around the six health systems strengthening (HSS) building blocks. These six categories offer a structure for organizing the assessment of capacities and gaps — now and into the future. The framework then moves on to consider WHO’s operational framework to develop the Recommendations section.

7. This assessment follows a stepwise linear approach. The first step characterizes the **climatology** in Haiti — highlighting the observed and future climate exposures relevant to health. The second step examines **climate-related health risks**, including identifying vulnerable populations. The final step assesses the **adaptive capacity of the health system** — identifying gaps for the management of current and future climate-related health risks. Together, these steps inform a series of **recommendations** for reducing climate-related health vulnerability in Haiti. The assessment is based on a review of the published literature, as well as national and international quantitative and qualitative data.

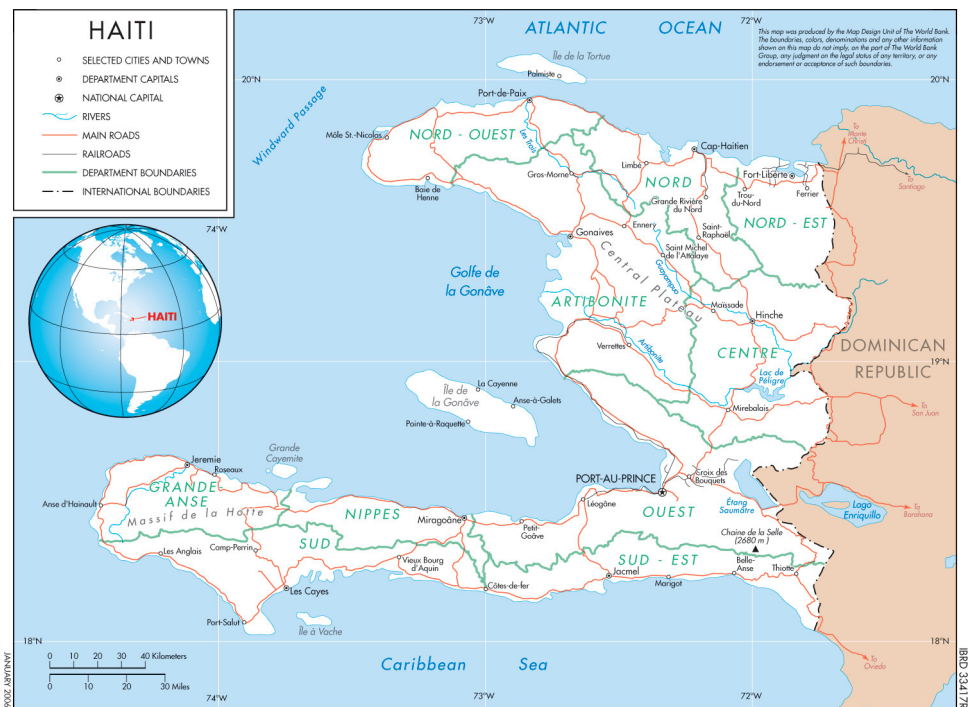
8. The assessment incorporates subnational considerations for health-related climate action. Within the context of this assessment, 10 administrative departments of Haiti were considered: Artibonite, Centre, Grand’Anse, Nippes, Nord, Nord-Est, Nord-Ouest, Ouest, Sud-Est, and Sud (Figure 2).

FIGURE 1.
World Health Organization (WHO) operational framework for climate-resilient healthcare systems



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

FIGURE 2.
Administrative boundaries of Haiti’s departments



Source: World Bank Cartography Unit.



CLIMATOLOGY

9. This section describes observed climatic changes and projected climate trends, highlighting priority climate-related exposures that should be considered in relation to human health risks.

Climate information is taken from the World Bank Group's Climate Change Knowledge Portal (CCKP), where historical, observed data is derived from the Climatic Research Unit, University of East Anglia (CRU). Observed changes in mean annual temperatures, mean maximum temperatures, mean minimum temperatures, and precipitation levels from the CCKP are derived from the CRU TS version 4.05 gridded dataset for the 1901–2020 period. Model-based climate projection data is derived from the Coupled Model Intercomparison Project Phase 5 (CMIP5) collection. CMIP5 is a standard framework for the analysis of coupled atmosphere-ocean general circulation models (GCMs), providing estimates of future temperature and precipitation scenarios. Projected changes are explored under the IPCC representative concentration pathway (RCP) 8.5^a for the short term (2030s; 2020–2039) and the medium term (2050s; 2040–2059).

HAITI'S GEOGRAPHY

10. Haiti is predominantly situated on the western portion of the island of Hispaniola in the Caribbean Sea, with smaller islands surrounding the country, including Île-à-Vache, Gonâve, Grosse Caye, Les Cayemites, Navassa, and Tortuga Island. The mainland consists of mountains, plains, and valleys, which influence the climate conditions across the country.

The mountainous northern region and the Northern Plain along the northern border with the Dominican Republic range in elevation from 600 to 1,100 meters (m). The central region consists of the Central Plateau that spans 85 kilometers (km) from the southeast

to northwest, with a width of 30 km. To the southwest of the Central Plateau are the Montagnes Noires, with elevations of up to approximately 600 m.

The southern region consists of the Plaine du Cul-de-Sac and the mountainous southern peninsula. The Plaine du Cul-de-Sac is a natural depression that is 12 km wide; it extends for 32 km from the border with the Dominican Republic to the coast of the Baie de Port-au-Prince. The mountains of the southern peninsula extend from the Massif de la Selle in the east to the Massif de la Hotte in the west. The range's highest peak — the Morne de la Selle — is the highest point in Haiti, rising to an altitude of 2,715 m. The Massif de la Hotte varies in elevation from 1,270 m to 2,255 m.

^a Information is provided for RCP4.5 in Annex B of this report.

Moreover, numerous rivers and streams traverse the plains and mountainous areas. The largest drainage system in the country is that of the Artibonite River. Rising from the foothills of the Massif du Nord as the Libón River, the river crosses the border into the Dominican Republic and then forms part of the border before re-entering Haiti as the Artibonite River. The 400-km Artibonite River is only one meter deep during the dry season, and it may even dry up completely in certain spots. During the wet season, it is more than three meters deep and subject to flooding.

regions of the island, with two pronounced peaks occurring between March and November. The remainder is arid (2.5 percent) — temperate without a dry season and with a hot summer (2.2 percent), or temperate with a dry winter and warm summer (1.7 percent).

The north wind brings fog and drizzle, interrupting Haiti’s dry season from November to January. However, from February to May, the weather is very wet. Northeast trade winds bring rains during the wet season. Monthly temperatures typically range from 19°C to 28°C in the winter and from 23°C to 33°C during the summer months (Figure 3).

Northern and windward slopes in the mountainous regions receive up to three times more precipitation than the leeward side; annual precipitation in the mountains averages 1,200 millimeters (mm). In contrast, the annual precipitation in the lowlands is as low as 550 mm; the Plaine du Gonaïves and the eastern part of the Plaine du Cul-de-Sac are the driest regions in the country.

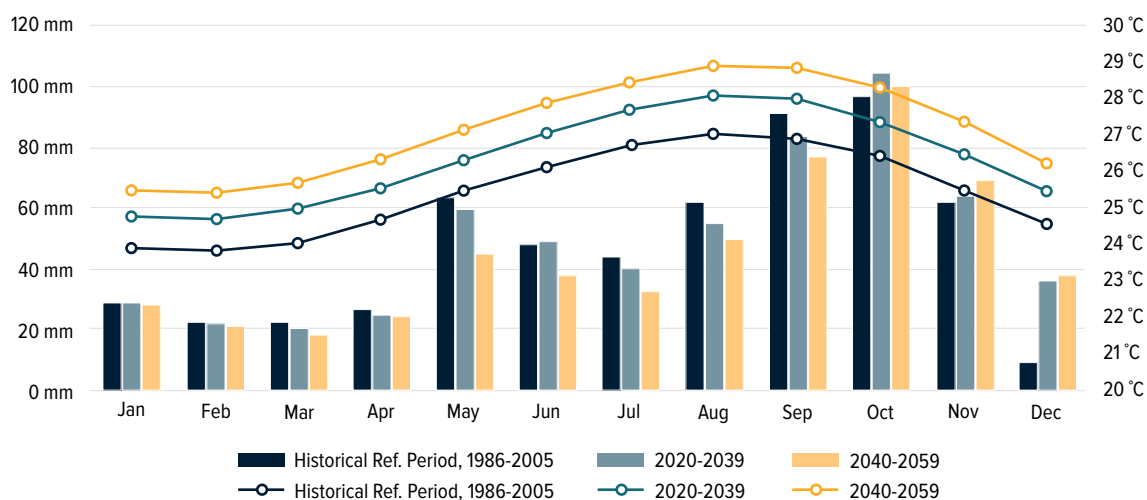
OBSERVED AND PROJECTED CLIMATE AND SEA-LEVEL RISES (SLRS)

11. Haiti has a hot and humid tropical climate that can be separated into six climate zones.

The country is predominantly tropical savannah (55 percent), tropical rainforest (25 percent), and tropical monsoon (14 percent). These areas are characterized by high temperatures and precipitation rates. The wet season is long, particularly in the northern and southern

FIGURE 3.

Projected average monthly temperatures and precipitation levels in Haiti



Source: World Bank Climate Change Knowledge Portal

12. There is already evidence of the climate changing in Haiti: as Section III of this report will show, this situation is leading to significant human health impacts.

Annual mean temperatures have steadily increased over the past half century. Since 1960, mean temperatures have risen by 0.45°C. Much of this warming has occurred between June and November. Temperatures across Haiti are fairly uniform: the variation in the subnational annual temperature is only approximately 2°C on average. The southwestern departments of Nippes, Grand'Anse, and Sud experience the warmest temperatures throughout the year, while the eastern departments of Centre and Sud-Est experience the coolest.

13. Precipitation is asymmetrical, due to the orientation of Haiti's mountain chains and the rain-bearing northeast trade winds.

On a national scale, variations in the average annual rainfall since the early 1900s have varied by less than 2 mm, with a rising trend recorded over time. Overall, Artibonite (1144 mm), Nord-Ouest (1198 mm), and Nord-Est (1220 mm) receive the least amount of average annual rainfall, while Sud (1955 mm) and Grand'Anse (1806 mm) receive the most. The heaviest rainfall has historically occurred in May for most departments, except for Grand'Anse, Nippes, and Sud-Est; they receive the most rainfall in October, with the Nord experiencing the heaviest rainfall in November.

14. The average national temperature will increase by 0.88°C in the 2020–2039 period and by 1.7°C in the 2040–2059 period, resulting in average temperatures of 26.35°C and 27.17°C, respectively.

The month of September will have significant temperature increases for the two time periods, that is, 1.04°C and 1.81°C, respectively. Sub-nationally, the Nord-Est department will

experience the highest increase (0.92°C by 2020–2039 and 1.76°C by 2040–2059). The maximum temperature is projected to reach an average of around 30°C (for both time periods), with the highest average maximum temperatures experienced in the Artibonite (31.27°C) and Nord (31.17°C) departments by 2020–2039. Moreover, the increases in the number of tropical nights (that is, where temperatures > 20°C), at the national level, are also expected to be 31.54 by 2020–2039 and 51.81 by 2040–2059.

15. Precipitation is expected to increase to 632.74 mm/year (+26.27 mm) by the 2020–2039 period, but it will decrease to 588.49 mm/year (–17.97 mm) by the 2040–2059 period.

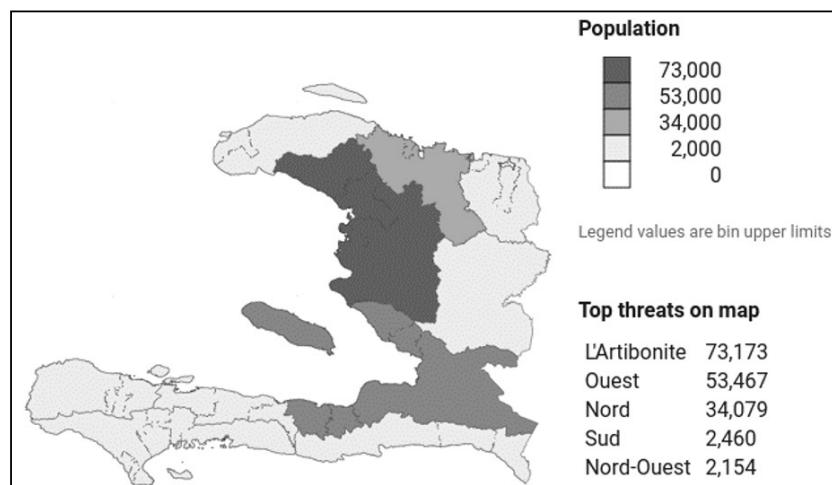
The month of October will experience the greatest increase of precipitation (+8.26 mm), while the greatest decrease (–7.7 mm) will take place in September during the 2020–2039 period. However, by the 2040–2059 period, there will be a decrease in precipitation of 18.95 mm in May. The department of Grand'Anse will experience the highest precipitation increase for the 2020–2039 period. However, all the departments will experience a decrease for the 2040–2059 period.

16. Over the past century, the rate of SLRs has roughly tripled in response to the increase in the global temperature of 0.8°C.

SLRs pose a significant threat to islands across the globe, including Hispaniola. Since the 1950s, the mean SLR in the Caribbean region has been approximately 1.8 mm/year. Historic sea-level data recorded from Haiti are sparse: published tide tables from the National Oceanic and Atmospheric Administration (NOAA) for the Port-au-Prince date back to only 2019. The IPCC AR6 in 2021² reported that the mean global sea surface rose by 0.20 m between 1901 and 2018 — constituting an average SLR

FIGURE 4.

Total population living below 1 m above the sea level in Haiti, by department



Source: Climate Central Risk Finder. 2021. Total population below 1m in Haiti by department. https://riskfinder.climatecentral.org/country/haiti?comparisonType=department&forecastType=BK_RCP85_p50&impact=Population_Worldpop15&level=1&protection=unprotected&unit=m

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

17. Available information suggests that SLR trends in the Caribbean have been broadly similar to global trends over this same period.³

In Haiti, it is expected that SLRs will increase by 0.21 m (0.17–0.24 m) by the 2030s and by 0.35 m (0.30–0.40 m) by the 2050s.⁴ Considering the country's topography, the Artibonite and Ouest departments have a great part of their land below 1 m above the sea level, where around 165,000 Haitians live (see Figure 4).

CLIMATE-RELATED HAZARDS

18. Haiti is vulnerable to several extreme climate-related events that will be exacerbated by ongoing climate change.

The most common are floods and hurricanes; but they also include landslides, droughts, and extreme temperatures. The impacts of these hazards are further compounded by anthropogenic causes, including deforestation, coastal degradation, and urbanization.

FLOODS

19. Floods are the leading factor of vulnerability in Haiti and throughout history.

Since 1991, the country has experienced 34 flood events (25 riverine floods, eight flash foods, and one coastal flood),⁵ with the most populated cities — all nestled in valleys along the coast — most affected. Widespread deforestation in the upper reaches of these valleys, coupled with the lack of drainage infrastructure, has created an environment that is conducive to flooding. When it rains, the steep, often barren, hills surrounding them flush rainwater toward the urban areas.

Riverine floods have impacted more than 502,910 people, leaving 3,024 lives lost and estimated damages of USD2,157,000,⁶ since 1991. Almost all of Haiti's 30 major watersheds are of concern, because of intense seasonal rainfall, storm surges in the coastal zones, and a deforested^b and eroded landscape. Given

^b Haiti is one of the most deforested countries in the world, with forest cover estimated at just 1.5 percent.

the near-complete absence of embankments and levees, this cycle then intensifies the next round of flooding, leading to the destruction of crops, farmlands, and agricultural infrastructure, as well as losses of livestock and human lives. On the other hand, coastal and flash floods account for approximately 85 percent of flooding cases. Flash floods have also resulted in adverse consequences since 1991 — 120,112 people affected, 98 lives lost, and damages estimated at USD1,439,000.⁷

20. There is high confidence that storm surges will increase in tandem with the mean SLRs, thus leading to more coastal flood hazard⁸ Haiti’s coastal flood hazard is classified as “medium,” that is, more than a 20 percent chance of potentially damaging coastal flood waves occurring in the next 10 years.⁹ Its riverine and urban flood hazards are classified as “high,” which means that potentially damaging and life-threatening river floods and urban floods are expected to occur at least once in the next 10 years. Although the surface flood hazard in urban and rural areas is not included in this hazard classification, it may also be possible in the coming years.

21. Extreme precipitation magnitudes are projected to increase over the 2030s and 2050s. The average largest 1-day precipitation level will increase slightly to 43.15 mm (+1.76 mm) on an annual average by the 2030s (compared to the 1986–2005 period)

and remain similar in the 2050s, at the national level. During the 2030s, the largest increase, with more risks of flooding, will be in October during the wet season (April to October). As for the 2050s, there will be a slight decrease in the average largest 1-day precipitation level (42.35 mm) (see Table 1). Sub-nationally, the greatest increases will be taking place in the Sud-Est and Ouest departments (+5.59 mm and +5.05 mm for the 2030s, along with +7.24 mm and +7.03 mm for the 2050s, respectively).

On the other hand, projections of the 5-day cumulative precipitation, where areas can become saturated over several days, present a different flood risk. There will be an average increase of 9.68 mm for the 2030s nationally, especially during the rainy months, with the Grand’Anse department experiencing the greatest increase (+20.2 mm). In the case of the 2050s, there will be a slight decrease nationally (–2.33 mm), with Nord-Ouest experiencing the greatest decrease (–6.69 mm), while Grand’Anse will experience increases in its average 5-day cumulative rainfall (9.57 mm, anomaly).

Lastly, while average largest 1-day precipitation (in mm) will increase, the number of consecutive wet days will decrease for the 2030s and 2050s (–0.86 mm and –6.62, respectively). Also, the rainy days are going to be more scattered throughout the seasons.

TABLE 1.

Projections on precipitation extremes for the 2030s and the 2050s, based on a high-emissions scenario of RCP8.5

	2020–2039	2040–2059
Avg largest 5-day cumulative (mm)	116.65	104.64
Avg largest 1-day (mm)	43.15	42.35
Consecutive wet days	71.46	65.7

Source: World Bank Climate Change Knowledge Portal

HURRICANES

22. Haiti lies in the Caribbean hurricane corridor; thus, it is regularly affected by storm surges (see Figure 5). The country is mainly subject to tropical waves, which tend to be influenced by the intertropical convergence zone and carried from east to west by trade winds. These climate events can lead to tropical cyclogenesis and produce cyclonic systems characterized by excessive rainfall and strong winds, resulting in the formation of storms: convective storms, tropical storms, or hurricanes.¹⁰

Haiti's storm season goes from June through November, affecting mostly the West and South departments. Hurricanes constitute the second-most frequent disaster type, representing 40 percent of the country's total disasters.¹¹ Hurricanes are also highly hazardous, with an approximately 20 percent chance of damaging wind speeds.¹² From 1991 to 2020, Haiti experienced a total of 35 storms — 31 hurricanes, three tropical storms, and one

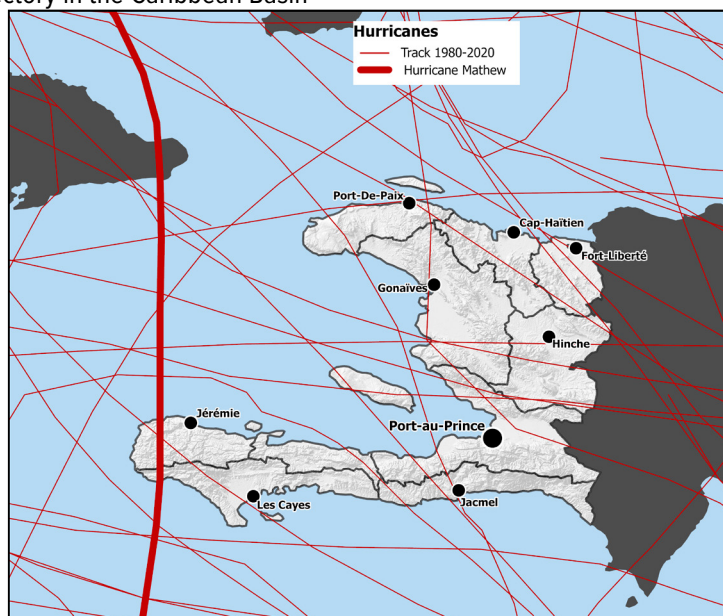
convective storm. In 2021, Haiti was ranked third among the countries most affected by extreme weather events in the world.¹³

23. In 2016, Hurricane Matthew made landfall in Haiti, and subsequently, became one of the most destructive hurricanes for Haiti.

The country was subjected to days of intense precipitation, with the total exceeding 30 inches in some locales.¹⁴ Due to its steep, deforested terrain, Haiti was vulnerable to floods and at risk of mudslides.¹⁵ The intense precipitation resulted in extensive flooding, infrastructure damage, crop losses, and significant mortality.^{16,17} The hurricane also led to 600 deaths, with 2.1 million people impacted,¹⁸ including over 50,000 internally displaced.¹⁹ Sub-nationally, the hurricane caused considerable damage to the southern peninsula and the northwestern parts of the country.²⁰ In particular, the Grand'Anse and Sud — both of which were located in the southwestern tip of Hispaniola — were the most affected.

FIGURE 5.

Hurricane Matthew's trajectory in the Caribbean Basin



Source: Knapp, K. R., M. C. Kruk, D. H. Levinson, H. J. Diamond, and C. J. Neumann, 2010: The International Best Track Archive for Climate Stewardship (IBTrACS): Unifying tropical cyclone best track data. *Bulletin of the American Meteor. Society*, 91, 363-376. doi:10.1175/2009BAMS2755.1

24. Severe hurricanes are projected to increase in frequency and severity. Haiti's geographical location along the hurricane corridor will worsen the country's vulnerability under climate change scenarios. By 2050, rainfall from hurricanes is expected to increase by 20–30 percent near the center, and by 10 percent in the outer circle of the hurricane (200 km or larger). Wind speeds from hurricanes will also increase by 2–11 percent.²¹

Although the frequency of Atlantic storms is projected to decrease, the most severe hurricanes from the Atlantic that will make an incursion into the Caribbean will increase its frequency by 80 percent by the end of the century.²² Cities such as Port-au-Prince and Gonaïves are 2–4 times more vulnerable to tropical storms than any other city in the country.²³ Increases in hurricane frequency and overall storm intensity will worsen flood and storm surge risks in the country.²⁴

LANDSLIDES

25. High deforestation rates, coupled with changing rainfall patterns, make landslides commonplace and particularly dangerous in steep sloping lands.²⁵ On many Caribbean islands, frequent heavy rains, the mountainous topography, and the volcanic geology combine to create high-hazard conditions for landslides (see Figure 6). On some slopes, landslides are common even when rainfall is only mild. The relationship between landslides and climate change is complex. While changes in rainfall and temperature may lead to more landslides, the increasing frequency of droughts, as projected in Haiti, may decrease the likelihood of these events.²⁶ In Haiti, landslides are common along all river valleys, where years of deforestation have left the upper reaches of the western basins bare.

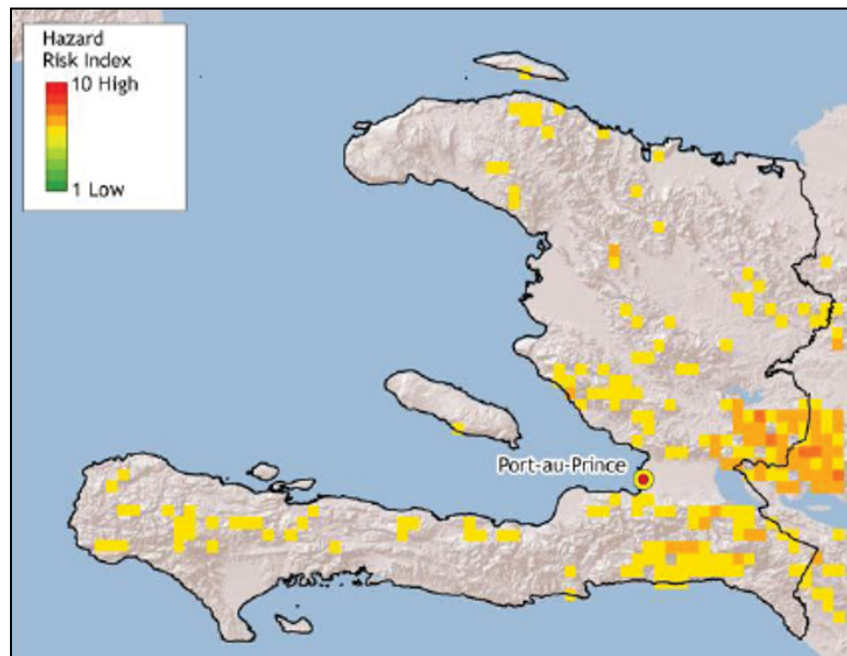
26. Landslides are among the climate change-related hazards that Haiti experiences. Even though landslides are the least frequent disaster in the country (1 percent of the reported natural disaster distribution),²⁷ Haiti's geographic location, which places it in the path of the Atlantic hurricanes, combined with the steep topography of its western region from which all major river systems flow to the coast, makes the country particularly vulnerable to landslides, especially between June and December. Taking into consideration the slope, the slope orientation, the water flows in the land, as well as hillside and geological factors, it is observed that most of Haiti has a moderate level of landslide susceptibility.

At the subnational level, the highest levels of landslide susceptibility are in the zones where the mountains are located, especially in the southern and southeastern parts of Haiti, due to the slope factor.²⁸ Port-au-Prince is one of the cities with the highest landslide risk ("very high"), especially its southern part. Also, in Léogâne — a city located in the western part of Port-au-Prince, the landslide risk is rated as "high" and "very high" (see Figure 6). In terms of potential damage, highways are highly susceptible to landslides, especially in the southern part of the country. For example, the highway that connects Port-au-Prince and Léogâne, along with the highway that starts in Port-au-Prince and continues to the eastern part of the country, are two of the riskiest roads in the country²⁹ (see Figure 6).

27. Projections about extreme precipitation events suggest that they would be the main trigger for future landslides. Increases in the average largest 1-day precipitation level for the 2030s indicate that landslides could occur concomitantly. Projections for the 2050s underline a decrease in rainfall,

FIGURE 6.

Risk of landslide hazard



Source: Global Facility for Disaster Reduction and Recovery. 2021. Climate Risk and Adaptation Country Profile: Haiti. <https://www.gfdr.org/en/publication/climate-risk-and-adaptation-country-profile-haiti>.

which could reduce the risk of landslide. At the same time, the increased frequency and intensity of hurricanes could impact Haiti's steep topography, resulting in more landslides.

DROUGHTS

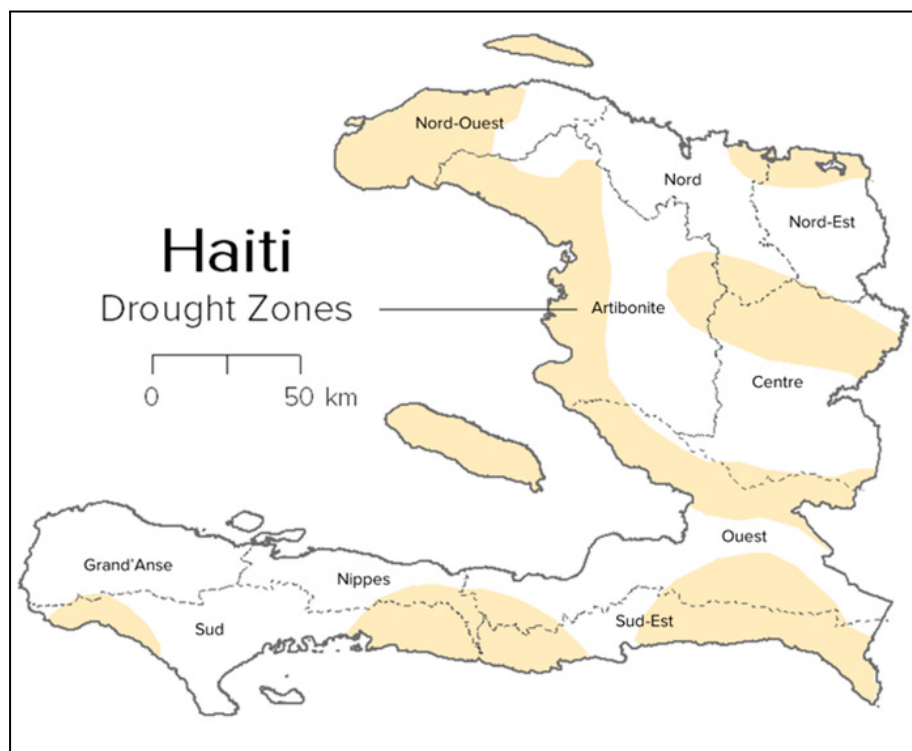
28. Haiti is susceptible to droughts due to rising temperatures related to climate change, deforestation, and limited water management infrastructures. Haiti is affected by the El Niño-Southern Oscillation — a climatic pattern that generates large-scale anomalies that increases surface temperatures in the Pacific Ocean. This climate phenomenon delays the start of the cyclone seasons, as well as increases the dry season. Departments in the North-West, Artibonite, North-East, and Central have experienced repeated droughts (see Figure 7).³⁰

From 1991 to 2020, the country went through five drought periods due to irregular and insufficient rainfall, resulting in crop failures, food shortages, and therefore, famine.³¹ These events tend to appear during the dry season (generally from December to April), exacerbated by the influence of the El Niño-Southern Oscillation. The five drought events have affected 8,855,521 people.³²

29. As rainfall will decrease for the 2050s, droughts are expected to become more extreme.³³ The annual Standardized Precipitation Evapotranspiration Index (SPEI) drought index measures drought severity according to its intensity and duration. Negative SPEI values indicate a negative water balance, whereby the -2 value equates to "severe drought." The annual SPEI drought index values for Haiti will be -0.42 for the 2030s and -0.68 for the

FIGURE 7.

Hazard climate drought zones



Source: HaitiData.org. https://haitidata.org/layers/geonode_data:geonode:hti_hazardclimate_droughtzone_polygon_052010.

2050s.³⁴ Although projections do not meet the -2 threshold, droughts would have an even greater impact, given Haiti's vulnerabilities in its water management infrastructure and agriculture system.

RISING TEMPERATURES

30. Rising temperatures in Haiti are going to be exacerbated by humidity. Whereas the previous discussion considered overall historic and projected temperature changes, this section will focus on temperature extremes defined as “temperatures $\geq 35^{\circ}\text{C}$,” using two classifications: (a) “very hot” days: $\geq 35^{\circ}\text{C}$; and (b) heat index days of $\geq 35^{\circ}\text{C}$. Notably, there are overlaps between these discussions, given how high current temperatures are across Haiti and the projections.

31. Although heatwaves in Haiti will remain an uncommon climatic event, humidity will increase the “feel-like” temperature. There are no reports of heatwaves or the number of “very hot” days to date. Moreover, projections for the 2020–2039 and 2040–2059 periods do not report any number of “very hot” days ($T_{\text{max}} > 35^{\circ}\text{C}$ and $> 40^{\circ}\text{C}$), under high-emissions scenario RCP8.5.³⁵ However, it is expected that this extreme temperature will increase in frequency from 2041 onwards.³⁶

Furthermore, the number of heat index days is expected to increase more drastically in the country. While Haiti will only experience an increase of 4.8 heat index days by the 2030s, however, the figure will accelerate to 31.42 by the 2050s nationally. It is projected that Grand'Anse will be the hottest department in the country, experiencing 25.25 heat index

days by the 2030s and 94.01 by the 2050s. Furthermore, departments — such as Ouest, Nord-Ouest, Sud-Est, and Sud — will go from registering approximately nine heat index days for the 2030s to roughly 60 days for the 2050s (see Table 2).

WILDFIRES

32. High temperatures, coupled with the high rate of deforestation, increase the frequency and intensity of wildfires. In Haiti, the probability of weather conditions exacerbating a significant wildfire is greater than 50 percent.³⁷ The country has only 3 percent of forest cover remaining at the national level; combined with rising temperatures, this could enable the

occurrences of wildfires.³⁸ The dependence of rural populations on charcoal, obtained from cutting trees, exposes them to wildfires and increases their vulnerability. In areas that have wildfire exposure, both duration and intensity have increased in the past years.³⁹

33. Wildfires in Haiti are likely to increase as a consequence of deforestation, prolonged dry spells, and the increase of high temperatures related to climate change. It is projected that these wildfires would increase in duration and severity.⁴⁰ However, there are no concrete estimations on how frequent and how intense they would become, or how they would impact human health.

TABLE 2.

Heat index days (> 35°C) anomaly projections, under high-emissions scenario RCP8.5

REGION	2020–2039	2040–2059
Haiti	4.8	31.42
Ouest	9.18	62.64
Grand’Anse	25.25	94.01
Nord Ouest	11.64	60.35
Nippes	1.8	45.04
Nord Est	0.8	7.13
Nord	4.58	41.02
Centre	3.96	28.41
Artibonite	5.64	45.5
Sud Est	9.11	59.28
Sud	8.49	59.01

KEY MESSAGES

Historic Observations

- Since 1960, mean temperatures have risen by 0.45°C. Much of this warming has occurred between June and November.
- Since the early 1900s, the average variations in annual rainfall have varied by less than 2 mm, with a rising trend recorded over time.
- The mean SLR rate in the Caribbean has been 1.8 mm/year.

Projected Climate

- Nationally, mean annual temperatures will increase by 0.88°C by the 2030s and 1.7°C by the 2050s.
- Annual precipitation will increase by 26.27 mm by 2030, but will decline by 17.97 mm in the 2050s.
- SLRs are expected to increase by 0.21 m by the 2030s and 0.35 m by the 2050s.

Climate Hazards

- Floods: Flooding is the leading factor of vulnerability in Haiti. Since 1991, the country has experienced 34 flood events. Extreme precipitation is expected to increase by the 2030s.
- Hurricanes: Haiti is highly vulnerable to storms, as it is geographically located along the hurricane corridor in the Caribbean. Although the frequency of the Atlantic storms is projected to decrease, the most severe hurricanes will increase their frequency by 80 percent by the end of the century.
- Landslides: Haiti's geographic location in the path of Atlantic hurricanes, combined with the steep topography of its western region from which all major river systems flow to the coast, makes the country particularly vulnerable to landslides, especially between June and December.
- Droughts: From 1991 to 2020, the country went through five drought periods due to insufficient rainfall, thereby resulting in crop failures, food shortages, and consequently, famine. Dry periods are expected to increase. The North-West, North-East, Artibonite, and West departments are more at risk of droughts.
- Rising temperatures: The frequency of hot days and hot nights increased by 63 and 48 days per year, respectively, between 1960 and 2003. Tropical nights and heat index days are expected to increase considerably for the 2030s and 2050s.
- High temperatures and the high rates of deforestation have increased the frequency and intensity of wildfires.



CLIMATE-RELATED HEALTH RISKS

34. Climate change influences human health outcomes and disease in innumerable ways. This section reviews evidence for the burden of current climate-related health risks in Haiti and projections of future risks of health outcomes due to climate change, based on the expected changes in the country's climate under RCP8.5. The health risks are presented according to prioritization and are examined according to historic, current, and projected risks, where information is available. The risks to Haiti's health system, in relation to climate change, are covered in Section IV.

35. Haiti is experiencing a double disease burden: the proportion of communicable diseases is declining, while the proportion of noncommunicable diseases (NCDs) is increasing.

This is important, since many communicable diseases and NCDs are climate-sensitive and will, therefore, interact with the overall climate-related burden of disease. Mental health and well-being are also important in the consideration of the climate-related burden of disease.

Although the causes of mortality are poorly documented in Haiti,⁴¹ the Haiti Health Plan uses the listing from the Institute for Health Metrics and Evaluation (IHME) in setting out the 10 leading causes of death in the country. In 2019, they are ischemic heart disease (4.56 percent of the total disability adjusted life years [DALYS]^c); stroke (4.6 percent); lower respiratory tract infections (6.32 percent); human immunodeficiency virus

(HIV) / acquired immunodeficiency syndrome (AIDS) (5.3 percent); neonatal disorders (9.3 percent); diabetes mellitus (3.13 percent); diarrheal diseases (5.59 percent); birth defects (5.4 percent); acts of interpersonal violence (3.51 percent); and chronic renal failure (1.57 percent).^{42,43}

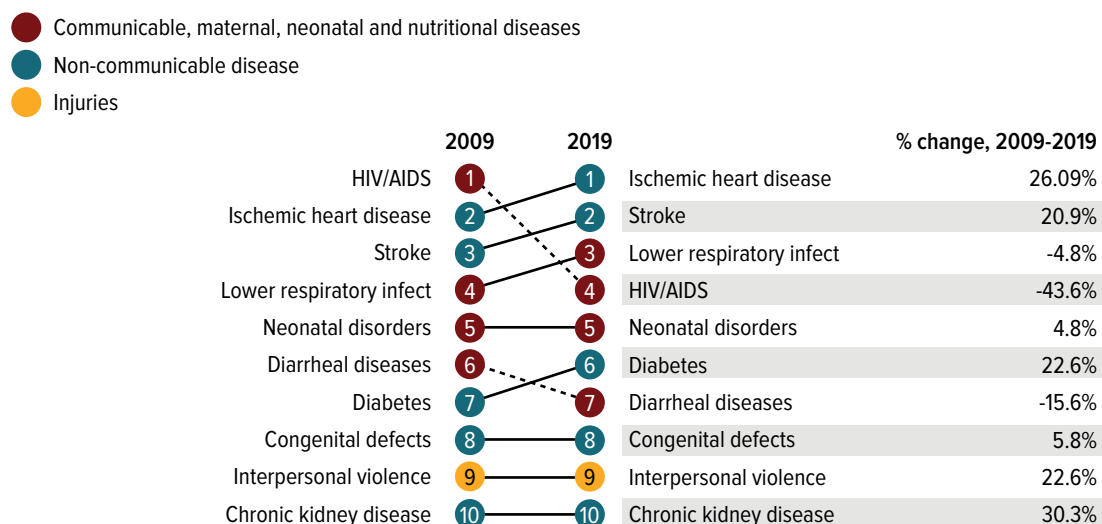
Of the 10 highest causes of death, HIV/AIDS showed the largest decrease, falling by 43.6 percent from 2009 to 2019, followed by diarrheal diseases (15.6 percent). These 2009–2019 changes in health outcomes suggest that the population is experiencing an epidemiological transition: mortality and morbidity caused by communicable, maternal, neonatal, and nutritional diseases (28.7 percent) and injuries (13 percent in 2016 and 9.3 percent in 2019) had declined, while NCDs had increased proportionally (57 percent in 2016 compared to 61.9 percent in 2019) (see Figure 8).⁴⁴

The disease burden attributed to NCDs (cardiovascular diseases [CVDs], cancers, congenital defects, stroke, and diabetes) is caused by multiple contributing factors. However, the

^c One DALY represents the loss of the equivalent of one year of full health. DALYs for a disease or health condition are the sum of the years of life lost due to premature mortality (YLLs) and the years lived with a disability (YLDs), due to the prevalent cases of the disease or health condition in a population. Source: [Disability-adjusted life years \(DALYS\) \(who.int\)](https://www.who.int/dalys).

FIGURE 8.

Top 10 causes of total number of deaths in 2019 and percentage change, 2009–2019, all ages combined



Source: Estimates generated by IHME and downloaded from <http://www.healthdata.org/haiti>.

link with climate change is clear. Increasing heat and drought conditions leads to the decreased yield and nutrient quality of crops, thus resulting in malnutrition. Poor air quality is caused by an increase in wildfires, as well as the continued burning of fossils and other household fuels. NCDs can also arise from a synergistic combination of multiple risk factors.

In 2019, the three risk factors that account for the highest NCD burden in Haiti are (a) malnutrition, (b) air pollution, and (c) high blood pressure, respectively. All three have links to climate change, with pathophysiological links to CVDs (including hypertension) becoming better characterized.⁴⁵ The risk factors for the total burden of diseases (communicable diseases, NCDs, and injuries) are presented Figure 9, with the majority being impacted by climate change.

36. Exposure to health risks from climate change are inequitably distributed within and across populations. Factors that affect vulnerability to climate are often similar to those that affect

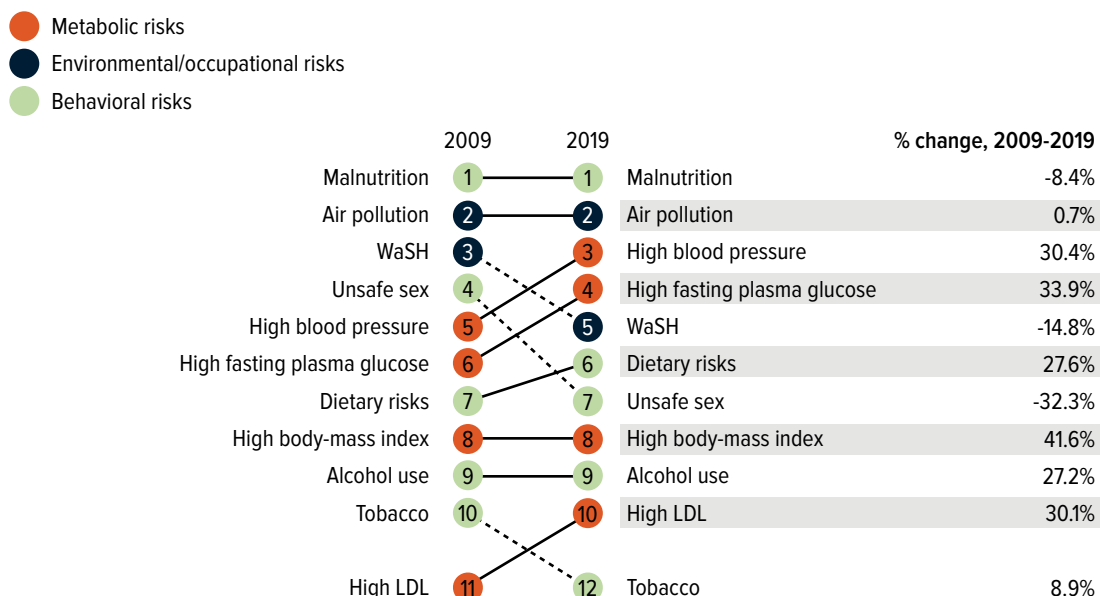
health more broadly.⁴⁶ Further, climate may exacerbate existing health inequalities, affecting particularly vulnerable groups such as the elderly; women and young children; those living with pre-existing conditions and disabilities; as well as groups in poverty, including those occupying informal urban settlements, along with displaced and rural populations.

37. Haiti suffers from extreme weather events such as storms, floods, droughts, and wildfires. Due to its location within the hurricane basin, Haiti had been adversely affected by storms Jeanne (2004), Matthew (2016), and Hanna (2018) — all of which resulted in fatalities.⁴⁷ In the period between 1991 and 2020, 4,803,699 people were affected by storms, with 5,753 deaths recorded (see Table 3).

Direct impacts, such as injuries due to climate-related events, represent 1.34 percent of the total DALYs in the country.⁴⁸ Tropical storms disproportionately impact those living in flood zones and coastal areas.⁴⁹ During

FIGURE 9.

Top 10 risks contributing to the total number of DALYs in 2019 and percent change, 2009–2019 — all ages combined



Source: IHME, <http://www.healthdata.org/haiti>.

TABLE 3.

Flood and storm events in Haiti from 1991 to 2020

EXTREME EVENTS	SUBTYPE	EVENTS COUNT	TOTAL DEATHS	TOTAL AFFECTED POPULATION
Floods	Total	46	3,208	723,748
	Coastal Flood	1	0	4,690
	Flash Floods	8	98	115,422
	Riverine Floods	25	3,024	502,910
	Floods (Uncategorized)	12	86	100,726
Storms	Total	35	5753	4,803,699

Source: Em-Dat. The database is made up of information from various sources, including UN agencies, NGOs, insurance companies, research institutes, and press agencies. Priority is given to data from UN agencies, governments, and the International Federation of Red Cross and Red Crescent Societies. EM-DAT includes all disasters from 1900 until the present, conforming to at least one of the following criteria: (a) 10 or more people dead; (b) 100 or more people affected; (c) the declaration of a state of emergency, and / or (d) a call for international assistance.

the 1985–2018 period, floods were the most frequent natural hazard in Haiti (47.58 percent).⁵⁰ For example, in 2004, intense precipitation resulted in two major floods with more than 2,700 fatalities, affecting more than 300,000 persons and severely damaging

hospitals and health centers⁵¹ (see Table 3). The capital city of Port-au-Prince is particularly vulnerable to flooding, with a large portion of its inhabitants residing on flood plains in poorly constructed housing.⁵²

38. Extreme weather events, such as storm surges, floods, and wildfires, are expected to become more frequent and intense. They can act as a force multiplier: for example, flooding causes soil erosion, which leads to decreased crop productivity and livestock, and, in turn, malnutrition. This is just one example of a synergistic interaction causing climate-related health risks.⁵³

39. Haiti's CHVA assesses six climate-related health risk categories. They include nutrition risks, waterborne and water-related diseases, vector-borne diseases (VBDs), heat-related morbidity and mortality, air quality health risks, as well as mental health and well-being. Each category is assessed, in terms of current and future risks, with considerations for both distinctive national and subnational features, where possible. It is important to note that these categories represent only the most pressing health risks to the population in Haiti.

NUTRITION RISKS

40. Weather and climate are the foundational drivers of healthy and sustainable diets. The mechanisms by which climate change affects nutrition via the food system are profound; they include acute and chronic effects on agricultural production, storage, processing, distribution, and consumption (see Figure 10). Nutritionally secure and stable diets not only depend on agricultural production, but also on the complex interactions of demand, economics, legislation, conflict, food waste, nutrient losses, food safety, and access.⁵⁴ Climate variability is already contributing to increases in global hunger and malnutrition.⁵⁵

While a comprehensive analysis of the climate change's impact on the food system is beyond the scope of this assessment, this

CHVA examines climate and nutrition linkages through a food security lens in Haiti, as it relates to the weather and climate impacts on agricultural productivity. Agricultural productivity — a key determinant of food availability — is affected by weather and climate in a multitude of ways: such events ranging from short-term shocks (for example, natural disasters) to longer term changes in agroecological conditions can drastically reduce yields or redefine the spatio-temporal patterns of crop suitability.

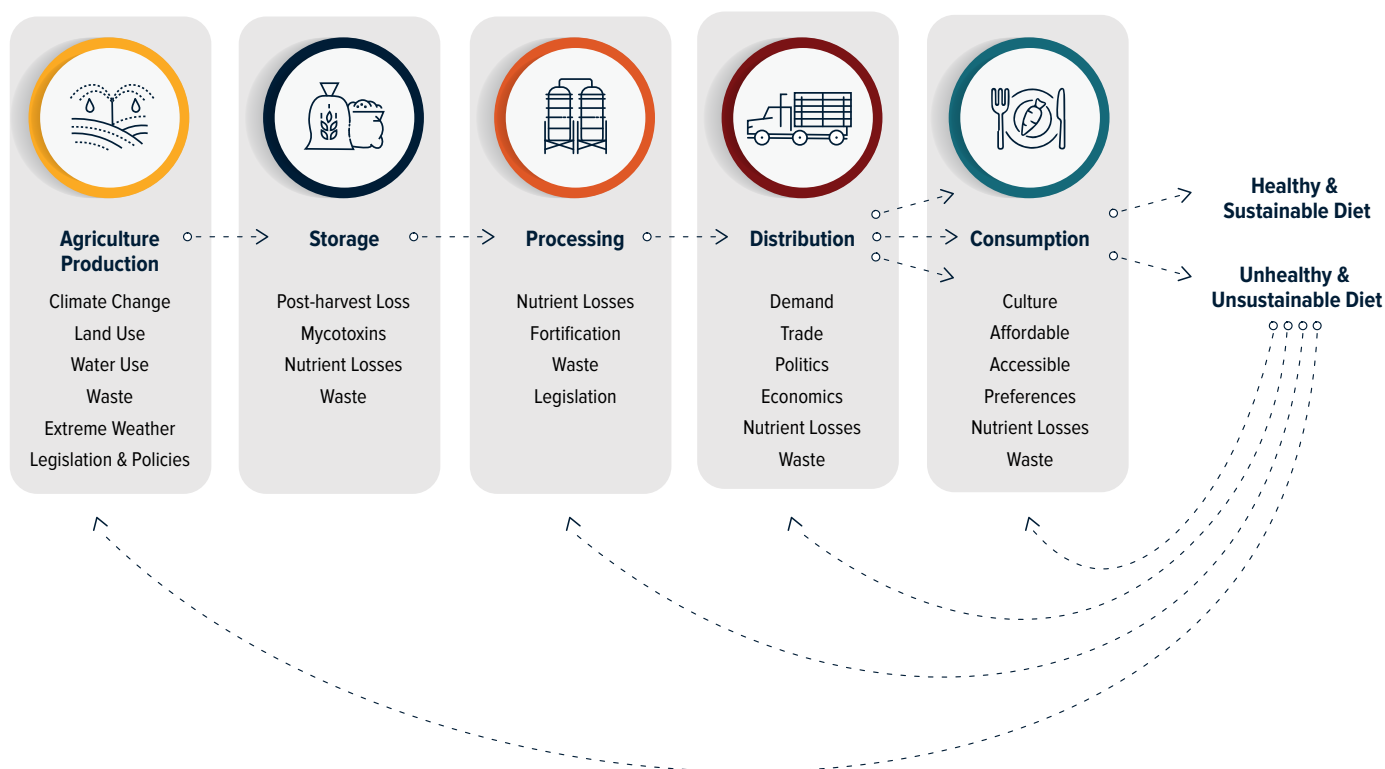
41. The level of chronic food insecurity in Haiti is among the highest in the world. Nearly half of the population (44 percent: 4.3 million people) face acute food insecurity, with the prevalence of undernourishment among 46.8 percent of the population for the 2018–2020 period.⁵⁶ The main causes of food insecurity and malnutrition in Haiti include low agricultural productivity, economic decline, limited access to clean water and sanitation, poverty, and political instability.⁵⁷

Agricultural productivity has languished in response to (a) recurrent natural disasters unrelated to climate (for example, earthquakes), (b) extreme weather events (for example, storms, flooding, landslides, and droughts), (c) high levels of environmental degradation, (d) the heavy reliance on rainfed agriculture, and (e) limited access to information and modern farm technologies.⁵⁸ Agriculture employs half of Haiti's total employment, with most farmers operating small (< 2 hectares [ha]) rainfed subsistence farms⁵⁹ that are highly vulnerable to climate stresses and shocks, such as the El Niño / La Niña phenomenon, which have increased the duration of dry spells.⁶⁰

42. As of 2018, 21.9 percent of children under five years old in Haiti were estimated to be

FIGURE 10.

Stages of the food system that drive healthy and sustainable diets



Source: Macdiarmid and Whybrow 2019.

stunted and 3.7 percent wasted, with the child mortality rate recorded at 8.3 percent.

Sub-nationally, the Centre department had the highest prevalence of stunting (30.1 percent), while Artibonite had the highest child wasting rate (4.3 percent) and the Ouest department had the highest child mortality rate (11.2 percent) (see Table 4).

According to the Integrated Food Security Phase Classification (IPC) phases of severity for acute food insecurity, 14 percent of the country's population was classified under "emergency" (IPC Phase 4^d) as of the reporting period from September 2021–February

2022. The populations were mostly living in areas in the Centre, Nord-Ouest, and Sud-Ouest departments; while 33 percent of the population (approximately 2,995,664), classified under "crisis" (IPC phase 3^e), was distributed throughout the national territory (see Figure 11).

43. Haitians' diets are characterized by poor quality and limited diversity.

Their diet is based on rice, maize, wheat, and sorghum, which is lacking in terms of foods rich in proteins such as fish, meat, dairy, or eggs.⁶¹ Furthermore, rice consumption is dependent on imports, which have increased since the 1980s.⁶² Nutritional concerns are linked to

d IPC Phase 4: Households either have large food consumption gaps, reflected in very high acute malnutrition and excess mortality, or are able to mitigate large food consumption gaps, but only by employing emergency livelihood strategies and liquidating assets. [[I had to "Accept Changes" here, because Word seems to be buggy with footnotes]]

e IPC Phase 3: Households either have food consumption gaps, reflected by high or above-usual acute malnutrition, or are marginally able to meet minimum food needs, but only by depleting essential livelihood assets or through crisis-coping strategies.

TABLE 4.

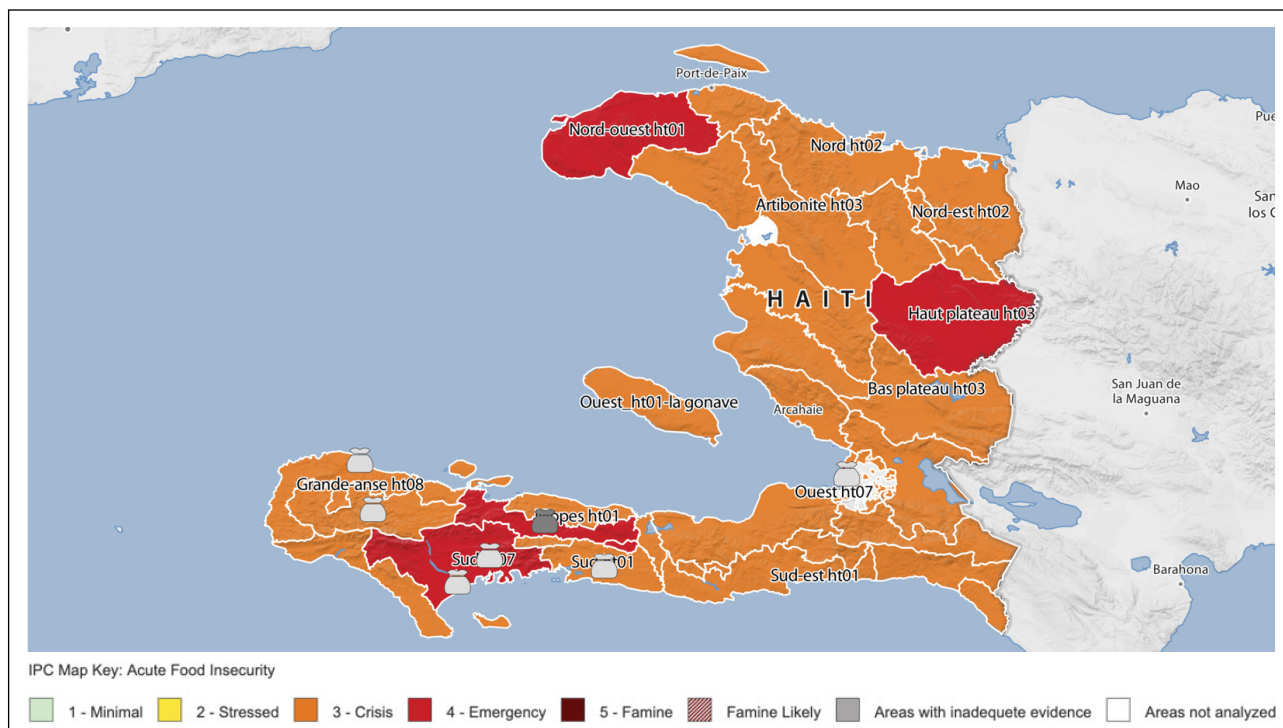
Child stunting, wasting, and mortality rates, by department

	CHILD STUNTING (%)	CHILD WASTING (%)	CHILD MORTALITY (%)
Aire Métropolitaine	20.2	5.9	8.9
Ouest	22.5	3.6	11.2
Sud-Est	20	2.5	7.6
Nord	20	3.6	5.4
Nord-Est	21	1.5	7.7
Artibonite	22.4	4.3	8.4
Centre	30.1	2.9	9
Sud	22	2.9	6.2
Grand'Anse	21.6	3.4	5.3
Nord-Ouest	20.3	2.4	5.8
Nippes	17.2	3.6	9
Total	21.9	3.7	8.3

Source: Global Hunger Index. 2019. Haiti: A closer look at hunger and undernutrition. <https://www.globalhungerindex.org/case-studies/2019-haiti.html>

FIGURE 11.

Acute food insecurity, Sept 2021 (Rural + Urban)



Source: Integrated Food Security Phase Classification (IPC).

Disclaimer: The information shown on this map does not imply that the IPC and CH officially recognize or endorse physical and political boundaries.

periods of the agricultural year when food is less available, namely April–June.⁶³

44. The exodus of the rural population to cities and abroad, and a lack of agricultural development, have also reduced food crops. The country's food imports — valued at USD1.05 billion by 2020 — rose by 21.2 percent from 2019. In particular, 80 percent of rice — an important food for Haitians — is imported. Other products, such as wheat, are also reliant on imports, as domestic production does not meet demand.⁶⁴

The country's dependency on food imports increases the vulnerability of its food systems. If supply countries are dealing with climate shock impacts in their crop production, they may not be able or willing to cater to Haiti's import needs. Moreover, regarding food affordability, the continued depreciation of Haitian currency, exchange rates, and the increased cost of public transportation due to fuel prices have also increased the vulnerability of poor Haitians primarily, as they cannot buy food for their households.⁶⁵

45. Droughts, soil erosion, reduced water supply, and increased crop damage have worsened food insecurity. Increased extreme rainfall triggers soil erosion and reduces soil fertility, aggravated by prolonged drought periods. Soil erosion is also worsened by deforestation rates in Haiti. Moreover, as droughts are expected to increase their duration and 92 percent of Haiti's agriculture is rainfed, this will lead to a reduction of crop yield.⁶⁶

46. Considering the projected decline of rainfall previously reported and an increase in the drought index, this would have important consequences on the replenishment of soil moisture and the availability of water

resources and, therefore, on food security for both the 2030s and the 2050s. The scarcity of water — pivotal for agriculture and livestock — is classified as a medium-level hazard in Haiti.⁶⁷ This means that there is up to a 20 percent chance that a drought still occurs in the coming 10 years. Although rice is not projected to be as impacted by climate change as other crops,⁶⁸ water scarcity and water management in Haiti could increase food insecurity in the country. Although the drought index is projected to be mild, the increased intensity of hurricanes and the overall decrease in precipitation, coupled with an inadequate water management infrastructure, the lack of development in the agricultural sector, and a dependency on food imports, will increase the country's vulnerability to food insecurity.

WATERBORNE AND WATER-RELATED DISEASES

47. Waterborne and water-related risks are prevalent in Haiti. This is a consequence of intense precipitation and drought conditions, coupled with inadequate water and sanitation systems. Climate change can cause the re-emergence of waterborne infectious diseases, as well as increase the persistence and virulence of pathogens.⁶⁹ The tropical climate creates sudden, extreme weather events, such as hurricanes and intense precipitation, with flash flooding in urban areas, resulting in the mixing of sewage with fresh water and consequent waterborne disease (WBD) outbreaks. The construction of homes on hill tops and deforestation results in landslides, as well as the buildup of waste in drains and culverts, causing multiplier risks and outcome challenges.

48. The population of Haiti is already vulnerable to waterborne and water-related diseases which may increase in response to the changing climate.

Haiti has the highest mortality rate for enteric diseases for all ages — both male and female (33.11 per 100,000 inhabitants) in the Latin America and the Caribbean (LAC) region and the western hemisphere⁷⁰ (see Figure 12). This is related to its poor water, sanitation, and hygiene (WaSH) infrastructure. Sixteen percent of the deaths of children under the age of five is directly related to WBDs⁷¹ such as cholera.⁷² Water and sanitation systems in Haiti are already fragile, leaving the population vulnerable to the transmission of diseases such as cholera, diarrhea, dysentery, hepatitis A, and typhoid. In low-income countries, changes in climate are expected to influence diarrhea rates;⁷³ however, the extent will vary depending on climate change scenarios and local factors.⁷⁴

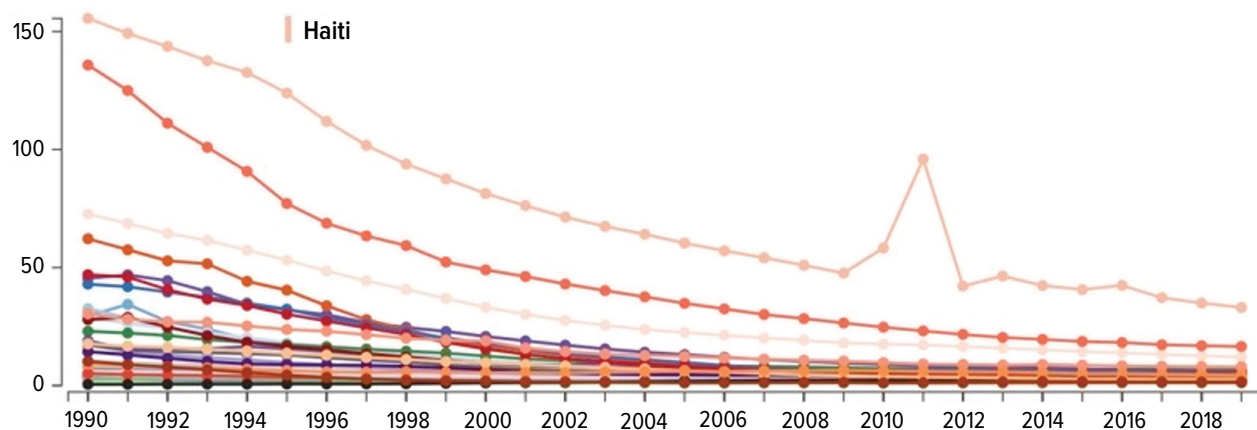
49. Extreme climate-related events in Haiti, such as hurricanes and floods, have increased the incidence of WBDs.⁷⁵ Hurricane Matthew in October 2016 resulted in increases in WBDs, and notably, a significant outbreak of cholera,⁷⁶

introduced by responders from overseas. Cholera became endemic from 2010 to 2018, resulting in approximately 819,000 reported cases and 9,786 deaths.⁷⁷ Contamination of the Meye tributary system of the Artibonite River, the poor sanitation services and the poor treatment of drinking water accelerated the epidemic, which then made the disease endemic.⁷⁸ The graph below shows the spike in enteric infections at the time of the earthquake, with Haiti having the highest rates in the LAC region (Figure 12). No cholera cases had been reported since 2019, and Haiti was declared free of cholera in February 2022.⁷⁹

Communities on the coast may also be exposed to increased risk of toxic algal blooms under a warming climate. These blooms are formed by dinoflagellates, which can result in paralytic and neurotoxic shellfish poisoning, as well as ciguatera fish poisoning (CFP). The LAC region experienced 7,800 incidents of human intoxication between 1970 and 2007, including 119 fatalities mainly associated with paralytic shellfish poisoning (PSP) along the Atlantic and Pacific coasts, and CFP in the Caribbean zone.⁸⁰ Shellfish

FIGURE 12.

Enteric infections deaths per 100,000 in the LAC region



Source: IHME.

and fish are important sources of protein in Haiti, particularly for coastal communities, thus making their contamination particularly devastating. These algal blooms can flourish in both coastal waters and inland fresh water sources, with growth stimulated by increasing temperatures.⁸¹ The Great South coastal areas are most affected, with significant concern reported in the communities of St Jean du Sud, Les Cayes, St Louis du Sud, Côtes de Fer, Jacmel, Cayes Jacmel, and Marigot.⁸²

50. Climate change has resulted in sargassum inundation on beaches. Concerns in the region began in 2011, with the Ministère de L'Environnement (MDE) in Haiti drawing attention to the issue since 2015.⁸³ When sargassum decomposes, it produces hydrogen sulfide — a gas that causes adverse cardiovascular and respiratory impacts, irritation to the upper airways and eyes, as well as neurobehavioral effects and symptoms.⁸⁴ Additional concerns include carcinogenic properties and the health risks associated with the accumulation of heavy metals, particularly arsenic and cadmium, in sargassum, although the evidence has yet to be fully established.⁸⁵

VECTOR-BORNE DISEASES (VBDS)

51. Weather and climate are critical drivers of spatio-temporal VBD distribution and transmission dynamics.^f At large scales, climate variability causes vector and host ranges to expand or contract, shifting the disease distribution and seasonality, and / or facilitating emergence or re-emergence of VBDS.⁸⁶ At local scales, vector abundance is a product of

microclimates, the availability of larval sites, the shade for resting, the sources of blood meals and nectar, and predator density.⁸⁷

This assessment focuses on mosquito-borne VBDS, including malaria, dengue, chikungunya, and Zika, due to their significant impact on Haiti. Other known mosquito-borne VBDS in Haiti include yellow fever and the West Nile virus fever. Likewise, other VBDS present in Haiti are lymphatic filariasis and leishmaniasis. Spatial models were constructed to demonstrate the plausible spatial distributions of the *Anopheles* (*An.*) vectors of malaria and the *Aedes* (*Ae.*) vectors of dengue, chikungunya, and Zika to assess the risk propensity of these diseases.

The results of these analyses should be taken as conservative estimates of the areas of Haiti that exhibit suitable conditions for vector breeding and suitable conditions for vector breeding where humans are present (that is, populated areas). The time frames under consideration are the historical reference period (1986–2005), the 2030s, and 2050s to match the data presented in Section II of this assessment. For further information on modeling methodology and inputs, see Annex A.

MALARIA

52. Despite nearly achieving the elimination of malaria in the 1960s,⁸⁸ malaria remains an ongoing public health problem in Haiti, especially among the populations of Ouest, Grand'Anse, Artibonite, and Sud (Table 5). After a surge in cases in the 1970s, more recent efforts have resulted in the number of malaria cases falling from 30,000 cases in 2012 to 10,000 in 2019.⁸⁹ In 2019, malaria contributed to 0.46 percent of total deaths, with mortality reported as ranging from 5–19

^f The main endemic insect vectors of infectious diseases in Haiti are as follows: *Ae. mosquitoes* — vectors of dengue, chikungunya, Zika, and yellow fever; *An. albimanus* — the primary mosquito carrying the malaria parasites; *Culex* mosquitoes carrying the West Nile virus fever and lymphatic filariasis; and *Phlebotomas* sandfly transmitting Leishmaniasis.

per annum over the 2010–2020 period,⁹⁰ and constituting 0.45 percent of the total DALYs.⁹¹ The incidence rate is now approximately 1,278 per 100,000, with the highest rates of transmission occurring after the rainy seasons of March to May and October to November,⁹² in the rural Grand’Anse department,⁹³ although other sources suggest that the Ouest department has 49 percent of the cases.⁹⁴

The primary vectors of malaria in Haiti are *An. albimanus* and *An. pseudopunctipennis*.⁹⁵ Female *An. albimanus* and *An. pseudopunctipennis* mosquitos will feed on both human and animals, but with some inconsistent biting and resting behaviors demonstrated across their range; they utilize both indoor and outdoor resting sites. Notably, *An. pseudopunctipennis* mosquitoes have broad thermal tolerance, ranging from 12°C–36°C, which has enabled the survival of the species across most of the Americas and throughout Haiti.

53. The malaria transmission risk in Haiti will largely remain unchanged through the mid-century, but will decline within the

Sud-Est, Ouest, and Nippes departments.

Throughout much of the country, projected temperature increases will not exceed the thermal tolerance of malaria vectors. Likewise, the minimum temperatures are already high enough to support the malaria species survival. Range expansion is not projected to occur according to this analysis; however, the overall suitable area will decline by 2.9 percent (35 square kilometers [km²]), 2.7 percent (134 km²), and 6.2 percent (126 km²), in Nippes, Ouest, and Sud-Est, respectively. These changes will likely place nearly 100,000 fewer people at risk of malaria transmission.

Changes to the geography of the malaria risk in Haiti through the mid-century are most likely to be attributable to human modifications of the landscape (that is, land use and land cover [LULC] change) that facilitate vector breeding and population increases, along with the adoption of malaria prevention, treatment, and control strategies. Notably, the opportunity to eliminate malaria on Hispaniola Island (comprising both Haiti and the Dominican Republic) is being considered again.⁹⁶

TABLE 5.

Number of malaria cases in Haiti in 2014, by geographic department

DEPARTMENT	NUMBER OF CASES	PERCENTAGE
Ouest	8,406	49%
Grand’Anse	2,143	13%
Artibonite	1,944	11%
Sud	1,367	8%
Nord-Ouest	940	5%
Nord	936	5%
Centre	535	3%
Nord-Est	297	2%
Sud-Est	367	2%
Nippes	159	1%
TOTAL	17,094	

Source: Malaria elimination in Haiti by the year 2020: an achievable goal? | Malaria Journal | [Full Text \(biomedcentral.com\)](https://doi.org/10.1186/s13075-014-0300-0)

TABLE 6.

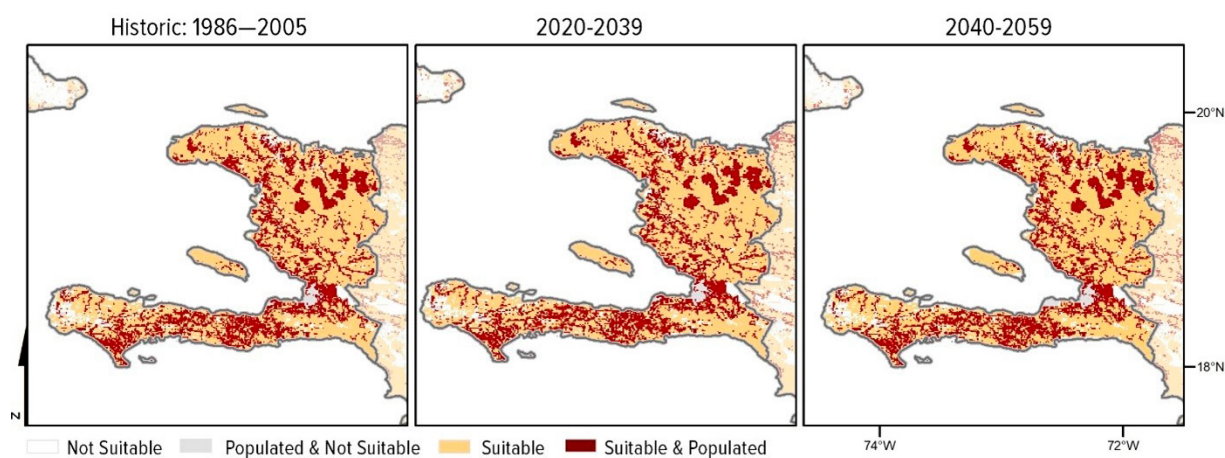
Current and projected suitable areas for malaria vectors, by department

DEPT.	PROPORTION OF REGION BY AREA SUITABLE FOR MALARIA VECTORS						VULNERABLE POPULATION				
	POPULATED, SUITABLE			OVERALL SUITABILITY			ABSOLUTE VALUES			DELTA (REF. PERIOD)	
	REF. PERIOD (%)	2030s (%)	2050s (%)	REF. PERIOD (%)	2030s (%)	2050s (%)	REF. PERIOD	2030s	2050s	2030s	2050s
Artibonite	32.4	32.4	32.4	96.8	96.8	96.8	930,337	930,337	930,337	0	0
Centre	18.6	18.6	18.6	98.9	98.9	98.9	486,842	486,842	486,842	0	0
Grand'Anse	16.1	16.1	16.1	68.4	68.4	68.4	295,563	295,563	295,563	0	0
Nippes	39.8	39.8	39.5	85.5	85.5	82.6	243,396	243,396	237,277	0	6,119
Nord	38.1	38.1	38.1	84.6	84.6	84.6	456,287	456,287	456,287	0	0
Nord-Est	36.7	36.70	36.7	97.1	97.1	97.1	135,350	135,350	135,350	0	0
Nord-Ouest	16.7	16.7	16.7	92.7	92.7	92.7	412,288	412,288	412,288	0	0
Ouest	39.5	39.5	38.0	88.3	88.3	85.6	1,064,656	1,064,656	1,027,143	0	37,513
Sud	44.5	44.5	44.5	91.3	91.3	91.3	556,056	556,056	556,056	0	0
Sud-Est	32.1	30.7	29.9	95.4	92.0	89.2	443,699	415,885	394,101	27,814	49,598
						TOTAL	5,024,474	4,996,660	4,931,244	27,814	93,230

Note: The table above was developed by the authors using data from various sources. See Annex A.

FIGURE 13.

Geographic and temporal distribution of malaria vectors



Note: The maps above were developed by the authors using data from various sources. See Annex A.

DENGUE

54. Despite an absence of routine systematic surveillance data, dengue is considered to be endemic in Haiti, as it is in the Dominican Republic.⁹⁷ A study from 2011 demonstrated the high prevalence of antibodies against dengue virus in all age groups — with 65 percent of three-year-olds already having antibodies from exposure to the virus, as well as evidence of hyperendemic transmission in the western and southeastern departments of Haiti.⁹⁸ Dengue is transmitted by the bite of infected *Ae. aegypti* and, to a lesser extent, *Ae. albopictus* mosquitoes. Over the 2004–2014 period, the number of cases of dengue and the severity of dengue virus infections have increased in the Americas, including the Caribbean.

55. Over seven million people in Haiti are vulnerable to dengue transmission, with the populations of Ouest and Artibonite at highest risk. The suitability for dengue vectors in Haiti has a distinctly spatial character, with

suitable areas largely located within population centers across the country. *Ae. Mosquitoes*, which transmit dengue, prefer biting humans over animals; they are commonly found in urban and peri-urban environments. Notably, projected increases in maximum temperatures through the mid-century will not be high enough to reduce the overall suitable area for dengue mosquito-vector species. Likewise, minimum temperatures are already high enough throughout the county to enable vector development and survival.

Very likely, the geography of dengue vectors throughout the country will be determined by changes in LULC driven by population expansion. Haiti's population is projected to reach by 2050 (Figure 14), which will create opportunities for vector-breeding sites, as new commercial and residential areas are developed in the absence of coordinated vector control measures. Importantly, while the findings of this analysis are meant to support dengue control measures, results

TABLE 7.

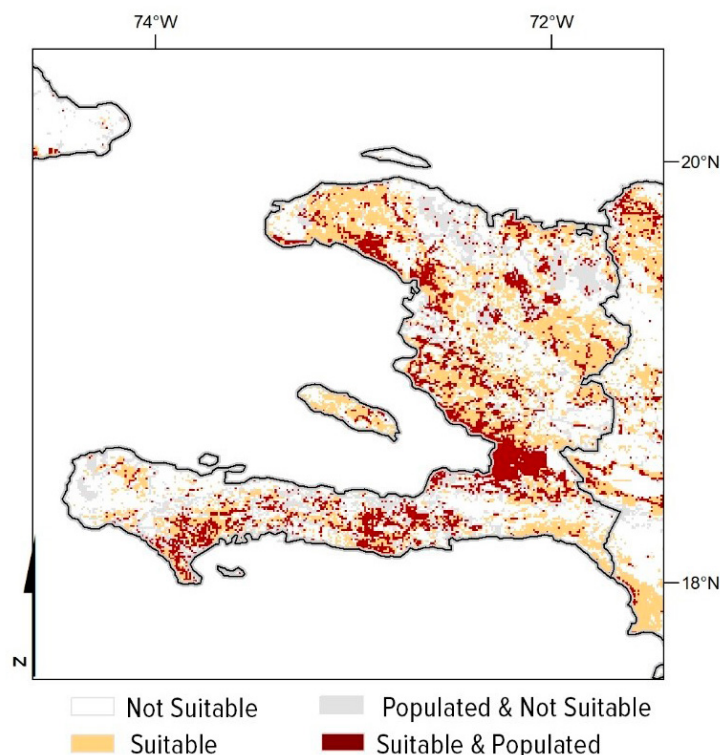
Vulnerable populations and areas suitable for malaria vectors

DEPARTMENT	PROPORTION OF REGION BY AREA SUITABLE FOR MALARIA VECTORS		VULNERABLE POPULATION
	POPULATED, SUITABLE (%)	OVERALL SUITABILITY (%)	ABSOLUTE VALUES
Artibonite	20.86	53.15	1,341,806
Centre	9.08	48.31	524,797
Grand'Anse	2.86	13.95	134,964
Nippes	11.61	23.78	126,475
Nord	15.25	28.84	657,881
Nord-Est	8.70	27.76	248,906
Nord-Ouest	9.88	51.03	382,814
Ouest	29.55	52.84	3,502,638
Sud	22.28	47.53	428,487
Sud Est	18.56	50.83	359,140
Total			7,707,908

Note: The table above was developed by the authors using data from various sources. See Annex A.

FIGURE 14.

Spatial and temporal distribution of dengue vectors



Note: The map above was developed by the authors using data from various sources. See Annex A.

may be extrapolated to assist in curtailing chikungunya and Zika risks as well, given that these diseases are vectored by the same *Ae. mosquito* species.

56. Chikungunya is caused by an arbovirus: it is transmitted to humans through the bite of a mosquito of the genus, *Aedes* (*Ae.*), mainly *Ae. aegypti*. Cases of chikungunya were first diagnosed in Haiti in 2014, when the Ministère de la Santé Publique et la Population (MSPP or the Ministry of Public Health and Population) reported a cumulative total of 39,343 cases between May 31 and June 16, 2014 in the 10 departments; the infection rate for Ouest was 67 percent.⁹⁹ Today, the incidence rate is reported to be 627 per 100,000 population.¹⁰⁰

57. Zika is caused by the flavivirus, which is transmitted through the bite of an infected

***Ae. genus mosquito*.** The disease was only identified in 2015, originally in Brazil, due to the unusually high incidence of congenital microcephaly, which can result in adverse fetal outcomes and neurological conditions in adults.¹⁰¹

58. The Zika disease spread through the Americas to the Caribbean including Haiti, and was declared a public health emergency of international concern by WHO in February 2016.¹⁰² During the emergence period of the disease — October 12, 2015 to Sept 10, 2016, MSPP reported 3,036 suspected cases of infection in the general population, with 22 suspected cases of the Zika virus disease in pregnant women, 13 suspected cases of the Guillain-Barré syndrome (GBS), and 29 suspected cases of Zika virus-associated congenital microcephaly. The National

Laboratory tested 294 specimens and found that 6.5 percent were positive.¹⁰³ It is reported that the surveillance program in Haiti needs to be strengthened to better monitor the evolution of Zika disease in Haiti.¹⁰⁴

59. Despite the strong correlation between VBD vectors and climate factors, climate is merely one determinant in the VBD transmission risk. The future risk of these diseases will depend on the changing climate conditions that define vector suitability, as well as environmental, social, and economic conditions.

HEAT-RELATED MORBIDITY AND MORTALITY

60. The health risks associated with heat include acute mortality; heat-related morbidity such as heat rash, cramps, exhaustion, dehydration; and the acute exacerbation of pre-existing conditions such as respiratory and CVDs;¹⁰⁵ individuals on medications are at further risk of detrimental interactions. There are no specific data on the impacts of heat on health in Haiti, nor are there clear projections. However, the impact of humidity, which can be high in Haiti, exacerbates the impacts of heat on health and well-being; this measure and projection are captured by the “heat index” reported in the climatology section of this assessment.

61. Heat-related morbidity and mortality creates pressure on the healthcare system.¹⁰⁶ Heat strokes, which can be described as the core body temperature exceeding 40°C (104°F) and leading to a central nervous system dysfunction, is perhaps the most dangerous heat-related illness, as it can result in severe morbidity and mortality.¹⁰⁷ When high temperatures interact with air quality, the levels of ozone, pollutants, and aeroallergens are

affected, which can, in turn, result in acute exacerbations of chronic respiratory and cardiovascular conditions.¹⁰⁸

Further, although there is no evidence of heatwaves as a major hazard for health in Haiti, the incremental increases in mean temperatures and the number of heat index days and tropical nights, along with the increase in the frequency of heatwaves predicted, during the 2041–2060 period under high-emissions scenario RCP8.5,¹⁰⁹ combine to present an increasing health risk for the population in Haiti. For example, it is estimated that 3.1 per 100,000 under five years old are currently at risk of mortality due to high temperatures,⁹ with DALYs at 108.11 per 100,000.¹¹⁰

62. Extreme heat also has an impact on mental health and well-being.^{111,112} High temperatures can aggravate mental health symptoms, as well as increase the risks of suicide¹¹³ and conflicts.¹¹⁴ More generally, research has shown that hot nights are associated with insomnia,¹¹⁵ with consequences including susceptibility to diseases and chronic illnesses,^{116,117} as well as adverse impacts on psychological and cognitive functioning.^{118,119,120}

63. Heat is an occupational health risk. There is a lack of reporting on heat-related injuries, illnesses, and deaths amongst occupations in Haiti. Nonetheless, studies from other countries indicate that workers in agriculture and construction are at a particularly high risk of occupational heat stress.¹²¹ Climate-based indices can be used to quantify workdays lost to extreme heat, reflecting recommended heat strain thresholds.¹²² Furthermore, studies on

^g “High” temperature is defined as a daily mean temperature that is warmer than the theoretical minimum risk exposure level value (TMREL) — the temperature with the minimum level of mortality for all included causes. The population-weighted mean TMREL is 25.6°C, with a range of 21.3–26.6°C. [High temperature — Level 3 risk | Institute for Health Metrics and Evaluation \(healthdata.org\)](#).

age-specific heat-related mortality indicate that heat-related mortality is high in adults in Haiti, compared with temperate or middle-income countries where heat-related mortality is only apparent in the older age groups (over 65 years old).

AIR QUALITY HEALTH RISKS

64. Global mortality, driven by the fossil fuel components of PM2.5, is estimated at 10.2 million per year.¹²³

Smoke from wildfires, dust storms, and other air pollutants can affect health acutely, as well as contribute to the development of severe chronic health conditions due to fine particulate matter (PM2.5) and other toxins. Health impacts include the increased risk of respiratory infections, lung cancer, COPDs, exacerbations of asthma, CVDs, and the advancement of dementia. Reducing fossil fuel usage has the clear co-benefits of producing both desired climate and health outcomes.¹²⁴ Those who are particularly vulnerable to particulate air pollutants include those with known asthma, chronic obstructive pulmonary diseases (COPDs), children. Ground-level ozone affects lung functioning, impacting individuals with asthma in particular, and can lead to premature mortality. In densely built-up population areas, rising temperatures can result in “smog-heat island” effects; smog also forms where air stagnates, for example, in low-lying regions. Other contributors to poor air quality in Haiti include power generation, diesel generators, and waste burning — all of which contribute as a positive feedback mechanism to climate-related health impacts.

65. The kinetics of the changing climate also influences atmospheric dust pollution.

Changes in wind patterns and strengths lead to increased PM2.5 such as, with desertification in some regions also exacerbating dust

formation, while heat and droughts increase wildfire risks — all of which can result in severe health impacts through inhalation. Specifically, changes in wind patterns and increased desertification increase the long-range transport of air pollutants. Under certain atmospheric circulation conditions, the transport of pollutants — including aerosols, carbon monoxide, ozone, desert dust, mold spores, and pesticides — may occur over large distances and over timescales typically of 4–6 days, leading to adverse health impacts.¹²⁵ Available data indicates that Port-au-Prince and Cap-Haïtien are areas that are the most affected.

66. In Haiti, mortality from particulate air pollution was responsible for about 14.05 percent of all-cause mortality.¹²⁶

The combined health impact of household exposures to particulate air pollution from the inadequate combustion of solid cooking fuels, plus general ambient pollution, was about 5,840 DALYS per 100,000 annually during the 2009–2019 period.¹²⁷ Over the 2009–2019 period, air pollution was the second-highest contributor to DALYS in Haiti across all age groups, second only to malnutrition.¹²⁸ Haiti’s annual mean concentrations are 19.0 micrograms per cubic meter ($\mu\text{g}/\text{m}^3$)^h for PM2.5 and 76.44 $\mu\text{g}/\text{m}^3$ (39 parts per billion [ppb])ⁱ for ozone in 2019.¹²⁹ These values exceed the WHO recommended maximum of 5 $\mu\text{g}/\text{m}^3$ for PM2.5 and 60 $\mu\text{g}/\text{m}^3$ for ozone.

Since 1990, the population-weighted concentrations of both ambient particulate matter and ambient ozone pollution in Haiti have fluctuated, even as the proportion of population using solid fuels (HAP) has fallen continuously since 2010. Despite this fall, air

^h $\mu\text{g}/\text{m}^3$ = micrograms per cubic meter, that is, one-millionth of a gram.

ⁱ Ppb = parts per billion; for ozone, 1ppb = 1.96 $\mu\text{g}/\text{m}^3$ (WHO guidance at 25°C) — [Microsoft Word - Conversion Factors Between ppb and.doc](#) ([defra.gov.uk](#)).

TABLE 8.

Regional and global comparisons of deaths attributable to outdoor air pollution, household air pollution, and fine particulate matter in Haiti, 2016

	HAITI	REGION AVERAGE	WORLD AVERAGE
Mortality rate attributed to household and ambient air pollution, age-standardized (per 100,000 population)	184.3	48.33 Haiti is the highest in the region.	92.43 Haiti is ranked 23rd in the world.

Source: USAID.²²⁰

quality in Haiti is considered to be “moderately unsafe,” according to the 2021 WHO’s air quality guidelines.¹³⁰

67. Air pollution affects pregnant women, the developing fetus, or both, in ways analogous to tobacco smoking — a well-known risk factor for low birth weight and preterm birth.

Babies —born too small or too early — are more susceptible to health problems such as lower respiratory infections, diarrheal diseases, brain damage and inflammation, blood disorders, and jaundice. Low birth weight and preterm birth are the leading risk factors for death in the first month of life. Other vulnerable groups are children under 5 years old and the elderly, due to damage and inflammation in the respiratory and cardiovascular systems in particular.

68. Improvements to air quality will result in co-benefits for the climate and the health of populations.

While those who have been exposed to air pollutants over long periods may already have chronic damage to lungs and arteries that may have evolved into cancers, heart disease, strokes, dementia, and COPDs in the years ahead, reducing or stopping exposure can halt further deterioration and resulting early mortality. At the same time, the improvement of air quality can also reduce triggers for acute-on-chronic

morbidity, such as the exacerbations of COPDs and asthma attacks.

MENTAL HEALTH AND WELL-BEING

69. The association between climate change-related events and mental health can be direct or indirect, short-term and long-term.

Acute events (such as floods) in the short term can precipitate a psychopathological pattern similar to experiencing traumatic stress, whereas exposure to extreme or prolonged weather-related impacts may result in delayed mental impacts, such as symptoms of post-traumatic stress in the future, or psychological impacts on younger generations. For example, mental health impacts in children can be manifested as behavioral disorders. Nonetheless, the impacts of climate change and extreme climate events on mental health and well-being are mediated by individual and community resilience.

The 2019 mental disorders epidemiology for Haiti records 1,660 DALYs per 100,000 population.¹³¹ However, given that the diagnostic capacity in the country is minimal, the data may not reflect the actuality. To be fair, research on the effects of mental health outcomes related to climate change lags behind the research related to physical health at the global level.

70. To assess mental health in the context of climate change, the full spectrum from mental “illness” to psychological and social well-being, or “psychosocial health,” is considered. This allows for the incorporation of the considerations of well-being and resilience.¹³² Adopting such an approach is particularly relevant in Haiti, where there is background strain on the resilience of the population, as well as limited opportunities for psychological or psychiatric assessments and diagnoses to inform an analysis. The concept of mental health and well-being can thus be framed as a spectrum of “psychosocial health.” It embodies the diverse psychological and social strains of climate change impacts such as housing, water, and income insecurities, as well as living in physically uncomfortable drought or humid conditions.

71. Extreme weather events can result in direct trauma, anxiety, and depression through personal injury, the death and injury of a close relative, damage or loss of property, as well as disruptions to livelihoods. Intense negative emotions, such as terror, anger, and shock, are recognized acute responses to natural disasters. These extreme events can also result in long-lasting psychological distress.^{133,134}

72. Mental disorders, such as depression, anxiety, and post-traumatic stress, are related to the increasing frequency of climate events. Extreme weather events, such as floods, droughts, and storms, are becoming increasingly common in Haiti. They are projected to increase the rates of mental disorders. Although there is a lack of information on the incidence and prevalence of mental health disorders in Haiti, global figures show that 14 percent

of the global disease burden is attributed to mental health illnesses.¹³⁵ Moreover, research shows that psychopathologies attributed to extreme weather events have increased by 17 percent, impacting about 30–40 percent of the population affected by the disaster. Research suggests that the impacts can persist up to two years after the event.¹³⁶

73. It is challenging to project mental health outcomes related to climate change. In Haiti, there is a need for improved surveillance and diagnostics, as well as specialist training and services, to meet the mental health and well-being needs of the population. Research in other countries¹³⁷ have projected levels of heat-related excess mortality for mental disorders. These estimates may not be transferable directly to the context of Haiti; however, the trends between increasing temperatures and associated mental disorders have also been found with regard to self-harm and suicide rates. Moreover, other findings suggest that suicide rates increase by 0.7 percent and 3.1 percent, respectively, for a 1°C increase in the average monthly temperature.¹³⁸

74. There are many factors that influence mental health and well-being, and the nature of resilience is not fully understood. For example, there is opportunity for post-traumatic growth (PTG) following a climate change-related extreme weather event, as opposed to the inevitability of the trauma. PTG is defined by Tedeschi and Calhoun (1995) as “*significant beneficial changes in cognitive and emotional life beyond levels of adaptation, psychological functioning, or life awareness that occur in the aftermath of psychological traumas that challenge previously existing assumptions about self, others, and the future.*”¹³⁹

TABLE 9.

Summary of the Climate Change Risks on Health Outcomes

RISK SUMMARY	
Nutrition and Food Security 	- Haiti is among the most food-insecure countries in the world. - Malnutrition is consistently the highest contributor to total DALYS over the 2009–2019 period, across all ages. - More than half of the population is food insecure, with more than one-fifth of the children chronically malnourished. - In the absence of adaptation, climate change is predicted to increase the duration of droughts and the frequency of flooding, resulting in reductions in crop yield,²¹⁹ thereby aggravating food insecurity and increasing malnutrition.
Vector-borne Diseases 	- In Haiti, the vectors for malaria may increase their spatial and temporal distribution, though currently, the highest rates are in the Grand'Anse and West departments. - There are also cases of dengue, chikungunya, and Zika. - All these diseases could spread, as changes in precipitation levels and internal settlements provide increased habitats for breeding and opportunities for the respective mosquito species to flourish.
Waterborne and Water-related Diseases 	- Waterborne and water-related diseases occur throughout Haiti due to inadequate water and sanitation systems, intense precipitation, drought conditions, and specific water contaminants. - Contaminated water, such as through the flooding of sewage and agricultural runoffs, results in the transmission of diseases, such as dysentery, hepatitis A, and typhoid, with poor sanitation systems contributing to large and rapid disease outbreaks. - Droughts of longer duration have been linked to the reduced availability of fresh water, the deterioration in water quality, stagnation, and disease outbreaks. - Coastal communities can be impacted through saline intrusions, as sea levels rise due to climate impacts, thus affecting the local groundwater, while the increases in the surface water temperatures on the coast and in inland waterways lead to the proliferation of the toxin-producing algal blooms. - Climate change patterns will influence and expand the ecosystem opportunities, growth and transmission rates, as well as the persistence and virulence, of pathogens.
Heat-related Morbidity and Mortality 	- Haiti's under-five-year-olds are at most risk of the predicted increases in the number of tropical nights. - At rates of 3.1 deaths per 100,000 and 108.11 per 100,000 DALYs, increasing temperatures present the highest risk for under-five-year-olds in the LAC region.

RISK SUMMARY

Air Quality and Respiratory Health



- The disease burden, due to poor air quality, is the second-highest contributor to DALYS across all ages.
- Factors include particulate matter, ozone, and chemical pollutants collecting in smog-heat islands in urban and low-lying areas.
- Wildfire smoke, dust, pesticides, and industrial chemicals can lead to adverse health impacts, reflecting changes in drought and wind patterns.
- Exposure to air pollution, both ambient and household, increases the risks of contracting diseases such as lung cancer, stroke, heart disease, and chronic bronchitis.
- Improving air quality is a priority in Haiti for the population to enjoy the co-benefits for climate and health.

Mental Health and Well-being



- Increases in the occurrences of extreme weather events, such as floods, droughts, and storms, also increase the incidence of mental health and well-being concerns.
- The recognition of this burden across age groups in Haiti is well-documented, following significant events, such as Hurricane Matthew, in 2016.
- There is evidence to support that individual and community resilience can be strengthened to support mental health and well-being, and even PTG.



ADAPTIVE CAPACITY

HEALTH SYSTEM OVERVIEW

75. Haiti's health system is characterized by a mix of public, private nonprofit, mixed, and private for-profit entities.¹⁴⁰ The publicly funded health system in Haiti has three levels: the national level is overseen by MSPP, with the health department level overseen by the health department directorate, while the district and community levels are managed by the district health unit and family health team.¹⁴¹ Following the earthquake in 2010, Haiti developed a Strategic Development Plan of Haiti (PSDH) to guide the implementation of strategies toward recovery and development, including in the health sector.¹⁴²

76. Haiti is exposed to climate hazards that impact the health system. The health system has managed extreme climate-related events, such as the 2016 Hurricane Matthew, as well as other severe natural hazards such as the 2010 earthquake.¹⁴³ Those climate and natural disasters impacted health infrastructures, as well as electricity, clean water, and sanitation systems.¹⁴⁴ The healthcare infrastructure has been severely compromised by earthquakes, hurricanes, and a lack of public expenditure in the health system.¹⁴⁵

77. The emergence of the Coronavirus 2019 (COVID-19) pandemic has brought with it a focus on health systems, specifically the acquisition of sufficient vaccinations for the population, as only 0.95 percent of the population is fully vaccinated. Nonetheless, Haiti has not suffered significantly during the pandemic, specifically in relation to COVID-19 deaths (827) and cases (30,473), since the start of the pandemic, as compared to other developing countries.¹⁴⁶

However, climate change, in combination with COVID-19, has the potential to disrupt and overwhelm health systems, including healthcare facilities and healthcare staff. This is especially important in settings that may already have weak health systems, including leadership challenges, a lack of resources, and / or limited capacity.

78. The extent to which Haiti is prepared for, and has the capacity to respond to, climate-related changes is a key modifier of climate-related health risks. In this assessment, Haiti's adaptive capacity^j to prevent and manage climate-related health risks is examined according to WHO's six health system building blocks (Figure 15).¹⁴⁷ These building blocks are further elaborated upon in the remainder of this section.

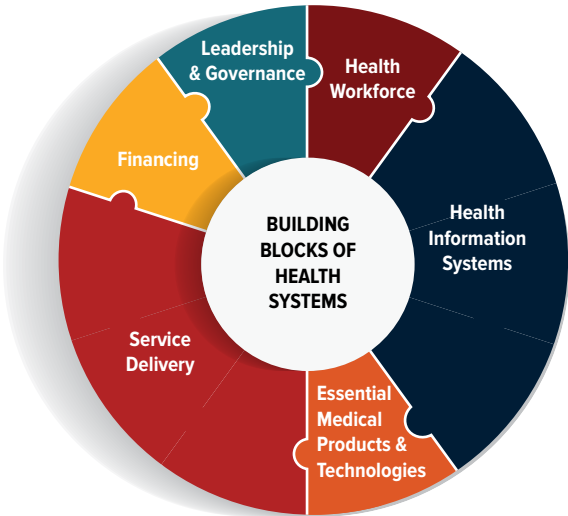
^j *Adaptive capacity* is defined by IPCC as "the ability of a system to adjust to *climate change* (including climate variability and extremes) to moderate potential damages, to take advantage of opportunities, or to cope with the consequences." The related term, *resilience*, is the ability to prepare and plan for, absorb, recover from, and more successfully adapt to, adverse events. People and communities with strong adaptive capacity have greater resilience. This assessment makes use of the terms, "adaptation" and "adaptive capacity," to encompass both terms.

LEADERSHIP AND GOVERNANCE

79. Haiti is committed to meeting the climate challenge through both adaptation and mitigation measures — coordinated and implemented by the Direction des Changements Climatiques (DCC) at MDE. Over the past decade, the government of Haiti

has demonstrated its political commitment and action to address climate change challenges through several global and country-level agreements and protocols — some relevant to health. Table 10 highlights the key policies and action plans in Haiti, which include considerations of climate change challenges, starting from 2012.

FIGURE 15.
WHO’s health system building blocks



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

TABLE 10.
Key policies and action plans in Haiti that consider climate change challenges

2012	National Health Policy, MSPP¹⁴⁸ The National Health Policy outlines the options adopted by the Haitian state to improve the health situation of the population and adapt it to the development requirements of the country. The policy highlights the suitability of the tropical climate for the development of vectors, particularly the An. and Ae. vectors of malaria and dengue fever. There are no other considerations for climate-health risks.
2012	Strategic Program for Climate Resilience (SPCR), Inter-ministerial for Spatial Planning and Inter-Ministerial Committee for Land Planning¹⁴⁹ Haiti developed the SPCR under the Pilot Program for Climate Resilience to mainstream climate change into national development planning. ¹⁵⁰ The objective of the SPCR is to reduce the country’s vulnerability to climate change in target regions experiencing different levels of risks. It also forecasts the consequences and impacts of climate change on key sectors of the national economy, as well as strengthens the resilience of both rural and urban communities in the target regions. It includes projects on climate change adaptation in the coastal cities of the Golfe de La Gonâve and strengthens the knowledge management of climate data to inform decision-making and policy dialogues. This program was supported by development partners including the World Bank Group, the International Development Bank, the African Development Bank, and the European Bank.

2013	Second communications on climate change, Direction des Changements Climatiques (DCC), MDE¹⁵¹
	The national communication is the result of a series of activities carried out under the auspices of DCC — the national political authority for policies and the implementation of actions in this area. The second national communication on climate change provides relevant information on the evolution of GHGs, mitigation measures, the country's vulnerability to extreme climatic events, and adaptation options. This includes the promotion of building techniques that limit CO₂ emissions and other pollutants in order to improve indoor and outdoor air quality. As such, it guides decision-making, in terms of mitigation and adaptation to climate change.
2014	Haiti Sustainable Energy Roadmap, Ministère des Travaux Publics, Transports et Communications¹⁵²
	The Haiti Sustainable Energy Roadmap looks at options for integrating renewable resources as much as possible into the energy sector of the country, focusing on those that are most appropriate. The recommended options for Haiti include hydropower, solar energy, wind resources, biomass, and biofuels. Additional recommendations, related to air pollution, identify the need for Haiti-specific data on the environmental and health impacts of power plants, including local pollutants and GHGs, as well as supplying efficient cookstoves and alternatives to charcoal to reduce HAP. This roadmap was developed in collaboration with the Worldwatch Institute.
2015	Intended Nationally Determined Contribution, MDE¹⁵³
	The Intended Nationally Determined Contribution (INDC) of the Republic of Haiti provides relevant information on the proposed effort to address climate hazards. The INDC outlines guidelines, on which the government's actions will be based for the next 15 years, for adapting to climate and reducing GHG emissions by 31 percent. The INDC highlights the country's adaptation priorities as the integration of water resources, watersheds, and coastal zone management; the rehabilitation of infrastructure; the improvement of food security; along with information, education, and awareness.
2006	National Adaptation Plan of Action (NAPA), MDE¹⁵⁴ (Revised in 2017)
	The NAPA is an important multisectoral and multidimensional exercise for implementing the National Policy on Climate Change. It is a driving force to accelerate Sustainable Development Goals (SDGs) by putting in place economic and investment scenarios. The priorities highlighted include watershed management and soil conversion, coastal zone management, the valorization and conservation of natural resources, the improvement of food security, water protection and conservation, the construction of rehabilitation of infrastructure, waste management and information, as well as education and awareness, with the first three considered to be top priorities. In terms of climate-health risks, the NAPA has identified drought-related hypertension. There are some adaptation projects¹⁵⁵ aligned to the NAPA, including the following:
	• Building Adaptive Capacity of Coastal Communities in Haiti (2011–2016).¹⁵⁶ The project aims to promote development that protects the local communities from climate change impacts. This includes creating resilient economies and societies, while reducing risks for vulnerable populations in Haiti. • AP3C Project (2015–2020). It aims to reduce Haiti's vulnerability to climate change through improved coordination on adaptation and mitigation and the improvement of the national environmental legislation — funded by the European Union's (EU) Global Climate Change Alliance (GCCA). • Pilot Program for Climate Resilience (2014–2021)¹⁵⁷ funded by the Inter-American Development Bank and the World Bank. This is a Caribbean regional program for building resilience in six countries (comprising Dominica, Grenada, Jamaica, St Lucia, and St Vincent and Grenadines). Objectives are integrated, with a focus on building capacity for climate resilience in development policies and planning, as well as scaling up and mobilizing climate resilience.

	• Ecosystem-based adaptation (2016–2020) funded by the Global Environmental Facility. The objective of the project is to increase the resilience of ecosystems and vulnerable communities through biodiversity conservation and the watershed management of three rivers in the country.¹⁵⁸ • Capacity-building project to implement Multilateral Environmental Agreements (2016–2018), supported by the UN environment program.¹⁵⁹
2019	National Policy to fight Climate Change, MDE¹⁶⁰ The National Policy on Climate Change aims to build on institutional strengthening and improvements in governance, endogenous climate financing, and efficiency in actions for fighting against climate change.
2019	National Disaster Risk Management Plan¹⁶¹ The National Disaster Risk Management Plan includes strategies to increase preparedness for disasters to ensure an effective response and quick recovery. The policy document describes climate change as a major risk on current and future strategic sectors for the country's economy. However, climate-health risks and consequently, adaptation strategies, are not addressed.
2021	Health Master Plan 2021–2031¹⁶² The Health Master Plan sets out the path that Haiti intends to follow toward universal health coverage (UHC). The plan is based on WHO's six building blocks (leadership & governance; financing; health workers; essential medical products & technologies; health information systems [HIS]; and health services). The document acknowledges that air quality is threatened, and that vulnerability to natural disasters, particularly floods, has increased considerably due to deforestation and impacts to watersheds. However, the report does not offer planning on climate health-risks and adaptation strategies.
2022	National Adaptation Plan (NAP) 2022–2030 The NAP provides adaptation actions for four key priority areas: agriculture, health, infrastructure, and water resources. These areas are prioritized due to their socioeconomic relevance and vulnerability to climate change. For the health sector's priority area, the adaptation actions focus on health insurance; the development of a climate-resilient health infrastructure; capacity building to ensure "first aid" for all Haitians; maternal care; the support of vulnerable populations; the promotion of natural medicine; along with the strengthening of health policies accounting for climate-related hazards and their awareness. The NAP includes cost estimates for implementing the proposed actions. Health-specific cost lines for health prevention and WaSH are projected to be slightly below USD13.5 million — less than 1.5 percent¹⁶³ of the total estimated budget.

HEALTH WORKFORCE

80. Haiti has challenges in building and retaining a strong health workforce, particularly in the public sector. Haiti is one of the 57 countries defined as having a crisis in human resources for health (HRH). For example, there are concerns about the quality of education, standards, and accreditation; poor career structures and skill mix in the workforce; urban-rural maldistribution, with specific issues with rural retention; insufficient and

irregular salary payments, as well as a lack of medical supplies and essential resources; and poor retention¹⁶⁴ characterized by international migration.

81. Attracting and retaining qualified health professionals is a chronic challenge, with as few as six health professionals per 10,000 people.¹⁶⁵ In 2018, Haiti was reported to have an estimated 2.3 medical doctors and 3.97 nurses and midwives per 10,000 population, which is below WHO's minimum threshold for

UHC — 44.5 per 10,000.¹⁶⁶ In total, there were an estimated 2,606 registered doctors, 4,227 nurses, and around 197 midwives.¹⁶⁷ Moreover, there is a shortage of other health professionals: for example, there were 1,731 medical pathologists and laboratory technicians, and by 2016, around 0.077 psychiatrists worked in the mental health sector per 100,000.¹⁶⁸ According to WHO, there are no environmental health workers in the country. The shortage is worsened by the outmigration of medical doctors and nurses due to a lack of adequate labor conditions.¹⁶⁹

82. The training and recruitment pipeline faces challenges. On average, 352 medical doctors, 4,234 nurses, and 75 midwives graduate from Haiti's educational institutions each year. With bilateral cooperation agreements supporting the training of medical doctors for Haiti, the total number of medical doctors reaches approximately 500–600.¹⁷⁰ However, after their studies, about 24 percent of medical doctors, 87 percent of nurses, and 59 percent of midwives remain unemployed due to insufficient recruitment resources.¹⁷¹

83. The health workforce, particularly doctors and nurses, is more concentrated in urban areas. Eighty percent of medical staff are located in urban health facilities, leaving less than 20 percent in rural areas where half of the population lives.^{172, 173} Both the private and government health sectors face shortages of doctors, nurses, and community health workers in rural areas. Traditional medicine and healers are typically linked to local religions and widely used in areas lacking in licensed practitioners; for example, traditional birth attendants are responsible for around 75 percent of birth deliveries in the country.¹⁷⁴ However, there is no data on how these traditional practices and practitioners manage conditions related

to climate-health risks, such as heat exposure and vector-borne and waterborne diseases, along with the management of mental health conditions.

84. Salary payment systems for health workers have curtailed health workforce capacity. Until 2018, health workers were paid by direct deposit. Widespread corruption resulted in the MSPP making salary payments by checks. However, such a process requires health workers to travel to urban centers to pick up their salary payments, thus leading to the loss of a workday and disincentivizing health workers to work in rural areas.¹⁷⁵ Moreover, delays in salary payments and insufficient remuneration are a common trend among health workers, constituting a primary cause of international outmigration.¹⁷⁶

85. NGOs are an essential part of the healthcare workforce. Organizations such as Partners in Health (PIH) have been working to improve healthcare access in Haiti since the early 1980s. The organization employs around 6,300 health staff, including 2,500 community health workers. They attend to more than 1.3 million people in primary care, maternal and child health care, HIV, tuberculosis, mental health, and more advanced care. A part of their work is focused on providing training to the health workforce; they offer six residency programs. Although PIH's workforce has provided services during extreme weather events such as hurricanes, there is no information regarding the integration of climate change impacts on health as part of the training of their health staff.¹⁷⁷

86. International aid and short-term medical missions (STMMs) are common in Haiti; they help to mitigate the health workforce shortage. However, these platforms tend to

result in unregulated activities, which are not integrated into the national health strategic planning. There is a need to coordinate STMMs with local health officials, so that there can be appropriate coordination, regulation, and distribution of an accredited health workforce to areas of the greatest need. Moreover, it is pivotal to incorporate the STMMs into a climate-health adaptation national strategy.¹⁷⁸

87. Efforts with multilateral stakeholders, such as the United States Agency for International Development (USAID) and the Health Finance and Governance Project (HFG), have focused on evaluating and improving conditions for human resources among public and private health institutions. For example, HFG has developed guidelines and programs to improve the accreditation process of medical doctors, nurses, and community health workers through the Reconnaissance project.¹⁷⁹ Efforts to improve access to quality health services have prioritized the health workforce, yielding the first Plan Stratégique de Développement des Ressources Humaines pour la Santé.¹⁸⁰ Furthermore, HFG and USAID have worked alongside the Directorate of Human Resources within MSPP to evaluate the capacity and conditions of human resources in public and private health institutions.¹⁸¹ These initiatives, supported by improvements in health financing management, seek to ameliorate workforce conditions and the retention of the human capital in the country.¹⁸²

88. There are no capacity-building programs in place that address the context of a changing climate and the capabilities of the health workforce to prepare for, prevent, as well as respond and adapt to climate change-related health risks. Haiti developed a Strategic Plan for the Development of Human Resources in the Health Sector for 2030. Among its

primary goals, it seeks to strengthen the health workforce and the health system. Moreover, it aims to improve labor conditions and retention mechanisms to improve health workforce deployment in the country. However, there is no mention of climate change in this document or training to manage specific climate-related health risks. Both professional training (for example, medical and nursing schools) and continued professional training (for example, on-the-job, post-graduate, and in-service training) mechanisms lack comprehensive information on understanding and reducing the health risks of climate change or training on disaster response, such as for floods, mudslides, and extreme events.

89. The extent to which Haiti's health workforce has adequate knowledge, technical capacity, and resources to prevent and manage current and future climate-change-related health risks remains unknown. There is a lack of a health workforce, and even with an adequate workforce, there are not sufficient resources. Although some training materials have been developed for extreme weather events such as hurricanes, expansion is needed across climate-sensitive disease programs, including the development and adaptation of educational curricula and training materials, as well as the integration of climate change into in-service health worker and community health worker training programs.

HEALTH INFORMATION AND DISEASE SURVEILLANCE SYSTEMS

90. Historically, there have been issues with incomplete data, inaccurate data, the lack of timely data collection, and parallel information systems among various partners working in health. In addition, the information

that is available is not always analyzed and used for decision-making in health planning and policy.¹⁸³ One of the main challenges is to set up and implement an effective and efficient structure that is capable of reorganizing and consolidating the various HIS, in order to effectively support evidence-based decision-making at all levels: institutional, local, district, and central.

91. Since June 2008, the Pan American Health Organization (PAHO) / WHO has been supporting MSPP to create a National Health Information System that will consolidate all relevant health information for use in health planning, decision-making, and action. This system will include information on morbidity, mortality, health systems, health services, human resources, and health financing at all levels of Haiti's healthcare system. Unfortunately, there was a considerable setback for the health information system project, when the 2010 earthquake destroyed the MSPP building, where the Planning and Evaluation Unit was located. Information on the recent progress of the development of the system is limited.

92. There are climate-related and natural disasters information technologies relevant to health and health systems being developed in Haiti. Disaster risk management (DRM) includes evaluating, adapting, and improving early warning systems and disseminating the information.¹⁸⁴ Initiatives — such as Haiti Data that produces data regarding climate-related events like floods, cyclones, earthquakes, water scarcity, and landslides — are pivotal for developing climate-related health risk estimation models. They show excellent potential for improving resilience in the healthcare system.¹⁸⁵

Following the 2010 earthquake, key programs and services were appraised as part of the post-earthquake response and recovery planning, which has taken a central role in informing current and future strengthening and prioritization within the health sector.¹⁸⁶ The disease surveillance system has been expanded and strengthened, facilitated by both disease surveillance, as well as outbreak management and clinical services.¹⁸⁷ Nonetheless, there is still a lack of climate-informed programs, such as early-warning monitoring systems. Furthermore, there is also a need to establish and strengthen current initiatives monitoring and addressing nutritional risks that are being exacerbated by climate change, as food security has been a historical healthcare challenge in Haiti.

ESSENTIAL MEDICAL PRODUCTS AND TECHNOLOGIES

93. In 2016, the Haiti government endorsed the essential service package (PES): it included a requirement for a range of basic health services; a list of drugs and equipment; and a minimum number of staff required for each level of care.¹⁸⁸ The Global Fund provides health facilities with the resources to manage cases of malaria, HIV/AIDS, and tuberculosis free of charge, and other supplies are purchased from MSPP's storage and registered distributors, where possible.

While the PES specifies the standards of implementation, it does not address how they are delivered. In actuality, implementation has stagnated due to the lack of basic infrastructure, resources, and skills. The healthcare system — from preventive to critical care — is inadequately equipped. Stockouts are

common in health facilities in Haiti. Another example is the powering of the solar-powered refrigerator for cold chain requirements, which are available at most rural health centers and dispensaries; however, they rarely have a functioning power system to ensure a constant electricity supply. These gaps and vulnerabilities in equipment and supplies have exacerbated the impact of climate-related health risks. There is no recent information available on the implementation of the PES.

HEALTH SERVICE DELIVERY

94. Healthcare delivery in Haiti remains fragile, characterized by the limited coverage of primary care services and suboptimal healthcare performance, resulting in considerable health vulnerability for the Haitian population.¹⁸⁹ Approximately 40 percent of Haiti's population lacks access to essential health and nutrition services.¹⁹⁰ Geographic access to the health service is limited for the rural population, in particular. This limitation is attributed principally to the insufficient number of facilities, the difficulties in reaching the facilities, and local customs.¹⁹¹ Poor facilities and service delivery in Haiti also diminish service utilization. As a result, primary care of good quality is accessible to only 23 percent of the population: 46 percent in urban areas and 5 percent in rural areas.¹⁹²

95. Extreme weather events, such as hurricanes and tropical storms, have strained the healthcare system. The increased intensity of these events has limited access to medication, medical advice, supply and cold chains, and clinic visits with appropriate healthcare personnel, thereby hampering the management of diseases and conditions.¹⁹³

96. Health infrastructure, including healthcare facilities, especially in remote areas, is also vulnerable to extreme weather events, becoming inoperable during events when they are most needed. The government's preventive and curative services in Haiti are delivered through dispensaries, health centers without beds, health centers with beds, and hospitals equipped with intensive care units (ICUs) (Table 11). Private healthcare facilities constitute almost half of the services (46.76 percent), followed by public facilities (37.21 percent) and facilities that are a mix between public and private services (16.03 percent).¹⁹⁴

97. A lack of transportation and adequate roads in rural areas makes access to health facilities a challenge for around half of the total population. Not all communes¹⁹⁵ have all levels of health facilities, with research suggesting that distance accounts for why 37 percent of the population does not seek healthcare attention.¹⁹⁶ Moreover, remote villages are accessible only by foot, and roads connecting villages with towns are often unpaved and inaccessible when riverine flooding occurs. There is a lack of reliable and affordable public transportation, and national ambulance services are only available in certain zones.¹⁹⁷

98. A lack of healthcare system capacity exacerbates risks from climate change. Recent research shows the lack of resilience in critical care healthcare infrastructure in Haiti (see Table 2), with most of its infrastructure concentrated in urban areas. The country lacks sufficient facilities with adequate numbers of ICU beds. Only 17.4 percent of the critical care facilities are equipped with ICU beds. Consequently, 80 percent of critically ill patients in hospitals without ICU are taken care of in the emergency department, which is also inadequately equipped.¹⁹⁸

TABLE 11.

Number of healthcare facilities, by type, across provinces

DEPARTMENT	CATEGORY				STATUS		
	DISPENSARIES (%)	HEALTH CENTERS WITHOUT BEDS (%)	HEALTH CENTERS WITH BEDS (%)	HOSPITALS (%)	PUBLIC (%)	PRIVATE (%)	MIX (%)
Artibonite	21.43	5.51	10.88	8.20	17.44	12.24	5.95
Centre	7.83	4.06	8.16	3.28	6.67	4.90	8.33
Grand'Anse	8.29	2.61	3.40	2.46	6.92	1.63	10.71
Nippes	4.61	0.58	4.76	2.46	2.56	0.82	10.71
Nord	8.76	12.75	7.48	10.66	7.44	12.45	9.52
Nord-Est	5.53	2.32	5.44	1.64	7.44	1.22	4.17
Nord-Ouest	15.90	2.32	8.16	3.28	14.62	4.69	7.74
Ouest	12.44	59.71	36.05	57.38	20.00	52.45	28.57
Sud	8.76	4.35	9.52	8.20	8.46	4.69	12.50
Sud-Est	6.45	5.80	6.12	2.46	8.46	4.90	1.79
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	DISPENSARIES (NO.)	HEALTH CENTERS WITHOUT BEDS (NO.)	HEALTH CENTERS WITH BEDS (NO.)	HOSPITALS (NO.)			
Total	434	345	147	122			

Source: Liste des Institutions Sanitaires Du Pays (MSPP 2015).

99. Longer-term strategies on DRM, such as projecting climate change trends, have been identified as part of a comprehensive approach for some climate-related health risks, with the aim of reducing the future burden. The disaster risk management report 2019–2030¹⁹⁹ includes climate change as a critical variable for the country's strategic planning on disaster risk reduction and management. It highlights the need to build cooperation between different governmental institutions, private initiatives, and community organizations. It also highlights the need for decentralizing health and social services to increase access to health and essential services across the national territory.²⁰⁰

100. Essential infrastructure, including health-related infrastructure, must be planned after assessing the information relevant to an area's geographical distribution, vulnerability, and hazard occurrence in order to reduce the risk of damage from climate-related events.²⁰¹

Healthcare infrastructure design needs to incorporate climate-smart features in order to reduce building damages or losses during extreme climate-related events. Protection from flooding events or hurricanes requires that existing infrastructure be guided by overall strategies for the management of water, strong winds, and floods, as well as future climate projections. Moreover, earthquake preparedness can also enhance climate adaptation, as there is an important crossover for strengthening health service delivery and the overall health system capacity.

The extent to which infrastructure assessments for the health sector are being conducted, building designs are incorporating projected climate change impacts, and retrofitting measures are being carried out are still unclear. There has been no comprehensive review of the healthcare infrastructure to identify climate change-related vulnerabilities and opportunities to improve its climate resilience.

FINANCING

101. The budget of the government of Haiti for health is limited. Despite its recent contribution for the purchase of routine vaccines, the country relies heavily on international funding and out-of-pocket (OOP) expenditures for Haitians to have access to health services.²⁰² The healthcare sector has been severely compromised due to both climate and natural disasters such as earthquakes and hurricanes, and a lack of public expenditure in the health system. Public health spending decreased from 16.6 percent in 2004 to 4.4 percent as of 2017.²⁰³ The 2018–2019 budget allocation for the health sector showed a further decline from 4.8 percent to 3.9 percent.²⁰⁴

102. Although 57 percent of the health budget went to curative care and 33 percent went to preventive care²⁰⁵ during the 2013–2014 period, there were no clear considerations of climate-related preventive investments. During the same period, the health budget of USD59.5 billion comprised (a) donor funds (56.7 percent), (b) OOP expenditure (30.1 percent), (c) the government's domestic budget (9.7 percent), and (d) the private sector (3.5 percent). By 2018, Haiti expended 7.695 percent of its total gross domestic product (GDP) on health²⁰⁶ (USD64.246 expenditure per capita) and registered an

increase in OOP expenditure to USD43.583 (as a percentage of total health expenditure).²⁰⁷ It is estimated that approximately 90 percent of the health operating budget goes to the payment of workforce salaries.²⁰⁸ The health expenditure budget is made on a year-to-year basis, making it difficult to plan and address structural needs in the healthcare sector.²⁰⁹

103. Risk pooling in Haiti does not account for climate and health-related risks. The Office d'Assurance Accident du Travail, Maladie et Maternité (OFATMA) is a public institution offering health insurance and social protection to employees in the public and private sectors.²¹⁰ OFATMA is mandatory for formal private and public sector employees, and voluntary for those working in the informal sector.²¹¹ The Office National d'Assurance Vieillesse (ONA) offers insurance to the elderly and disabled.²¹² Private and public companies provide health coverage through OFATMA for their employees and dependents; however, these benefits constitute small, fragmented risk pools within each company.²¹³

In general terms, illnesses and health care costs are not evenly distributed, with some population groups facing higher health risks, which may be exacerbated by climate change. Climate change can exacerbate underlying health burdens, while increasing the potential and size of certain catastrophic financial health risks, especially among the most vulnerable.

104. Haiti's reliance and dependence on donors / aid for health expenditure makes it vulnerable, in terms of its ability to ensure the financing sustainability of climate-health programs. For example, donor funding went from USD44 per capita in 2011 to USD15 in

2016. International financing and aid tend to be detached from a national plan. There is no systemic approach in consolidating information on contributions and programs from foreign aid and NGOs.

105. From 2011 to 2014, the country received a total of USD282 million for climate-disaster relief, being the number-one country of 35 small island developing states (SIDS).

Currently, there is a total of USD1.3 billion of international funds channeled to climate change or climate-related projects.²¹⁴ Of the USD1.1 billion for long-term projects, USD773 million are focused on sustainable energy. Among most of the projects currently funded, 50 percent comprise adaptation projects, 21 percent mitigation, and 29 percent both mitigation and adaptation.²¹⁵ These funds are being distributed among four main areas: (a) food security; (b) disaster risk reduction; (c) renewables and energy; and (d) integrated water system management.²¹⁶

106. There is no evident allocation of funding by the government of Haiti that is dedicated to addressing the impact of climate change on health and health systems. Although there is a commitment in the government's National Adaptation Plan to Climate Change and their National Plan on Disaster Risk Management, there is no precise strategic planning for climate-health finance and resource allocations for climate-related health risks and vulnerabilities. The lack of a long-term vision increases the risk of the sustainability of climate-related health projects.

Building resilient health systems for climate change requires budget allocation as an integrated component in the overall planning of a national health plan. Although Haiti has prioritized climate change projects — mostly on water conservation and DRM, these efforts have not focused on the health sector. Ultimately, guidelines for integrating a climate-resilient approach for health care and public health systems are not available to inform rationalized resource allocations.

107. A total of 76 climate change-related projects²¹⁷ have been developed in Haiti; however, none of them prioritize the health sector.

Although some climate change projects indirectly impact human health issues due to climate change, such as food security efforts, or water and waste management, international funding is not being used to conduct health-based adaptation measures.

108. The health co-benefits of climate change mitigation have not been adequately promoted as cost-effective options.

Arguments for implementing climate change mitigation policies often focus on perceived short-term financial costs. However, cost assessments rarely account for the health co-benefits of these policies — strengthening the resilience and outcomes for human health. Therefore, additional studies are needed to quantify the longer-term cost savings from adopting the health co-benefits of climate change adaptation policies in Haiti.

TABLE 12.

Summary of the health system adaptive capacity gaps for Haiti

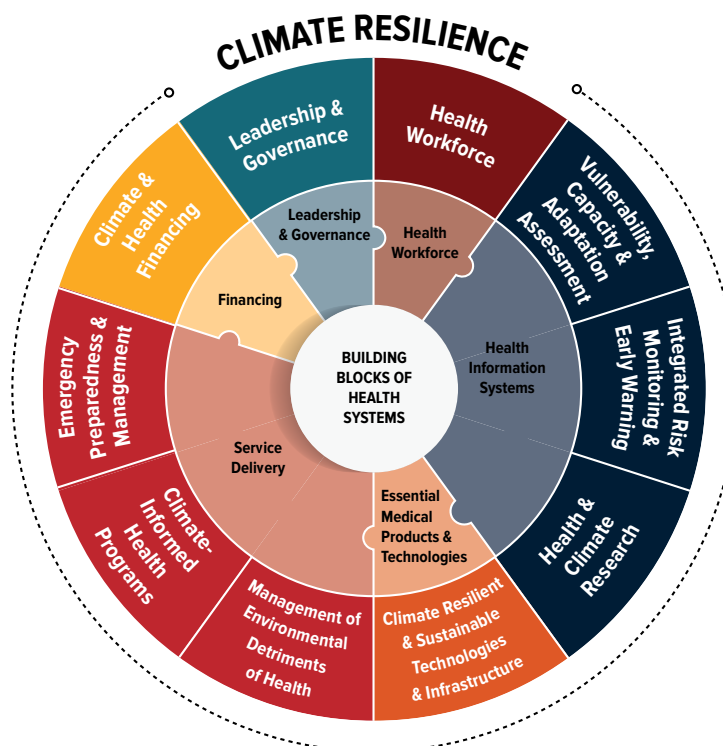
BUILDING BLOCK	SUMMARY OF GAPS IN ADAPTIVE CAPACITY
Leadership and Governance	- Haiti is committed to meeting the climate challenge through both adaptation and mitigation measures; however, the coordination mechanism to facilitate cross-sector action on climate change and health is limited. - Consideration for climate-health related risks is limited in national health policy documents.
Health Workforce	- The number of skilled health professionals is well below WHO's minimum threshold for achieving UHC, with notable urban-rural discrepancies. - There are existing HRH capacity issues pertaining to the lack of proper skill-mix; the inadequate quality of education, standards, and accreditation; the health system's poor absorption capacity; the outmigration of medical doctors; and career structure challenges. - There is a lack of a systematic approach for capacity development on climate-related health risks, while emergency preparedness and responses constitute a key challenge for Haiti's health workforce.
Health Information and Disease Surveillance Systems	- There are incomplete data, inaccurate data, a lack of timely data collection, and parallel health information systems. - There is a lack of climate-informed programs, such as early warning and monitoring systems. - There is no recent comprehensive review of HIS in Haiti.
Essential Medical Products and Technologies	- There are important gaps between policies and practice for essential medical products and technologies, including infrastructure and resources. Though there are standards for essential medical products, how they should be delivered is not addressed. - The country lacks sufficient facilities with enough ICU beds.
Health Service Delivery	- Health service delivery is challenging in Haiti, stemming from fragmentation, limited national institutional capacities and technical expertise, and the development of parallel vertical programs at the federal and provincial levels. - Coordination across sectors to ensure that climate risks are being incorporated into infrastructure planning is inadequate. - There is a lack of access to healthcare facilities in rural areas.
Health Financing	- There are no budget estimations for long-term strategic planning. - Haiti's reliance and dependence on donors / aid for health expenditure make it vulnerable, in terms of sustainable financing for its climate-health programs. - There is no evident allocation of funding dedicated to addressing the climate change's impact on health and health systems within the health sector.

RECOMMENDATIONS TO ENHANCE HEALTH SYSTEM RESILIENCE TO CLIMATE CHANGE

109. This section describes recommendations for enhancing Haiti's health system resilience to climate change, including health interventions and strategies for adaptation. Organized according to WHO's operational framework for resilient health systems (Figure 16) and drawing from consultations and review of all relevant governmental policies, as well as the World Bank's Health, Nutrition and Population (HNP) Climate and Health Guidance Note, the recommended options are based on an assessment of both the magnitude of the current and projected climate-related health risks, along with the existing gaps in the country's adaptive capacity to manage and / or prevent these risks.

FIGURE 16.

WHO's Operational framework for building climate-resilient health systems



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

110. The CHVA recommendations are aligned with the guiding principles for the World Bank’s Strategy for Fragility, Conflict and Violence 2020–2025.²¹⁸ These principles focus on (a) addressing the drivers of fragility and short- and long-term risks, including climate-related shocks; (b) protecting essential institutions, such as MSPP, and ensuring resilient governance; (c) strengthening the capacity of core institutions and their legitimacy; and (d) mitigating the consequences of an FCV context, which can be exacerbated by climate and health challenges, by supporting the most vulnerable communities.

Furthermore, recommendations to strengthen the health system’s resiliency could also incorporate social protection systems in order to enhance human capital and reduce inequalities, contributing to reducing risks in the context of fragility and conflict in Haiti. The provision of adaptation and mitigation interventions for strengthening the health system — in response to a changing climate — needs to bolster the government’s capacity and political legitimacy in ensuring resilient systems in Haiti.

LEADERSHIP AND GOVERNANCE

- 111. Develop a climate and health action plan based on the newly released HNAP 2022–2030.** This action plan would focus on the 85 adaptation actions in the health priority area (Encadre #2) identified in the HNAP.
- 112. Establish a mechanism to monitor the health sector’s adaptation measures and related indicators.** This mechanism would need to include the adaptation actions included in the Haiti Nationally Determined Contributions

(NDC) 2.0 (2022), as well as those in the HNAP. This monitoring mechanism should be able to track the progress of the activities of the Haiti government, as well as those of its development partners.

HEALTH FINANCING

- 113. Establish a budget line item with MSPP that is aimed at implementing adaptation measures for the health sector and providing funds for preparedness for extreme weather events.**
- 114. Develop a monitoring system to track funds from the MSPP and its development partners that are being directed to climate and health projects and programs.** This system could be intertwined with the progress tracking system of the NAP.

SERVICE DELIVERY

- 115. Develop standard operating procedures (SOPs) that account for climate-related health risks and ensure the continuity of the provision of health services during extreme weather events.** These SOPs could be developed at the facility level, focusing on primary healthcare services, and at the system level, ensuring the procurement of pharmaceutical and medical equipment in line with climate-related health risks.
- 116. Enhance disaster contingency planning, specifically including the deployment of medical products to aid the response to climate shocks.** This would include integrating climate-related health considerations into district- and community-level disaster management plans and will need to involve the coordination between MSPP and other stakeholders (such as NGOs and community

organizations) for organizing activities related to preparedness and emergency responses.

- 117. Review national building codes to incorporate the requirements of healthcare facilities by taking into consideration exposure to acute climate shocks and the need to maintain service delivery.** Importantly, this review could include the incorporation of climate risk projections into these codes / permits.

HEALTH WORKFORCE

- 118. Work with existing initiatives to incorporate climate considerations into national health worker accreditation programs.** This approach could build on the continuing efforts of the former “Reconnaissance” accreditation system that has now transitioned to the ownership of Haitian institutions and expanded from its origins with nursing staff to incorporate schools of medicine and pharmacy.
- 119. Design and implement measures that provide incentives and increase the retention of the healthcare workforce in rural areas.** Key NGOs, such as PIH, could be a key part of these measures. Issues that could be prioritized are expected to include the payment system, which impact rural workers in particular.

HEALTH INFORMATION SYSTEMS

- 120. Expand the utility of Haiti Data to complement the hydromet information currently available with climate-related health information.** Data sets could be complemented with targeted modeling and the important analysis of outputs, through the publication of frequent reports and recommendations, to assist policymakers and planners in the decision-making process.
- 121. Develop early warning systems for extreme weather events that integrate and disseminate information on climate-related health risks.** These early warning systems could be linked with a centralized emergency operations center system in order to facilitate the decision-making process. It could utilize mobile telephone platforms to send timely information to health and emergency professionals, and the general public.



ANNEXES

ANNEX A. METHODS FOR ESTIMATING MOSQUITO SUITABILITY IN HAITI, UNDER RCP8.5

To demonstrate the plausible spatial distributions of the vectors of dengue and malaria, spatial models were constructed to assess the risk propensity of these diseases. Climate data are taken from the historical reference period (1986–2005), the 2030s, and the 2050s. The epidemiology of VBDs is directly influenced by environmental factors that facilitate vector development and survival. It is important to recognize that spatial modeling results are limited by the input data's spatial resolutions and the parameterization of predictor variables, as demonstrated from the literature review including laboratory studies.

Here, results are largely a function of minimum and maximum temperatures (that is, the thermal tolerance levels of vector species), as well as LULC (that is, the characteristics of the species' preferred habitats), whose input data's spatial resolutions are 25 km and 100 m, respectively. These resolutions provide large, rather than fine-scale, estimations of suitable breeding areas.

In addition, this methodology does not incorporate sociodemographic factors, which can play an appreciable role in facilitating or curtailing vector breeding risk. To determine the population at risk of these VBDs, suitable areas were spatially overlaid with population data from the Global Human Settlement Layers (2015) to calculate the population residing in suitable areas, by region. Population data are held constant in all models, in the absence of spatial population projection information. As such, these results should be taken as a conservative estimate of the areas of Haiti

presenting suitable conditions for vector breeding and suitable conditions for vector breeding where humans are present (that is, populated areas).

ANNEX B. ASSUMPTIONS ON THE COURSE OF FUTURE GLOBAL CLIMATE CHANGE

Predicting the future climate of any country requires several assumptions to be made about the direction of the future global climate. The World Bank's CHVAs follow the RCPs developed by IPCC. They describe four scenarios along which the climate of the planet might change over the coming decades. The four RCPs are named according to the assumed level of global radiative forcing and the difference between the energy absorbed by planet Earth versus the energy reflected back into space by 2100.

The radiative forcing is measured in watts per square meter, resulting in the four IPCC RCPs as follows: RCP2.6, RCP4, RCP6, and RCP8.5. Each RCP shows the planet trapping progressively higher amounts of energy from RCP2.6 (the lowest) to RCP8.5 (the highest). A wide range of factors will determine which RCP will most closely predict the course of the planet's future climate for the rest of this century.

- Mid-range emissions (RCP4.5): This scenario is a stabilization scenario that assumes action is taken by all countries to curb climate change, resulting in a global average temperature rise of no more than 2°C and 3°C above pre-industrial temperature levels by 2100.
- High-end emissions scenario (RCP8.5): This scenario represents the extreme end

of plausible climate change, delivering an estimated global average temperature increase of about 5–6°C by 2100 (NOAA 2021), relative to pre-industrial temperature levels. RCP8.5 is currently recognized as “business as usual.” Given today’s current environment, RCP8.5 is the most realistic scenario for the future.

For the purposes of the World Bank’s vulnerability assessments and the specific near-to-mid-term time periods — 2030s to 2050s, RCP8.5 is the most likely scenario, and it is the one being used throughout the assessment. RCP4.5 can be useful as a risk comparison to demonstrate a plausible “avoided impact” through strong mitigation efforts.

In addition to selecting the most likely scenario for the future global climate, it is also useful to define a baseline period to represent the current climate within which observed health impacts have occurred. It is also helpful to define future time periods that can be compared against this baseline, and for which assumptions or models can be used to predict changes in future climate-related disease burdens. The World Bank’s CHVAs use two 20-year time periods: together, they cover the next four decades to show imminent climatic changes and medium-term climatic changes in a given country.

The baseline period covers 30 years, since this has conventionally been the length of time over which climatic conditions are measured to reduce the noise from annual or other cyclical variations. Looking to the future, 20-year time periods are used as a consequence of the accelerating pace of change of global climate, which also allow for the analysis of climate-related threats over a sufficiently proximate timescale.

- 2030s: This is the 20-year period from 2020 to 2039, with 2030 as the chronological mid-point. It can be seen to represent the immediate coming years to which countries and their governments need to respond with utmost urgency.
- 2050s: This is the 20-year period from 2040 to 2059, with 2050 as the chronological mid-point. It can be seen to represent a medium-term period, still well within the lifetime of current populations over which countries and governments have sufficient time to make profound changes in preparation for expected threats.

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MARCH 2024



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