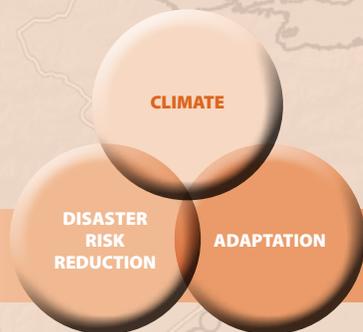


Vulnerability, Risk Reduction, and Adaptation to Climate Change

HAITI



COUNTRY OVERVIEW

Haiti is a small impoverished country occupying the western half of the Island of Hispaniola, which it shares with the Dominican Republic. Haiti's terrain is dominated by rugged mountains interspersed with river valleys and coastal flat lands. With its coastline spanning 1,771 km and a population of over 8 million, much of this densely populated island resides near the coast. Despite being the first nation in Latin America to gain independence, Haiti has a long history of political violence and economic imbalance. Haiti ranks 149th out of 182 countries in UNDP's 2009 Human Development Index and ranks at the top of the Corruption Perception Index.¹ Population pressures have led to extreme environmental degradation, with an estimated 98 percent of forests cleared for fuel. These destabilizing forces have left most Haitian extremely vulnerable to natural disasters. Hurricanes and tropical storms routinely hit Haiti, causing massive flooding and deadly landslides. In January 2010, Haiti was decimated by an unprecedented earthquake of magnitude 7.0.

Key Sectors

Agriculture and Food Security
Coastal Zone Management
Forestry and Biodiversity
Water Conservation
Infrastructure

Source: Haiti Plan d'Action National d'Adaptation (PANA). 2006.

While Haiti has received a staggering amount of foreign aid and funding to develop its economy, to improve basic services, and to rehabilitate its environment, poverty has not subsided. Compounding development challenges are the repeated and devastating impacts of natural disasters (hurricanes, flooding, droughts, and earthquakes). In order to reduce Haiti's vulnerability to such hazards, adaptation measures need to be integrated into development planning under the different areas related to water management, agriculture, fisheries, land use, and forestry.

CLIMATE BASELINE AND CLIMATE FUTURE

Located in the Caribbean's Great Antilles, the 27,750 sq km island of Haiti has a hot and humid tropical climate. Daily temperatures typically range between 19°C and 28°C in the winter and 23°C to 33°C during the summer months. Rainfall varies according to the island's varied topography, with the center regions receiving more rainfall than the North and West. 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 mm, while 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, where, combined with temperature, evaporation rates are high.² The island experiences year-round tropical humid conditions and is subject to the variability driven by the El Niño conditions. The wet season is long, particularly in the northern and southern regions of the island, with two pronounced peaks occurring between March and November.

CLIMATE BASELINE

Major Climate Processes³

El Niño
La Niña
Sea Level Rise
Cyclones in the Atlantic

Impacts on Climate

- Drier and hotter conditions⁴
- Colder and wetter conditions

- Brings heavy rainfall during the wet season

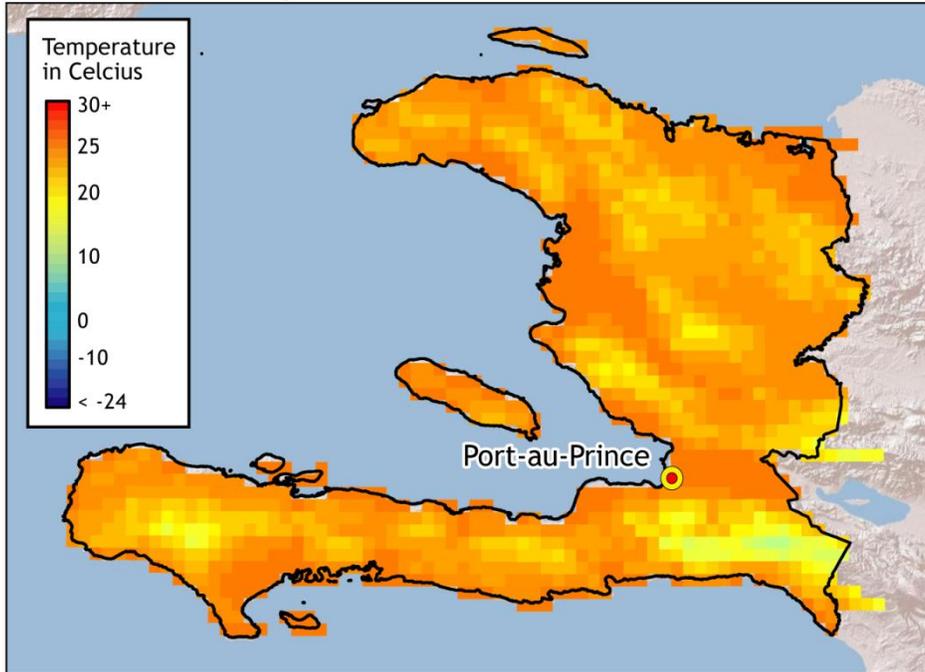
¹ Transparency International.

² Water Resources Assessment of Haiti.

³ IPCC 4th Assessment Report and UNDP Climate Profiles, Weather and Climate Extremes in a Changing Climate, 2008. US Climate Change Science Program, Synthesis Assessment Product 3.3.

⁴ El Niño is also known to suppress cyclonic activity in the Atlantic.

Mean Annual Temperature



Total Annual Precipitation

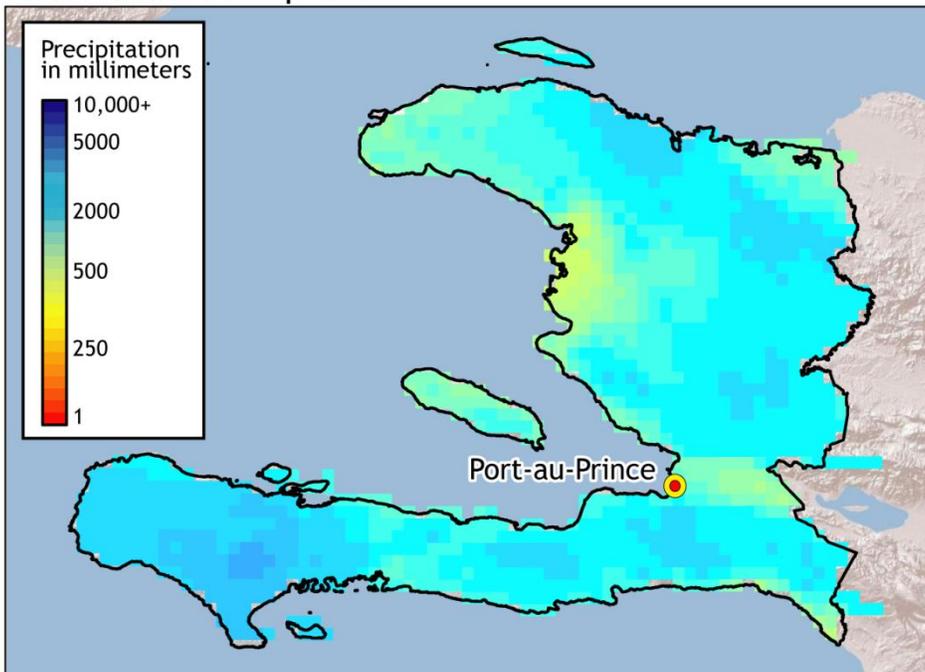


Figure 1: Climate baseline for Haiti

Climate baseline summary for Haiti (since 1960):^{5,6}

- ➔ Mean temperatures have increased by 0.45°C, with warming most rapid in the warmest seasons (June-November).
- ➔ The frequency of hot days⁷ and hot nights⁸ increased by 63 and 48 days per year, respectively, between 1960 and 2003.
- ➔ The frequency of cold days and cold nights⁹ has decreased steadily since 1960.
- ➔ Mean annual rainfall has decreased by 5 mm per month per decade since 1960.
- ➔ The intensity of Atlantic hurricanes has increased substantially since 1980.¹⁰

CLIMATE FUTURE

Climate change summary for Haiti¹¹:

- ➔ Temperatures are expected to increase by 0.5 to 2.3 °C by 2060¹², with warming most rapid in December-February.
- ➔ The number of hot days and nights are projected to increase throughout the country.
- ➔ The number of cold nights is projected to steadily decrease or become rare.
- ➔ Rainfall projections project decreases in rainfall during June-August, while rainfall projections during the remainder of the year are less certain.
- ➔ According to the Intergovernmental Panel on Climate Change's Fourth Assessment Report, the Caribbean is vulnerable to sea-level rise, which is projected to be between 0.13 and 0.56 m by 2090.¹³
- ➔ The future intensity and frequency of hurricanes in the Atlantic are still a subject of research, but according to the US Climate Change Science Program, increases in hurricane rainfall and wind speeds are likely, with simulations showing that for each 1°C increase in sea surface temperatures, core rainfall may increase by 6-17% and surface wind speeds of the strongest hurricanes will increase between 1-8%⁹, with associated increases in storm surge levels.

CLIMATE CHANGE IMPACTS ON NATURAL HAZARD VULNERABILITY

AT A GLANCE

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

⁵ IPCC 4th Assessment Report and UNDP Climate Profile for the Dominican Republic.

⁶ World Bank Climate Change Knowledge Portal, UNDP Climate profile for the Dominican Republic.

⁷ Hot days are defined as the temperature exceeded on 10% of days in the current climate of that region and season.

⁸ Hot nights are defined as the temperature exceeded on 10% of nights in the current climate of that region and season.

⁹ Cold nights are defined as the temperature below which 10% of nights are recorded in the current climate of that region or season.

¹⁰ Weather and Climate Extremes in a Changing Climate, 2008. US Climate Change Science Program, Synthesis Assessment Product 3.3.

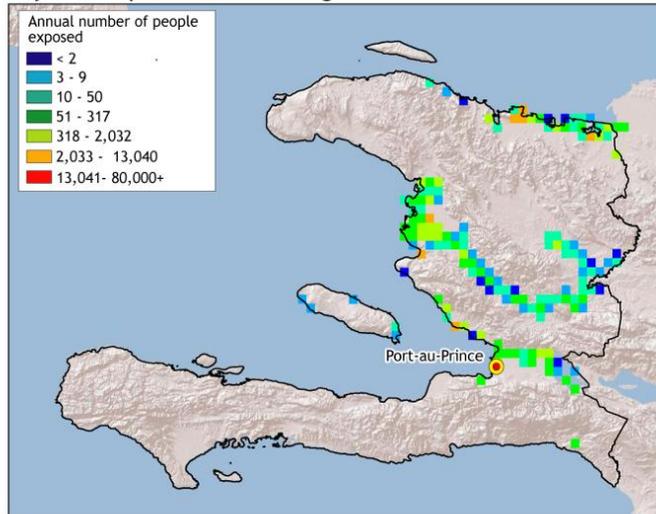
¹¹ Ibid, note 6.

¹² Haiti's First National Communication.

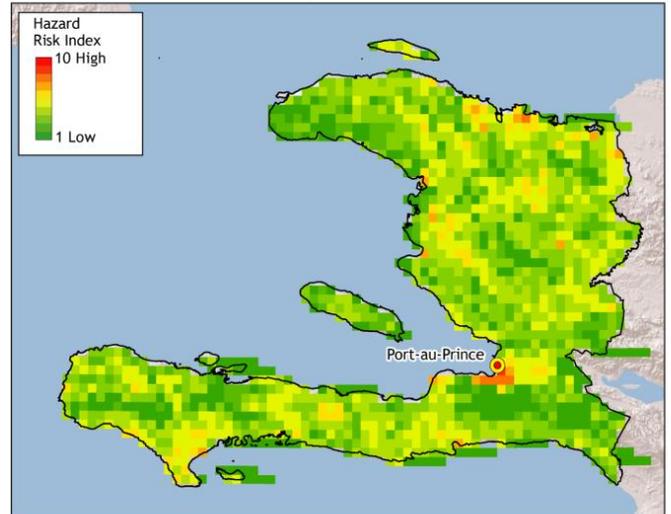
¹³ Christensen et al. (2007) IPCC Working Group I Report: 'The Physical Science Basis', Chapter 11 (Regional Climate projections): Sections 11.6 (South and Central America), and 11.9 (Small Islands).

hydrometeorological disasters, especially between June and December. Landslides are common along all river valleys, where years of deforestation have left the upper reaches of the western basins bare.

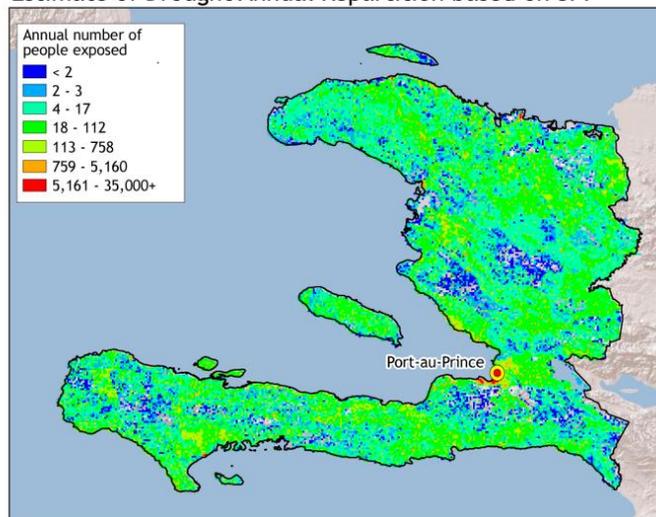
Physical Exposure to Flooding



Estimate Risk Index for Tropical Cyclone Hazard



Estimate of Drought Annual Repartition based on SPI



Risk of Landslide Hazard

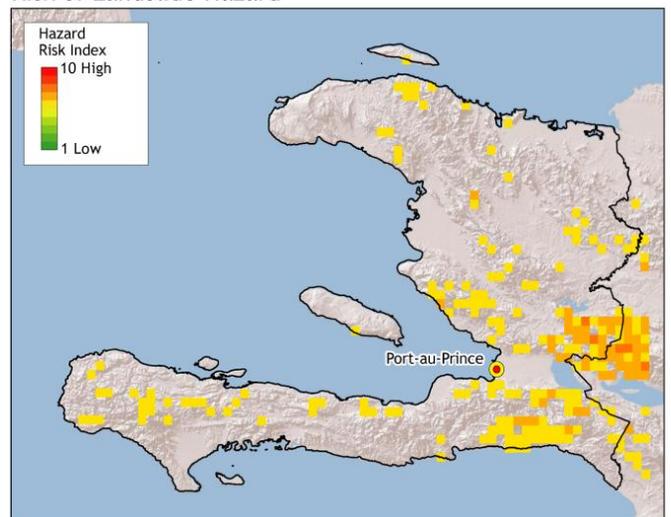


Figure 1: Exposure to climate-related hazards across Haiti¹⁴

➔ **Hurricanes**—Over the past 30 years, Haiti has been hit by six hurricanes, and while most of this small island nation is affected, the West and South Departments lie in the path of the strongest hurricanes¹⁵. Impacts from cyclones range across the whole spectrum, including loss of life, livestock, destruction of agricultural lands, erosion, river siltation, increased incidence of water-borne diseases, and famine.

¹⁴ UNEP Global Risk Identification Programme (GRIP), www.gripweb.org.

¹⁵ Hurricane Mitch, which hit the country in 1998, had a damaging impact on between 15 and 20% of crops, 80% of banana plantations and 100,000 small livestock, according to FAO. The storms affecting Haiti in recent years have led to agricultural losses totaling US\$ 61 million countrywide, resulting in reduced food production. According to the Ministry of Agriculture, Natural Resources, and Rural Development, the storm resulted in the loss of approximately 3% of total livestock in the country, representing around 100,000 livestock.

➔ **Floods and Storms**—Floods are the leading factor of vulnerability in Haiti. The country's most populated cities are all nestled in the valleys along the coast. When it rains, the steep, often barren hills that surround them flush rainwater toward the urban areas. Widespread deforestation in the upper reaches of these valleys, coupled with lacking drainage infrastructure, creates an environment conducive to flooding. The capital city of Port-au-Prince is particularly vulnerable, with a large portion of its inhabitants residing on flood plains in poorly constructed housing. Waste management is under-developed, leading to increased risk from water-borne diseases.¹⁶

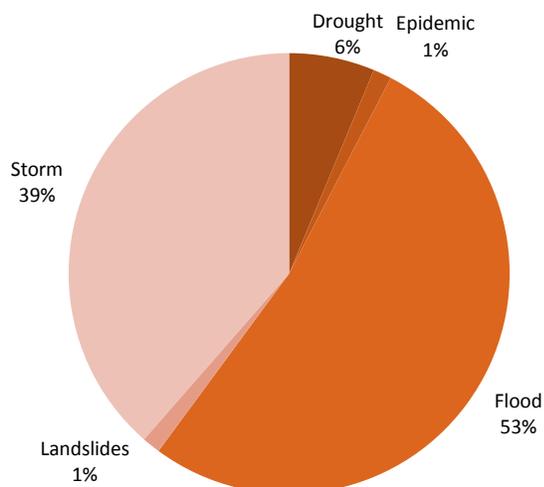


Figure 3: Reported natural disaster distribution in Haiti

Source: EM-DAT- Source of data: "EM-DAT: The OFDA/ CRED International Disaster Database, Université Catholique de Louvain, Brussels, Bel." Data version: v11.08 .

➔ **Landslides**—High deforestation rates, coupled with intense rainfall, make landslides commonplace and particularly dangerous in the steep sloping lands.

➔ **Drought**—The North-West, Artibonite, North-East, and Central departments frequently experience repeated droughts, brought about by a combination of erratic rainfall patterns coupled with a limited water management infrastructure.¹⁷ Droughts have destroyed crops, reduced agricultural production, and decreased food security.

Implications for Disaster Risk Management

- ➔ Missing or poorly managed water infrastructure makes the agricultural regions and hence, the livelihoods that depend on them, particularly vulnerable to a changing climate. More erratic and unpredictable rainfall patterns will place greater strain on planting choices and timing.
- ➔ Projected increases in temperature, coupled with decreases in rainfall during the critical summer months (June-August), are likely to intensify drought conditions in the center of the country. Building resilience in the farming sector to address increased evapotranspiration and water scarcity during these months will be critical to efforts to support food security.
- ➔ Increased hurricane intensity as a product of climate change under future climate conditions is still a matter of debate among the scientific community. Nevertheless, according to the Intergovernmental Panel's Fourth Assessment Report, increased hurricane wind intensities (5-10% by 2050) are likely, with core precipitation increases of 25%.^{18,19} Increased wind and rainfall intensities are likely to lead to higher and more violent storm surges.
- ➔ An effective early warning system to warn and prepare farmers to confront extreme weather events could reduce the impacts of these weather shocks in the farming system.

¹⁶ Water Resources Assessment of Haiti, US Army.

¹⁷ Haiti Plan d'Action National d'Adaptation (PANA) 2006.

¹⁸ Weather and Climate Extremes in a Changing Climate, North America, Hawaii, Caribbean and US Pacific Islands, US Climate Change Science Program, Synthesis and Assessment Product 3.3, June 2008.

¹⁹ Nature, 4 Sept 2008: The increasing intensity of the strongest tropical cyclones.

SECTORAL CLIMATE RISK REDUCTION RECOMMENDATIONS**AGRICULTURE**

Haiti's economy is based primarily on agriculture, which employs 66 % of the work force and contributes 27% of the GDP. Coffee, rope fiber (jute), sugar, and cocoa are the principal export crops grown.²⁰ Food security relies heavily on rainfed, subsistence farming. Poor farming practices have degraded a majority of the arable countryside, leading to severe erosion. Since 1980, agricultural yields have remained stagnant, despite significant increases in land and labor resources allocated to agricultural production. International food aid has also significantly increased and is required in every season to meet the population's caloric demands.²¹ While disasters like hurricanes are hardly new to Haiti, the frequency, magnitude, and harmful impacts of these storms are expected to increase; when these weather systems hit land, they wreak havoc on Haiti's already fragile farms, deforested mountainsides, and eroding critical soil. An effective early warning system to warn and prepare farmers to confront extreme weather events could reduce the impacts of these weather shocks on the farming system.

As Haiti's climate grows increasingly warmer and drier, particularly during the critical summer months, agricultural practices will need to be adjusted for the land to remain productive. New tools are required by all segments of the population to address the surmounting challenge of increasing agricultural outputs in the face of a changing climate. To prevent potentially devastating yield losses, farmers, extension agents, and politicians will need guidance on how to restore soil quality and ecosystem integrity. Priority adaptations include: planting drought-resistant seeds, growing crops in suitable land to prevent depletion of soil nutrients, raising awareness of land conservation practices, developing a seed bank of drought-resistant and high-temperature tolerant varieties, installing rainwater-harvesting tanks, improving irrigation systems, and establishing a weather surveillance system aimed at providing farmers with an early warning of droughts and fires.²² In fact, as indicated in the figure 3, a reliable irrigation system, coupled with improved input management, is an opportunity to increase yields of crops managed under one or both of these practices. In order to avoid maladaptation, these new activities would need to be coupled with soil conservation and reforestation practices to prevent any further degradation and to restore soil health at the farm level.

WATER

Haiti relies on rain water to meet a majority of its water needs. The country's 11 main drainage basins provide Haiti's water supply and are themselves fed by a variety of interweaving streams carrying fresh water down from the mountains. The intermittent streams of these systems, particularly on the windward mountain slopes, are vulnerable to rainfall-induced flash floods during the rainy season. Roughly 92% of the country's agriculture is rainfed, and the bulk of an existing irrigation infrastructure lies in disrepair and/or was severely damaged by the 2010 earthquake. The potential irrigable area is more than double the current irrigated area, and small irrigation schemes, which take advantage of rainwater-harvesting structures, could offer great potential for yield sustainability, particularly for rural subsistence farmers.

Projected increases in future temperature, coupled with unreliable rainfall patterns (particularly during the summer months), will necessitate the establishment of an efficient water management system in order to secure a reliable water source and prevent future shortages. As previously noted, one solution to reducing the vulnerability of the critical agriculture sector is to expand and renovate the country's aging irrigation system.

²⁰ Water Resource Assessment of Haiti.

²¹ FAO Aquasat Country Profile for Haiti 2000, <http://www.fao.org/nr/water/aquastat/countries/haiti/index.stm>.

²² Haiti's Plan d'Action National d'Adaptation (PANA) 2006.

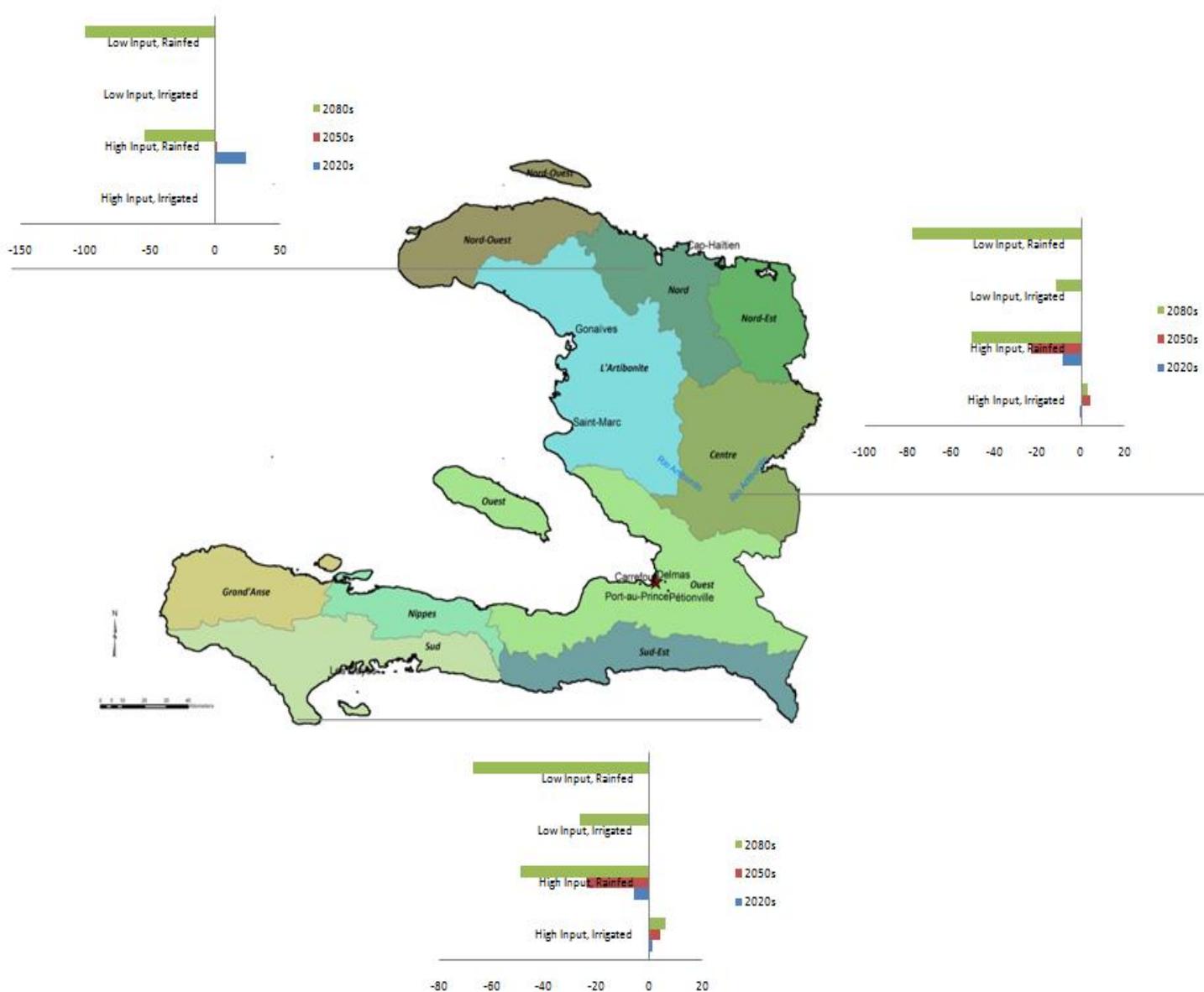


Figure 3: Projected yield (%) changes for the “best” cereal in the region in 2020, 2050, and 2080 as compared to the period 1970-1999²³

Poor quality of housing, transportation networks, communication infrastructure, and access to health services all exacerbate Haiti’s vulnerability to natural disasters and climate change:

- ➔ **Poverty**—Haiti is considered by many economic indicators to be the poorest nation in the world. Roughly 80 percent of its population lives below the international poverty line and lacks access to safe drinking water, health care services, and sanitation.

²³ World Bank Climate Change Portal (sdwebx.worldbank.org/climateportal). Data from IIASA, http://sdwebx.worldbank.org/climateportal/doc/Agr_metadata.pdf.

- ➔ **Health**—Health facilities are largely concentrated in the capital of Port-au-Prince, yet 60% of the population lives in rural areas. Half of the population can be categorized as ‘food insecure’ and less than half have access to clean water. Malnutrition and the spread of water-borne diseases during floods pose a significant threat to the country’s population.

EXISTING ADAPTATION FRAMEWORK/STRATEGY/POLICY AND INSTITUTIONAL SETUP

A sample of the institutions working on climate change adaptation in Haiti is listed in the matrix below:

Name	Area of Work
<i>Governmental</i>	
Ministry of Agriculture, Natural Resources and Rural Development (MARNDR)	Promotes agriculture, rural development, conservation and utilization of natural resources; this includes irrigation and drainage.
Ministry of Interior and Territorial Collectives (MICT)	Implemented the Natural Risk Disaster Plan (PUGRD) that outlines the roles and responsibilities of government officials at all levels.
Directorate of Natural Resources (DIA)	Responsible for soil and forest management.
Ministry of the Environment (MDE)	Environmental protection authority. Manages Haiti’s National Agricultural Investment Plan—a large-scale project (\$772 million) to reconstruct and develop the agricultural sector. It focuses on supporting small-scale farmers, sustainable natural resource management, and improving food security.
<i>International</i>	
Lambi Fund of Haiti	Provides financial resources, training, and technical assistance to rural communities; programs focus on sustainable development, animal husbandry, restoring environmental integrity, and reforestation.
Oxfam	Supports agricultural development programs.
<i>Regional</i>	
Caribbean Community Climate Change Center	Established in August 2005 as the official coordinating body of the Caribbean response to climate change. It is the official repository for regional climate change data, providing climate change-related policy advice to the Caribbean Community (CARICOM) member states.
Caribbean Disaster Emergency Response Agency	Conducts projects and builds states’ capacity in comprehensive disaster management, vulnerability assessments, community disaster preparedness, and hazard mitigation among others.
Association of Caribbean States	Coordinates various projects on disaster preparedness and relief with own and donor funding, e.g., a Database of Financial Mechanisms for Disasters (a list of all organizations that provide reimbursable and non-reimbursable post-disaster funding), a Radio Soap Opera on Natural Disasters in the Caribbean , and assistance to member states in creating National Post-Disaster Funds ⁹ .
<i>NGOs</i>	
Floresta	An NGO working to reverse deforestation and poverty. In Haiti they have established a program where participants have planted 24,318 trees in reforestation projects. Furthermore, 42 miles of anti-erosion barriers and 1036 ravines were constructed to control soil erosion on otherwise vulnerable hillsides, and 674 compost piles were established, providing healthy organic soil to use as fertilizer for farms and family gardens.

Haiti is highly prone to large-scale natural disasters, such as hurricanes, floods, earthquakes, and droughts. Population growth, poverty, environmental degradation, inadequate infrastructure, and a large agricultural sector create and exacerbate the vulnerability of Haiti. Changes in soil quality and rain-storm frequency have already forced farmers to change their methods, but much more is required. Without doubt the reconstruction and sanitation efforts put in place after the devastating 2010 earthquakes are of utmost priority in the current

development framework, but many of these efforts themselves will be more sustainable in the long term if climate change considerations are mainstreamed. The following are examples of strategic institutional gaps in the country, for which a mainstreaming agenda would be key:

- ➔ Address soil erosion and damaging floods and landslides by strongly promoting reforestation initiatives, particularly in the valleys and streams feeding Port-au-Prince, Saint-Marc, and Gonaïves where damages are substantial.
- ➔ Secure livelihoods by mainstreaming disaster risk management activities into all agricultural interventions, offering guidance and tools for local farmers to turn the tide on land degradation and to engage in sustainable practices, such as the planting of appropriate crops for steep sloped land, particularly around Cap-Haïtien, Fort-Liberite, and the basin of the Artibonito.²⁴
- ➔ Promote livelihood diversification, particularly in the lowland plains where monocultures dominate and where significant malnutrition levels exist, including the areas around Les Cayes, Saint-Marc and Gonaïves, and Cap-Haïtien.
- ➔ Improve irrigation infrastructure to principal agricultural areas, including east and west of Port-au-Prince, Saint-March, and Gonaïves.

Priority Adaptation Sectors and Activities

Sector	Proposed Activities
Water Management	Construct community cisterns, build new dams, reduce sedimentation, rehabilitate water points (i.e. wells), increase quantity and quality of ground water reserves, increase technical capacity and establish a network of observational points, improve drainage channels, and repair aging public water system.
Agriculture	Develop and conserve fertile lands, improve irrigation and water storage (tanks), promote resistant crop varieties, integrate appropriate technologies, and promote low-impact crops in areas of low fertility, access to micro credits, community associations, and weather early warning systems.
Fisheries	Establish an assistance fund, forbid unregulated construction in high-risk areas especially near the coast, construct protective barriers, harbor constructions, and modernize tackle.
Biodiversity	Monitoring and long-term ecological research.

Source: Haiti's Plan d'Action National d'Adaptation (PANA) 2006

RESEARCH, DATA, AND INFORMATION GAPS

Haiti's status as a developing country dependent mainly on agriculture and susceptible to a wide variety of natural disasters makes it particularly susceptible to the effects of climate change. Added to this is the fact that like most other developing countries, Haiti lacks the requisite monitoring systems to understand the dynamics of dangerous climate systems, thus making the task of developing short-term response or disaster mitigation strategies extremely difficult. Clearly, addressing the impact of the 2010 earthquake is a high priority activity for the country. However, the opportunity to mainstream climate resilient development under the reconstruction effort is itself an opportunity in adaptation. However, significant challenges in data and research need to be addressed in order to climate proof these activities. A proactive approach to address the impacts of climate variability and change is to reduce the sources of current vulnerability to natural hazards. Monitoring, early warning, and response mechanisms need to be integrated as outlined in the adaptation priorities noted above.

²⁴ Haiti: A gathering storm, Climate Change and Poverty, 2009. Oxfam International.

RESEARCH GAPS

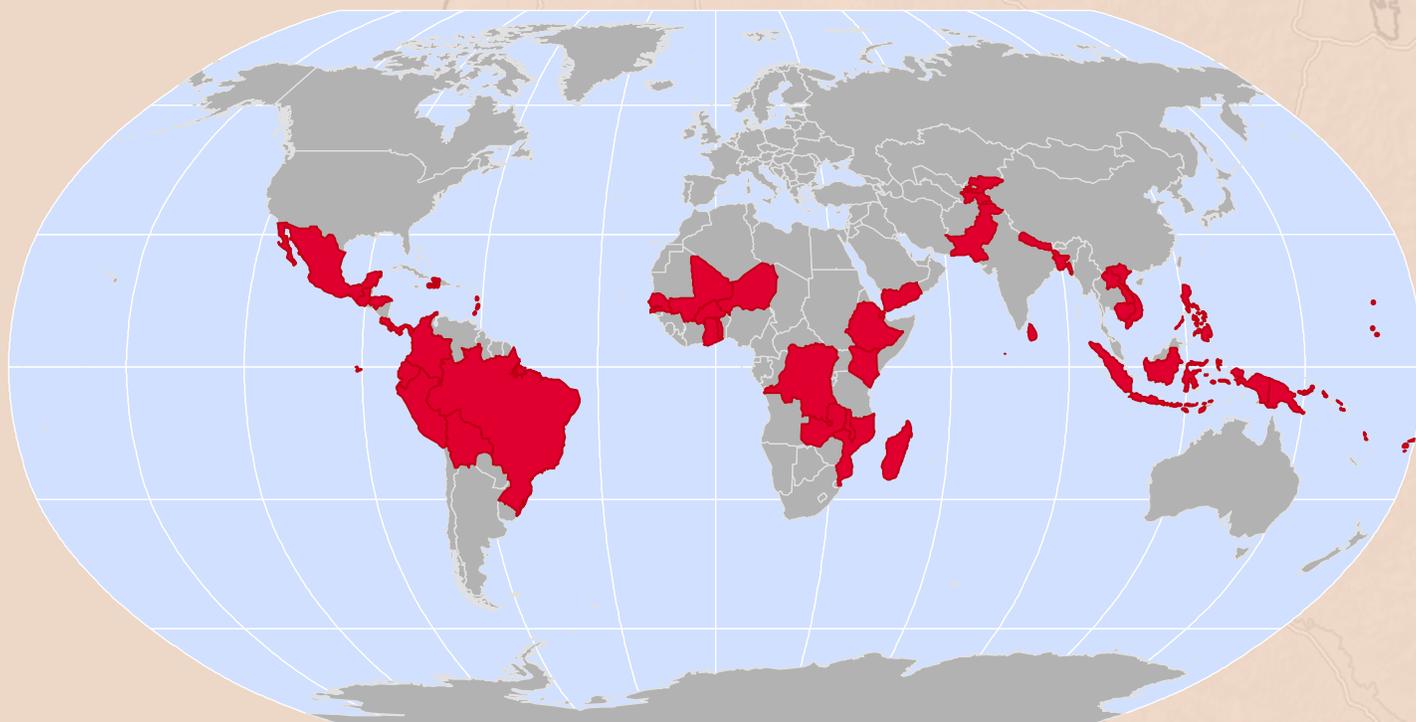
- ➔ Addressing deforestation and the success of reforestation projects will both be dependent on finding alternative sources of fuel for a growing population. Research must be focused on alternative fuel sources, including fast growing crops and the regulation of charcoal production, to restore the forest cover balance in the country.
- ➔ Livelihood diversification is central to the reduction of Haiti's vulnerability. Research and trials are needed to explore sustainable livelihood strategies that can be up-scaled by regions. Priority regions need to be identified, as for example, in the requirement for appropriate crops for steeply sloped land in Cap-Haïtien, Fort-Liberite, and the basin of the Artibonito.
- ➔ As noted above, the potential irrigable area is more than double the current irrigated area, and small irrigation schemes, which take advantage of rainwater-harvesting structures, could offer great potential for yield sustainability, particularly for rural subsistence farmers. Identification of priority areas for these investments should be based on current vulnerability assessments, which are themselves lacking.
- ➔ A needs assessment for irrigation infrastructure, particularly for the agricultural areas in east and west of Port-au-Prince, Saint-March, and Gonaïves, is required.

DATA AND INFORMATION GAPS

- ➔ Downscaled climate information is available in Haiti from the Caribbean Climate Change Centre in the form of the PRECIS model (UK Met Office), but this information has not been applied to the study of future impacts on the agriculture and water sectors. These efforts need to be supported and the information emerging from these studies disseminated in usable form to the development community.
- ➔ A timely early warning system, including the installation of weather stations in key basins is needed. Although several weather stations are actively collecting weather data across Haiti, the country's varied topography means that many critical regions are left uncovered. For example, no meteorological stations exist on the upper reaches of the Artibonito basin, which severely limits the utility of modeled river flows under a changing climate. Additional analyses are needed to identify critical monitoring points to secure a timely response.
- ➔ Awareness-raising and extension activities need to be focused on providing agricultural interventions, offering guidance and tools for local farmers to turn the tide on land degradation and to engage in sustainable practices, such as the planting of appropriate crops for steep sloped land, particularly around Cap-Haïtien, Fort-Liberite, and the basin of the Artibonito.

Climate Risk and Adaptation Country Profile

This Country Profile (<http://countryadaptationprofiles.gfdr.org>) is part of a series of 49 priority country briefs developed by the Global Facility for Disaster Reduction and Recovery (GFDRR) and the Global Support Program of the Climate Investment Funds (CIF). The profile synthesizes most relevant data and information for Disaster Risk Reduction and Adaptation to Climate Change and is designed as a quick reference source for development practitioners to better integrate climate resilience in development planning and operations. Sources on climate and climate-related information are linked through the country profile's online dashboard, which is periodically updated to reflect the most recent publicly available climate analysis.



Acknowledgments: The *Country Profiles* were produced through a partnership between the Global Facility for Disaster Reduction and Recovery, the Global Support Program of the Climate Investment Funds, and the Climate Change Team of the Environment Department of the World Bank, by a joint task team led by Milen Dyoulgerov (TTL), Ana Bucher (co-TTL), Fernanda Zermoglio, and Claudio Forner. Additional support was provided by Sarah Antos, Michael Swain, Carina Bachofen, Fareeha Iqbal, Iretomiwa Olatunji, Francesca Fusaro, Marilia Magalhaes, Habiba Gitay, Laura-Susan Shuford, Catherine Nakalembe, Manisha Ganeshan, Roshani Dangi, Anupam Anand and Li Xu. IT, GIS, and map production support was provided by Varuna Somaweera, Katie McWilliams, and Alex Stoicof from the Sustainable Development Network Information Systems Unit (SDNIS). Jim Cantrell provided design. The team is grateful for all comments and suggestions received from the regional and country specialists on disaster risk management and climate change.

© 2011 THE WORLD BANK GROUP
1818 H Street, NW
Washington, DC 20433
Internet: www.worldbank.org
Contact: Milen Dyoulgerov,
mdyoulgerov@worldbank.org

This volume is a product of the World Bank Group. The World Bank Group does not guarantee the accuracy of the data included in this work. The boundaries, colors, denominations, and other information shown on any map in this work do not imply any judgement on the part of the World Bank Group concerning the legal status of any territory or the endorsement or acceptance of such boundaries.

All rights reserved.



GFDRR
Global Facility for Disaster Reduction and Recovery

CLIMATE
INVESTMENT FUNDS



HAITI