

CLIMATE CHANGE RESILIENCE

The case of Haiti

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Natural and human-induced hazards (storms, floods, and droughts) have highly destructive impacts on buildings, land, water, livestock, and people in Haiti. The poorest Haitians, including low-income women, children, and elderly people, are especially vulnerable. There is already evidence of climate change, including higher mean temperatures and altered rainfall patterns. Without adaptation actions, climate change is likely to magnify the damaging effects of hazards and to increase poverty. Resilience-building measures include flood control, integrated river basin management, reforestation, promotion of wood-energy alternatives, adoption of new crop varieties and farming practices, reduction in cultivation of steep slopes, and creation of non-farm livelihood options. The prospects for climate change resilience are now intricately tied to post-earthquake reconstruction. As Haiti turns its attention to preparing for more disasters and rebuilds significant portions of its infrastructure, there is a real opportunity to integrate climate resilience into these efforts. But Haiti faces serious governance, capacity, and finance challenges. Capacity is weak because of a lack of sensitization to climate change, inadequate technical knowledge, and meagre finances. It is essential to disseminate information about climate change and variability and their impacts in order to press leaders to incorporate climate change resilience into development plans and policies.

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EXECUTIVE SUMMARY

Haiti's climate has changed over the past four decades. Annual mean temperatures have risen, and the rainy season now begins up to three months later than usual. Projections of future climate change indicate that annual mean temperatures will continue to rise over the course of the 21st century. Rainfall variability is also expected to increase, meaning more extreme droughts in the dry season and more intense rainfall in the wet season. Sea-level rise and increased storm surges are also expected. The coastal plains are increasingly subject to the influx of saltwater, and as ocean surges lead to saltier soils, farmers can no longer cultivate them. These factors will exacerbate current serious problems of flooding and erosion in coastal areas that lie in the direct path of tropical storms and hurricanes. In the absence of significant adaptation efforts, these dynamics will in turn have severe impacts on water resources, land, agriculture, and forests. Annual population growth of 1.5 per cent means over 11 million mouths to feed by 2020 and additional pressure on agricultural resources.

Flooding is a major problem in almost all of Haiti's 30 major watersheds, because of intense seasonal rainfall, storm surges in the coastal zones, a deforested and eroded landscape, and sediment-laden river channels. Flooding washes away fertile soil, depositing it on river beds. Given the near-complete absence of embankments and levees, this cycle then intensifies the next round of flooding, leading to the destruction of crops, farmland, and agricultural infrastructure, as well as the loss of livestock and human lives. Future climate change is expected to exacerbate these problems.

Haiti is one of the most deforested countries in the world, with forest cover estimated at just 1.5 per cent. Deforestation contributes to soil degradation, erosion, flooding, desertification, and scarcity of water resources. Dependence on charcoal and firewood as energy sources is the major contributor to deforestation. Haiti has attempted to carry out reforestation projects over the years, but few have succeeded. This is due to lack of soil material for trees' roots to take hold; inadequate soil moisture in the dry season; poor maintenance; failure to develop selective tree species breeding; and lack of energy alternatives. Widespread sharecropping and renting of land mean that farmers lack incentives to invest in long-term efforts such as tree cultivation and agroforestry.

Haiti's economy is based primarily on agriculture. Crop yields throughout the world's tropical regions are expected to drop as a result of shortened growing periods, higher temperatures, changing precipitation patterns and other climate-related factors. Haiti's cycle of drought, storms, and floods has devastating impacts on agriculture, and changing rainfall patterns wreak havoc with farmers' planning. Until quite recently, the government and donors neglected the farm sector, but, as we discuss in later sections of this report, investment in smallholder agriculture is vital to building climate resilience.

Most of Haiti's irrigated land lies in the rice-growing Artibonite department. Deliberate overflowing of the Peligre hydropower dam, in order to maintain the power supply in metropolitan Port-au-Prince, greatly exacerbates flooding in the Artibonite Valley. Farmers in the lower valley often face drought as well.

On the consumption side of the food-security equation, Haiti depends heavily on food imports. Global prices for key staples are expected to rise by 120–180 per cent by 2030, in part as a result of the effects of climate change, with ominous implications for Haitian consumers.

Haiti has little capacity to adapt to climate change and its impacts. Disaster risk-management plans in hurricane-vulnerable low-lying coastal zones are poorly elaborated. The government administers a flood early warning system, but it does not as yet provide adequate, accurate, and real-time data. In addition, an early warning system is useful only if there is also the capability

and will to respond in a timely manner. There are few accessible and adequate shelters located on high ground and equipped with food and medicine.

Haiti's current forestry policies do not systematically incorporate strategies to address climate change. There is a bias in favour of ligneous trees for charcoal production. Property ownership is a major problem; the state owns considerable tracts of land, so it should promote the development of cooperatives to work those tracts. There is a need for a land management system, including protected zones, and also for leadership and financial assistance from the state to promote preservation and restoration of forests. Policies on protected areas should emphasise engagement of local people in the design and management of the zones, which could also create job opportunities in eco-tourism. Some reforestation efforts focus on agroforestry, but small land holdings and prior deforestation constrain this approach. With no access to credit, farmers cannot wait for trees to mature to start earning income. In contrast, cash crops such as beans provide up to three harvests per year and thus provide a steady flow of income.

Some on-going initiatives aim to promote renewable energy technologies as alternatives to charcoal. However, at present, the government has not put renewables at the centre of its energy policies.

Haiti currently has no national vision for its agriculture system, although discussions are underway to determine how to develop adaptive capacity. Strategic plans need to include alternative livelihood activities (industry, tourism, and services) to reduce the demographic pressure on agriculture. Small farmers continue to use the same crop varieties, instead of adopting cultivars better suited to the changing climate. Nevertheless, at the local level, farmers are seeking their own independent methods of agricultural adaptation. For instance, farmers try to spread their risks by cultivating gardens in different sites and practice diversified crop production using a mixture of long-cycle and short-cycle crops. They also share resources when they plough and plant. In order for them to strengthen resilience and promote adaptation to climate change, though, these efforts urgently need to be supplemented and supported by reinvigorated and rehabilitated agricultural research, extension, and training structures and improved farmer access to financial services.

Better water resources management is also a critical issue for resilience building. The Ministry of Agriculture is making efforts to improve the irrigation systems in the Artibonite Valley, but there is an absence of policies aimed at adapting agriculture and agricultural water management to climate change.

Women make up 55 per cent of the population and are highly involved in all agricultural activities: planting, harvesting, marketing, and processing. Women, and especially female household heads, need access to education about climate change.

Haiti lacks an adequate system to collect data on weather, crops, and soils. For instance, the existing network of weather stations is very poorly developed. The government's effort in recent years to develop a comprehensive agricultural census, with donor support, is a major step toward overcoming some of the data problems. Improved data collection is essential for developing climate change resilience.

The country faces many governance challenges. Donors do not always align their assistance with national plans or make efforts to strengthen national leadership, and donor coordination is frequently lacking. The state is poor and depends on development aid for 50 per cent of its revenues. The Ministry of the Environment receives only a very small proportion of the government budget. People in rural areas should be actively involved in creating national adaptation action plans, but their awareness of climate change issues is limited at the community level. The government seldom engages in serious consultations with citizens on public policy matters. The need to decentralize services and technical competencies is urgent.

In order to build resilience to climate change, the government should focus on flood control, energy and forestry, and agriculture. We propose a flood control project for the Artibonite River Valley that would require joint efforts by the Haitian and Dominican governments, with support from donors. It would create retention ponds and reservoirs adjacent to the hydropower dams. The ponds and reservoirs would store excess water from behind the dams and allow maintenance of hydropower generation at full capacity without periodic releases. The project would also focus on removing sediment from the Artibonite riverbed and using it to increase the soil cover and fertility of the valley's degraded lands, as well as for reforestation. Flood mitigation actions would also include cleaning and dredging the river and rectification/re-profiling of the waterway so as to reduce rainy season inundations. The fortification and raising of embankments and levees would protect coastal communes from the severe flooding that results from storm surges backing up the Artibonite River and overtopping its banks. The proposal is likely to be very costly to implement, requiring substantial contributions from the two governments and donors. But in light of the valley's importance to food security in Haiti, the benefits of enhanced flood control more than justify the costs.

National inter-ministerial agreement on land use planning can also help reduce the country's vulnerability. Donors should support government initiatives to establish national watershed management guidelines and identify strategic watersheds to target for long-term interventions to diminish flooding vulnerability. Inter-donor and inter-agency collaboration is necessary, both at the policy and field-operations levels.

Plans are in place to create energy forests. Measures such as planting and cutting rotation, so as to maintain the forest stock, and planting trees that grow quickly, can prove to be advantageous. It is essential to recognize that Haitians cut trees to make charcoal because this is one of the few ways for poor rural households to earn income. The best way to encourage people to protect trees is to provide them with alternate livelihood options.

Sediment removed from river beds can be used to support reforestation on the hillsides. The soils would have to be properly anchored so as to avoid erosion during the rainy season. Temporary workers will be needed to progressively install soil conservation structures along the entire length of the slopes, and to remove excess soil following rainfall. After the soil is properly anchored and trees are planted, the young trees need adequate soil moisture, which could come from retention ponds built at the base of the hills to collect runoff water during the wet season. Donors should provide financial and technical assistance to reforestation efforts. As one of the Least Developed Countries, Haiti should have preferential access to funds available for climate change mitigation and adaptation under the UN Framework Convention on Climate Change.

Another major initiative would be to reduce charcoal demand and provide alternative energy sources, so as to protect against additional deforestation. Widespread promotion of energy-efficient cook stoves will lower charcoal consumption. Alternative energy sources include crop residues and solar and wind power.

Since most Haitians continue to rely on agriculture for their livelihoods, agricultural development is essential, and agricultural practices can play an important role in Haitians achieving greater resilience to the effects of climate change. However, Haitian agriculture faces a host of serious problems that policies and programs must address. To improve data collection and dissemination, each community needs data agents who will gather information on weather and agricultural prices, and disseminate it to local farmers. There is an urgent need to develop collective consensus on the issues of land tenure and ownership. The country needs new agricultural practices, including the use of new crop varieties suited to the changing climate, such as drought-resistant, short-cycle, and salt-tolerant varieties, as well as new cultivation practices. For example, agriculture must shift from steep slopes onto more intensively cultivated lowland plains and other sites less vulnerable to erosion. Market practices must also adapt to these changing circumstances. For instance, the government can provide farmers and traders with incentives to develop market links conducive to spontaneous adoption of sustainable

natural resource management. Because of the high cost of purchased agricultural inputs, a low external input approach to agricultural development makes sense in Haiti. And as Haiti experiences tremendous post-harvest losses, it urgently needs to develop food-processing industries. Integrated river-basin management that addresses both agricultural practices and socio-economic factors is the key to overcoming many constraints. If the funds and technical capacity are available, the use of pump, sprinkler, and centre-pivot irrigation systems can be introduced that are more efficient and less time-consuming for farmers.

Urgent attention is needed to governance issues. Lack of political will, leadership, transparency, coordination, and consultation of citizens are major problems. The national government can pass laws and enact policies that promote agriculture. Civil society and donors have important roles to play in both implementation and holding the state accountable.

The prospects for climate change resilience in Haiti are now intricately tied to post-earthquake reconstruction. As Haiti turns its attention to preparing for more disasters and rebuilds significant portions of its infrastructure, it is essential to seize this opportunity to integrate climate resilience into these efforts.

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ACRONYMS AND ABBREVIATIONS

CNSA	Coordination Nationale pour la Sécurité Alimentaire (National Food Security Coordination Agency, Haitian Ministry of Agriculture)
EWS	Early Warning System
IDB	Inter-American Development Bank
IPCC	Intergovernmental Panel on Climate Change
NGO	Non-government organization
MARNDR	Ministère de l'Agriculture, des Ressources Naturelles, et de Développement Rural (Ministry of Agriculture, Natural Resources, and Rural Development, Republic of Haiti)
MICT	Ministère de l'Intérieur et des Collectivités Territoriales (Ministry of the Interior and Local Administration, Republic of Haiti)
ODVA	Organisme pour le Développement de la Vallée de l'Artibonite (Artibonite Valley Development Agency, MARNDR)
PNAP	Programme Nationale d'Alerte Précoce (National Early Warning Programme, Republic of Haiti)
REDD	Reduction of Environmental Degradation and Deforestation
SRI	System of Rice Intensification
USAID	United States Agency for International Development

GLOSSARY

Adaptation: Adjustment in a system in response to actual or expected climatic stimuli and their effects or impacts. It is an on-going process, and may be either planned or spontaneous.

Adaptive capacity: The potential of individuals, communities, and societies to be actively involved in the processes of change, in order to minimize negative impacts and maximize any benefits.

Climate change: Any change in climate over time, whether due to natural variability or as a result of human activity.¹

Climate variability: Variations of the climate on all spatial and temporal scales beyond that of individual weather events. Variability may be due to natural internal processes within the climate system (internal variability), or to variations in natural or human-caused external factors (external variability).

Hazard: A dangerous phenomenon, substance, human activity, or condition that may cause loss of life, injury, or other health impacts, property damage, loss of livelihoods and services, social and economic disruption, or environmental damage. Hazards may be natural hazards or human-induced, and may also be primary or secondary. A secondary hazard would be the direct result of a primary hazard. For example, an earthquake can cause landslides or a tsunami.

Resilience: The ability of women, men, and children to realize their rights and improve their well-being despite shocks, stresses, and uncertainty. Oxfam considers resilience at the individual, household, and community levels, because this is where impact is ultimately felt. However, clearly many causes of vulnerability cannot be resolved at this level, so the roles and responsibilities of states and other relevant institutions, including private companies and investors, must also be addressed. Some commentators talk of negative resilient systems (such as corruption or organized crime). However, as Oxfam's definition of resilience centres on thriving despite the risks, we view these as 'resistant to change' rather than resilient.

Risk: The combination of the consequences of an event and the likelihood of its occurrence. Risk can have both negative and positive outcomes: the most common concept of risk emphasises negative outcomes; however, taking informed and calculated risks is necessary for development, economic growth, and political change.

Vulnerability: The propensity or predisposition to be adversely affected. Vulnerable people therefore include those with disabilities or chronic diseases, older and younger people, indigenous people, and those disadvantaged on account of class, gender, or caste. According to the UN Office for Disaster Risk Reduction (UNISDR):

There are many aspects of vulnerability, arising from various physical, social, economic, and environmental factors. Examples may include poor design and construction of buildings, inadequate protection of assets, lack of public information and awareness, limited official recognition of risks and preparedness measures, and disregard for wise environmental management. Vulnerability varies significantly within a community over time.²

The International Federation of Red Cross and Red Crescent Societies adds that the level of vulnerability depends on 'the characteristics of a person or group in terms of their capacity to anticipate, cope with, resist, and recover from the impact of a natural or man-made hazard'.³

1 INTRODUCTION

Because of its location in the Caribbean hurricane zone and widespread deforestation, Haiti has long faced severe natural and human-created hazards. What are the impacts of climate change, now and in the future? This report examines Haiti's vulnerability to a changing climate. It focuses in particular on coastal zones, energy use, deforestation, drought, flooding, erosion, river sedimentation, and agriculture and food security. The report analyses Haiti's adaptive capacity, adaptation options, and finance and governance issues. It concludes with recommendations related to resilience building and climate-change adaptation needs and opportunities.

RESEARCH METHODOLOGY

Research for the paper consisted of a literature review and 20 key informant and focus group interviews carried out in Haiti between December 12–20, 2011, in the Port-au-Prince metropolitan area and the Department (province) of Artibonite. The interviews employed a structured questionnaire that included some background material on climate change and a series of questions built around five principal themes: current vulnerability to climate change, future vulnerability, sectors that are most vulnerable, adaptive capacity, and governance and policies. Researchers informed interviewees of their interest in using a gender lens for all questions and discussion.

2 HAITI'S VULNERABILITY TO CLIMATE CHANGE

By all accounts, Haiti's climate has recently seen many changes. According to data collected by the Haitian Ministry of Agriculture, Natural Resources, and Rural Development (Ministère de l'Agriculture, des Ressources Naturelles, et de Développement Rural, or MARNDR), mean observed temperatures rose by more than 1 degree centigrade between 1973 and 2003.⁴ Extreme and variable weather conditions alternate between drought in the dry season (generally December to April) and intense storms and hurricanes in the wet season (generally August to November). Haiti lies in the primary pathway of tropical storms that originate in the Atlantic Ocean and strike Caribbean islands every hurricane season. According to the people whom we interviewed during the course of our research, the country has experienced radical changes in climate variability, especially the seasonality of rainfall and the frequency and intensity of hurricanes and tropical storms, which has led to flooding and erosion—the impacts of which are magnified by severe environmental degradation—and is very likely attributable to climate change.

The changes in variability and extreme weather that our interviewees noted are in line with the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC).⁵ For example, the report indicates that in the 1990s, 35 per cent of tropical cyclones were classified as Category 4 or 5, compared with only 20 per cent in the 1970s.⁶

Flooding is a major problem in almost all of Haiti's 30 major watersheds, due to intense seasonal rainfall, storm surges in the coastal zones, a deforested and eroded landscape, and sediment-laden river channels. During the tropical storm and hurricane season, as much as 40 millimetres of rain may fall each day.⁷ This leads to rapid runoff from deforested and eroded mornes, or small mountains, and hills, as well as the overtopping of rivers.

Flooding washes away fertile soil, depositing it on river beds (of the Artibonite, the Grande Rivière de Jacmel, and the Rivière de Grande Anse, for example). Massive sedimentation has raised the beds of many waterways, and there is a near-complete absence of embankments and levees. These factors intensify the next round of flooding, leading to the destruction of crops, farmland, and agricultural infrastructure, as well as the loss of livestock and human lives. Future climate change is expected to exacerbate these problems.

The low-lying plains of the Ouest and Artibonite departments and the narrow coastal zones of the Sud, Sud-Est, Grande Anse, and Nippes departments are especially vulnerable to flooding (see Figure 1 and Table 1).⁸ On the Cul de Sac Plain of the Ouest department, the Rivière Blanche and Rivière Grise basins are subject to particularly severe flooding.⁹ Heavily populated coastal towns, such as Jacmel, Les Cayes, and Gonaïves, lie in the direct path of the storms. The coastal plains contain important aquifers that are increasingly subject to the influx of saltwater, and as the soils become saltier as a result of ocean surges, farmers can no longer cultivate them. The result is enormous economic losses. Low-income communities located near rivers and coastal floodplains experience significant loss of human life during the storm season as a result of both flooding and the destructive power of gale force winds. Inundations from torrential rains also negatively affect public health, as they facilitate the spread of such diseases as cholera.

These conditions have led to an exodus of farmers from the mountainous regions to urban areas such as Gonaïves, Saint Marc, and Port-au-Prince, as well as to the Dominican Republic and other countries, in a quest for employment as well as education for their children. This migration reduces the labour available for Haitian agriculture. Meanwhile, the country's coastal

cities face sea-level rise and storm surges. By one estimate, because of the high density of urban centres, Haitians in cities such as Port-au-Prince and Gonaïves face two to four times the tropical cyclone risk other Haitians face.¹⁰ Hurricane contingency plans — for evacuations, for example — exist, but there is no money for food, shelter, and health services.

Figure 1: Map of Haiti



Source: UN Department of Field Support Cartographic Section.

The vulnerable population also includes low-income fishing communities. There are 30,000 Haitian fishers, mostly farmers who fish part-time, and women are actively involved in seafood marketing. Fisheries provide an important component of Haiti's food supply, and the annual catch of about 16,000 metric tons is worth \$75 million, with processing adding \$50 million in value.¹¹ In the 1990s, there were attempts to develop fishery policies, but these were shelved because of political turmoil. Foreign industrial fleets have overfished the shallow waters near Haiti's coast, and catches are declining, because most Haitian fishing boats are not equipped to venture into deep waters where Japanese and Portuguese vessels predominate.¹² Climate change, river sedimentation, and pollution have all degraded strategic ecosystems for fish reproduction, such as mangroves and coral reefs. Haitian fishers, including those with modern gear, face boat and equipment losses when severe storms strike. These issues need to be addressed as part of efforts to build resilience to climate change.

Projections of future climate change indicate that annual mean temperatures in the Atlantic Ocean and Caribbean Sea will increase between the decade of the 2020s and the 2080s, with the rate of increase accelerating over time. Rainfall variability is also expected to increase, meaning more extreme droughts in the dry season and more intense rainfalls in the wet season¹³ (see Table 2).

Furthermore, according to the IPCC, sea-level rise (1.8 millimetres per year)¹⁴ and increased storm surges¹⁵ are expected in the future. These factors will further exacerbate the problems of flooding and erosion in the coastal departments, especially Sud and Sud-Est, which lie in the

direct path of tropical storms and hurricanes. In the absence of serious adaptation efforts, this will have severe impacts on key water resources, land, agriculture, and forests.

Further complicating the picture is annual population growth of 1.5 per cent. This means that Haiti will have more than 11 million mouths to feed by 2020,¹⁶ and this puts additional pressure on the land.

Table 1: Severity of climate risk in Haiti's Departments

(1 = maximum risk, 10 = minimum risk)

Department (Province)	Hurricanes	Floods	Drought
Artibonite	10	2	3
Centre	9	9	6
Grande Anse	2	7	9
Nippes	5	8	8
Nord	7	5	7
Nord-Est	8	10	2
Nord-Ouest	6	4	1
Ouest	4	1	4
Sud	1	3	10
Sud-Est	3	6	5

Source: *Haiti Survie/FOE Haiti*, « *Les Manifestations des Changements Climatiques en Haïti* », 2006.

Table 2: Projected changes in mean annual temperature (°C) and rainfall (%), Atlantic Ocean and Caribbean Sea

Climatic change	2020s	2050s	2080s
Mean annual temperature	0.9+/-0.16	2.03+/-0.43	3.06+/-0.84
Mean annual rainfall	-2.2+/-7.3	-5.2+/-11.9	-6.8+/-15.8

Source: *Murari Lal, Hideo Harasawa, and Kiyoshi Takahashi*, "Future Climate Change and its Impacts Over Small Island States," *Climate Research* 19 (2002): 179–192.

3 DEFORESTATION AND ENERGY

Forest resources and ecosystems are critical to climate resilience because they provide water, food security, protection from natural hazards, organic matter for soil fertility, carbon sequestration, and support for livelihoods. Haiti is one of the most deforested countries in the world. Forest cover is estimated at 1.5 per cent, compared to 25 per cent in 1927. Only the southern departments (Sud, Grande Anse, Sud-Est, Ouest, and Nippes) have any cover whatsoever.¹⁷ The agriculturally important Artibonite department is almost entirely deforested.

A recent study of agriculture and forestry found that in the Grand Rivière du Nord Basin in the Nord and Nord-Ouest departments, there was 13 per cent coverage by mixed hardwoods together with agroforestry (integrated cultivation of crops and trees) in 1978, but this had fallen to less than 1 per cent three decades later. Important changes occurred between 1998 and 2009: considerable denudation of the forests and an increase in intensive, seasonal cultivation of such crops as corn, beans, and sorghum on steep (greater than 60 per cent) slopes. There are also scattered agroforestry activities involving fruit trees (mangoes, citrus, avocados, and cashew nuts).¹⁸

Deforestation has led to and compounded other environmental problems. It contributes to soil degradation, flooding, desertification, and scarcity of water resources. For instance, the removal of forests allows for rapid flow of rainwater toward water courses, thereby reducing the recharge of ground water and aquifers, not to mention loss of the purifying effect of forests and their “carbon sink” properties. Furthermore, deforested lands are subject to widespread erosion, especially following intense rainfall in the wet season, and this has led to massive river bed sedimentation in several of the main drainage basins, such as those of the Artibonite River, the La Rouyonne-Cormier Rivers of the Léogâne watershed, and the Grande Rivière de Jacmel.¹⁹

Efforts to build climate change resilience must include an effective approach to increasing tree cover. At present, however, laws regulating deforestation are not enforced, because in recent years, the majority of forest rangers lost their jobs.

Dependence on charcoal and firewood as energy sources is now the major cause of deforestation, with 70 per cent of harvested wood being used to make charcoal. It is utilized mainly for household cooking but also by agricultural processing enterprises and dry-cleaning businesses. Much past deforestation resulted from efforts to clear land for cultivation. The January 2010 earthquake caused 600,000 people to leave affected urban areas in search of shelter with rural relatives or friends, which increased the number of people relying on forest resources.

According to an Energy Sector Management Assistance Programme study, Haiti meets 72 per cent of its energy requirements from local resources, primarily firewood and charcoal (66 per cent), along with *bagasse* (residues left over from sugarcane processing; 4 per cent) and hydro-energy (2 per cent). Imported fossil fuels (mainly kerosene and petrol) account for the remaining 28 per cent.²⁰

Charcoal production is highly inefficient, as 70 per cent of wood energy is lost in the fabrication process. Impoverished rural Haitians make charcoal in the desperate pursuit of some sort of income.²¹ Rural Haitians have recently cut down even income-producing fruit and nut trees to make charcoal, since one sack of charcoal fetches 1,000 gourdes (\$25).²²

Haiti has attempted to carry out reforestation projects over the years, planting millions of new trees. Local non-government organizations (NGOs) grew trees in their own nurseries, using

small-container technology. Extension agents have distributed more than 80 million trees to farmers for planting since the 1980s, usually for free.²³ Women are actively involved in many reforestation efforts.²⁴

Unfortunately, few of these projects have succeeded. There are no official statistics, but estimates point to a success rate of less than 10 per cent, due to lack of soil material for tree roots to take hold and inadequate soil moisture in the dry season, which causes young plants to wilt and die.²⁵ Other problems include inadequate monitoring of seedlings, unregulated grazing of livestock, and widespread sharecropping and renting of land, which mean that farmers lack incentives to invest in long-term efforts such as tree cultivation and agroforestry.

4 AGRICULTURE AND FOOD SECURITY

Haiti's economy is based primarily on agriculture, which employs 60 per cent of the work force and contributes 25 per cent of the gross domestic product.²⁶ Climate and weather are key factors in agricultural resilience and productivity. Crop yields throughout the world's tropical regions are expected to drop as a result of shortened growing periods, higher temperatures, changing precipitation patterns and other climate-related factors. Even though most Haitians depend on agricultural livelihoods, until quite recently, the government and aid donors neglected the farm sector in terms of investment and technological innovation. Investment in Haiti's smallholder farmers and the agricultural sector in general is vital to building climate resilience. However, it will be critical to foster an appropriate agricultural model for Haiti if it is to satisfy its food security needs.

In general, it is becoming more and more difficult to get profitable returns on investments in agriculture, because of weather conditions, degraded soils, and loss of cultivable soil due to deforestation, flooding, erosion, and low-capacity subsistence farming methods. Due to steep slopes and poor soils in much of the country, Haiti only has 7,700 km² of land that is classified as cultivable. Nevertheless, 11,900 km² (1.2 million hectares) are actually exploited, which means that substantial land that is not suitable for farming is under the plough. Lands on the plains cover about 550,000 hectares, and the potential for irrigation is 135,000 to 150,000 hectares. But only 90,000 hectares currently are supplied with irrigation systems, of which 80,000 ha are effectively irrigated.²⁷

Aerial detection and analyses of drainage basins using low-resolution aerial remote sensing show a tendency toward reduced growth and yields of several crops.²⁸ This could be attributed to poor soil quality, increasing water deficits, and acceleration of maturation due to the warmer and more drought-prone climate.²⁹

The cycle of storms and floods discussed earlier has a devastating impact on agriculture. In 2004, some 3,000 people perished in Gonaïves following Hurricane Jeanne, and hillside erosion led to crop destruction, as gravel flooded farmers' fields, making cultivation difficult afterward. In 2008, the Sud, Nippes, and Sud-Est departments were hit by four hurricanes in rapid succession. Because of the lack of tree cover and the steep slopes, the series of hurricanes caused considerable losses of soil, crops, livestock, and rural roads, thereby reducing access to fields and making produce transportation difficult. The storms affected more than 800,000 people, with many deaths. In November 2010, less than a year after the devastating earthquake, Hurricane Tomás caused similar damage, as did Hurricane Sandy in 2012.³⁰

Droughts also constrain agriculture, severely affecting the dry mornes in the northern (Nord-Ouest, Nord, and Nord-Est) and Central (Centre and Artibonite) departments.³¹ The most vulnerable zones are those without irrigation systems, which are concentrated on the plains of Artibonite, Cul de Sac (Ouest), Torbeck (Sud), and Maribahoux (Nord-Est). On the mornes and in the mountainous regions, where the slopes exceed 20 per cent, there are no irrigation systems, and deforestation and erosion have left little cultivable top soil. Some agricultural experts argue that it is not worthwhile economically to invest in agriculture in drought-prone regions such as the Nord-Ouest department, because of poor yields for crops such as corn and the failure of agroforestry projects.³²

Extreme climatic conditions ranging from drought on the one hand to excess rain on the other have become common. Since 2000, climate changes have been observed: increased episodes of cyclones, as well as increased frequency and intensity of localized drought.³³ In recent years,

the Nord, Sud, and Nippes departments have displayed irregular and unpredictable weather patterns during both the dry and wet seasons, so much so that it has become difficult to plan the agricultural calendar. These conditions have had significant impacts on agricultural practices and crop yields. The weather has become highly variable, changing from one extreme to the next. Also, because of drought during the dry season, rivers are almost dry, but then they flood during the wet season due to excessive and intense rainfalls.

The rainy season now begins up to three months later than it did in the past. Rains arrive in May and even June rather than in March, thereby extending the droughty dry season. This severely disrupts agricultural planning and hinders the planting of rain-fed crops such as corn and beans. As a result, there are severe decreases in yields and the already meagre farm profitability, which in turn further affect food security. For example, the October 2010–March 2011 second bean crop, consisting mainly of black beans, suffered significant yield losses due to flooding. Then there was a marked delay in sowing the first bean crop of 2011 because of delayed rains and drought across the country.³⁴ Farmers on the Cul de Sac Plain, northwest of Port-au-Prince, where there are no large-scale irrigation systems, suffered particularly significant losses.³⁵

Farmers who follow the pattern of planting following the first rains in non-irrigated areas suffer crop losses if there is drought afterward. The lack of an efficient climate monitoring network or information system for small farmers severely constrains their ability to adapt their practices to changing conditions.

Even when the rains arrive on time in May and June in the Nord and Nord-Ouest departments, the soil is exposed and soil erosion is rampant, especially in the downstream part of the river valleys. This leads to flooding, as well as to sediment deposits in the communes in the valleys' lowest reaches.³⁶

Coastal towns such as Les Cayes and Gonaïves are already more or less at sea level and are very vulnerable to climate-driven sea-level rise and storm surges that further exacerbate the problems of soil erosion by salinizing agricultural soils, thereby rendering agriculture almost impracticable. Climate-driven sea-level rise and storm surges also impact agriculture and fisheries in the low-lying coastal zones of the Cul de Sac Plain.

On the consumption side of the food-security equation, Haiti depends heavily on food imports.³⁷ The rapid rise in global food prices in 2007–2008 severely affected Haiti's open economy, making food unaffordable for many Haitian consumers. Global prices for key staples are expected to rise by 120–180 per cent by 2030, due in part to the effects of climate change. This will prove disastrous for low-income food-deficit countries such as Haiti and raises the prospect of a wholesale reversal in human development.³⁸

CLIMATE CHANGE AND AGRICULTURE IN THE ARTIBONITE VALLEY

Most of Haiti's irrigated land lies in the Artibonite department, which has more than 500 km² of good quality agricultural land.³⁹ Rice is the major crop in the low-lying areas of the department. Farmers in the middle and upper reaches of the Artibonite Valley produce rice on 32,000 irrigated hectares, rotating this with beans, tomatoes, or sweet potatoes and then corn, in order to maintain soil fertility. There are two major rice crops per year: April or May to October, the major season that corresponds to the wet season, and October or November to March, which corresponds to the dry season. It is also possible to grow a second crop of rice in the dry season in irrigated zones.⁴⁰

There is no irrigation in the lower parts of the valley near the coast, which face serious water-related agricultural constraints. These areas are frequently waterlogged as a result of heavy

rains, flooding from upstream, sea-level rise, and storm surges. In Bokozel during tropical storms and hurricanes, sea water backs up the Artibonite River and causes the river to overflow its banks, which are not very elevated. In the coastal zones near Gonaïves, Grande Saline, and Desdunes Communes, salt water intrusions are contributing to soil hardening. Farmers in this area increasingly need salt-tolerant crop varieties.

Grande Saline Commune lacks both drainage and irrigation systems. Flooding from the sea and the interior mountains often undermines local salt production. About 150 hectares in the low-lying coastal zone are totally unusable for agriculture because of a lack of drainage and stagnant water. These conditions will likely spread to inland areas of similar topography as sea levels rise. Local farmers point to an increased incidence of plant pests and diseases,⁴¹ and this may very well be due to climate change.⁴²

Deliberate overflowing of the Peligre hydropower dam to maintain the power supply in metropolitan Port-au-Prince greatly exacerbates flooding in the Artibonite Valley. The Canot irrigation dam was created to divert irrigation water to larger and wider areas and to ease flooding via two channels on either side of the Artibonite River. Instead of alleviating floods, however, these diversion spillways simply facilitate inundations due to the overflow events caused by the upstream release of water behind the Peligre and Dominican Republic hydropower dams. The floods devastate almost the entire valley.

Farmers in the lower valley often face drought as well. They cultivate rain-fed rice when rainfall is adequate. But Gonaïves and Grand Saline are especially susceptible to drought, and sometimes the rains fail. Farmers in Grande Saline Commune must use time-consuming bucket irrigation methods, because their land lies above the irrigation canals. Normally pumps would resolve this problem, but the available pumps do not function most of the time, and sometimes there is no electricity to run them.⁴³ Bean farmers in Anse Rouge, Terre Neuve, and Gonaïves on the Gonaïves Plain are the cultivators in the department who are most vulnerable to drought and the late arrival of rains.

In the upper, mountainous part of the Artibonite department, where there also is no irrigation, farmers used to plant corn in April. But now the rains come much later. This not only disturbs the agricultural calendar but also deprives farmers of one crop during the year.

These widespread irrigation problems have far-reaching consequences. Farmers may see their beans begin to flower, but there is little or no grain formation, and this condition results in low yields and crop failure. This may well be the result of acceleration of maturation and drought.⁴⁴ In addition, when the rains do arrive, between July and September, there are severe crop losses because of flooding and inability to harvest.⁴⁵

5 ADAPTIVE CAPACITY, ADAPTATION, AND GOVERNANCE

Haiti lacks the capacity to adapt to climate change and its impacts. Even without policies promoting adaptation, people adapt autonomously depending on their needs and desires, and the results may be good or bad, as for instance in forestry (failed reforestation efforts), agriculture (choice of cultivars), and fishing (inadequate boats). Haitians have in their own way started to develop the means to adapt to changing climate conditions, such as behaviour modification, education, and sensitization. However, the efforts are uneven and not always fully researched or understood. For example, people now build houses with concrete roofs, but given the threat of earthquakes, this may not be a good idea.⁴⁶

The most vulnerable populations are those who lack the resources and capacity to adapt. This includes people living in extreme poverty, especially women, who must spend considerable time and energy providing food, water, and firewood for their households.⁴⁷ Dependent people, such as young children and elderly persons, are also at high risk. Food insecurity and the impacts of the 2010 earthquake further negatively affect people's lives.

DISASTER RISK MANAGEMENT

Disaster risk-management plans and practices remain inadequate to address the severe hazards that Haiti faces. For instance, in hurricane-vulnerable low-lying coastal zones such as the Sud and Sud-Est departments not enough data have been collected to create sound risk-management plans. It has therefore become more and more difficult to manage risks and disasters. Contingency plans thus should be re-evaluated. The situation is now starting to be addressed by putting in place early warning systems in case of floods due to heavy rains.

Standards for rebuilding homes and other structures are likewise problematic. There are no formal building codes in Haiti, and following the earthquake, people use international standards.⁴⁸ But too many organizations and individuals simply have rebuilt as before, without following any standards whatsoever, because of the high cost of following standards and acquiring building materials (which are imported), as well as a lack of technical capacity.⁴⁹

Addressing flood risks

The government and donors have undertaken a number of projects to address flooding, but no comprehensive plan has been put in place. At the national level, MARNDR and the Department of Civil Protection⁵⁰ jointly administer an early warning system (EWS), the Programme Nationale d'Alerte Précoce (PNAP), which is financed with a \$5 million loan from the Inter-American Development Bank (IDB) that is payable only through 2013. As of 2011, the PNAP had created a network of more than 100 hydro-meteorological gauges and warning stations capable of transmitting local and satellite radio data to PNAP headquarters in the capital.

This network is concentrated in the 13 catchments with the highest flood risk. The system has some limitations: alerts follow guidelines from a manual that is not of the highest quality, and warnings are based on subjective reports on river levels in neighbouring villages. Furthermore, the system does not yet provide adequate, accurate, and real-time data that could underpin an efficient rapid-response system. Such a system would require an optimized and denser network of automatic warning stations. The data would need to feed into a suitable hydrological model supported by digital terrain information. Most importantly, an EWS is useful only if there is also

the capability and will to respond in a timely manner. Adequate response capacity would include accessible and adequate shelters located on high ground and equipped with food and medicine, but there are few of these at present. Even when they are available in the Artibonite Valley, in general, farmers are reluctant to leave their animals and belongings behind, and this sometimes leads to the loss of human lives and livestock.⁵¹ Another problem is vandalism and theft at the existing solar-powered automated weather stations. Efforts to address this have included improved solar panel design and use of batteries not also suitable for cars.

Local projects to reduce flood risk through enhanced preparedness and establishment of community EWSs began as early as the mid 1990s, and some are now relatively well developed. These projects include establishment of community-based emergency response teams and disaster-preparedness committees, construction of emergency shelters, and evacuation planning. However, few projects were proactive or broad in their coverage; most began following a specific flood disaster and targeted downstream communities.⁵²

The US Agency for International Development (USAID) is supporting flood control activities through its Feed the Future-West project. These include dredging and channel re-profiling of the Rivière Grise and Rivière Blanche in the Cul de Sac Plain, as well as dredging and resurfacing irrigation channels with concrete bases so as to increase the flow of water to farmland.

ADAPTATION IN THE FORESTRY AND ENERGY SECTORS

Forestry adaptation

Adaptation in the forestry sector is crucial in light of the ecological services that forests provide. These include regulation of the hydrological cycle, the reduction of flash floods, and soil conservation and fertility.

However, Haiti's current forestry policies do not systematically incorporate strategies to address climate change. There is a bias in favour of ligneous trees for charcoal production, and losses and poor revenues from agriculture drive continued deforestation. There are no initiatives, coercive actions, or sanctions to prevent cutting down trees. The profit motive, rather than natural resource conservation, drives most forestry activities (for example, in former pine forests). In interviews with local officials and educators, we heard repeatedly that the state is absent or weak when it comes to the forestry sector.

Property ownership is a major problem. The state owns considerable tracts of land, so it should promote the development of cooperatives to work on state land. There is a need for a land management system, including protected zones, and also for leadership and financial assistance from the state to promote preservation and restoration of forests.⁵³

Some reforestation efforts focus on agroforestry, with farmers usually cultivating sugarcane and tubers (yams, cassava, and sweet potatoes) alongside such fruit trees and plants as banana, mango, avocado, and citrus. The revenues offer an incentive not to cut down the trees, and such mixed farming systems also protect soils from erosion. But small land holdings and prior deforestation constrain agroforestry. Farmers leave their land to their children in equal parcels, because of the continued use of French colonial inheritance rules. This practice militates against the promotion of large farms such as coffee plantations, and also limits the ability of low-income smallholders to engage in reforestation on small plots of land that must also support crop cultivation. Demographic and economic pressures lead to a prevalence of brush-cut agriculture for beans, pigeon peas, and potatoes for personal consumption and for markets.⁵⁴

In 1996, then-president René Garcia Prével introduced an agrarian-reform policy that distributed 2,000 hectares of state land to 4,000 families, giving them each 0.5 hectares. Assailants and

squatters attacked poor and old persons and took their land, crops, and belongings. Those who seized the land from the intended beneficiaries had political connections, so the agrarian reform was entangled with corruption and conflict, even at times leading to death. Also, some people who received land resold it and migrated to the Dominican Republic in order to make a profit and avoid conflict. In the end, more than 100 hectares of the agrarian reform land remain unused, and cultivation efforts lead to conflict and violence.⁵⁵

One of the major hindrances to agroforestry is cash flow; coffee only provides one harvest per year, and then only after the trees mature. With no access to credit, this translates into no income for an extended period. But cash crops such as beans provide up to three harvests per year and thus provide a steady flow of income. Also, the agroforestry system is not well adapted to environmental conditions in the mountainous zones where soil fertility and erosion pose serious problems, and that is why farmers prefer to shift to quick-yielding cash crops (corn or beans) using brush-cut methods to maintain their revenue streams.⁵⁶ Another problem is the total lack of policies to support the development of processing enterprises to turn fruits into marketable value-added items, such as jams and juices.

The National Coffee Institute was created to support the coffee industry, and it is hoped that this will help promote reforestation, since coffee plants require a shady environment. But training of technical experts and agronomists is still necessary. Civil society (NGOs and universities, for example) can also help to promote agroforestry cooperatives to enhance cultivation practices and processing and marketing of products.

There are a number of important civil-society initiatives in the forestry sector. The Fondation Seguin has embarked on an ambitious reforestation program in the Sud-Est department. The objective is to plant 300,000 trees in the degraded pine forests now occupied by varieties of bamboo. The Fondation Macaya seeks to reforest the Macaya Park. The Société Audubon⁵⁷ promotes biodiversity through sensitization of children: the children study environmental issues, and their parents do not have to pay school fees if they sign a contract not to cut the trees. Another similar initiative, the Centre de Propagation Végétale, is a collaborative effort among Cuba, the Dominican Republic, and Haiti aimed at restoring forests and biodiversity sites in Haiti. It has launched pilot projects in the Nord-Est Department, and plans are in place for additional activities elsewhere. The pilot projects carry out education and awareness-raising on agroforestry through discussions with community residents and make their desires a priority in the final selection of plants and trees.⁵⁸

Energy sector adaptation

Some initiatives aim to promote renewable energy technologies as alternatives to charcoal. Mostly private sector efforts are underway in the Nord-Ouest department to use wind energy. Solar energy is increasingly being harnessed, but it is most often linked to the use of cellular telephones and to road signs and street lights. Solar-powered batteries are frequently stolen. Renewable technologies could be especially beneficial in rural zones that are off the main electricity grids. However, at present, the government has not put renewables at the centre of its energy policies.⁵⁹

AGRICULTURAL ADAPTATION

Adaptive capacity in agriculture remains extremely low. Small farmers continue to use the same crop varieties, instead of adopting cultivars better suited to the changing climate.

At the same time, some autonomous agricultural adaptation has occurred. Smallholder farmers live in very difficult economic circumstances and within a wide variety of micro-climates. Farmers try to spread their risks by cultivating gardens in different sites: lowland, mid elevation, and high elevation, with seed selection attuned to the particular micro-climate. Resilience to

climate change and economic conditions is also reflected in the practice of diversified crop production using a mix of long-cycle crops such as yams and pigeon peas that assures at least one harvest per year, and short-cycle crops such as beans, which provide up to three harvests per year. Groundnuts can be cultivated in higher mountainous regions and on sandy soils. But groundnut cultivation requires the tilling of the soil at planting and harvest, exposing it to erosion in the rainy season. A further element of adaptive capacity in agriculture is work organization: farmers share resources when they plough and plant. But they still need help with regard to research, new varieties, and adaptation of cropping systems to the changing climate.⁶⁰

Government agronomists and engineers, as well as many low-income farmers who are aware of the problems of climate change, are willing to make efforts at adaptation and resilience building, but there is a dire lack of money, and labour is in short supply. In our interviews, mayors from communes in the Artibonite Valley emphasized the need to strengthen knowledge on climate change issues, and then to take concrete action to address the problems.⁶¹ Farmers whom we interviewed similarly called for a vigorous campaign aimed at sensitizing and educating people in vulnerable areas to climate change.⁶²

The Haitian government is very concerned about climate change and its food-security impacts. But, thus far, government policies have not provided farmers with much of the needed support. During Préval's two presidential terms (1996–2001 and 2006–2011), the government provided farmers with an 80 per cent subsidy on the price of fertilizer. During the 2008 food price crisis, public demonstrations led the government to add a tractor subsidy as well, and also to carry out dredging, cleaning, and straightening of the Artibonite river channel, to reduce flooding. These measures led to significantly increased crop yields.⁶³ But the government needs to do much more to, for instance, promote cooperatives and access to credit for the farming community. The government currently has inadequate technical and financial resources to enhance adaptive capacity and resilience to climate change. The nation lacks a vision for agriculture, although discussions have begun about how to develop adaptive capacity by, for example, creating crop insurance.⁶⁴ Strategic plans need to include alternative livelihood activities (industry, tourism, and services) to reduce the demographic pressure on agriculture.

Another problem is that there is little public agricultural research capacity. MARNDR sponsors a number of research centres, such as the Centre de Recherche et de Documentation Agricole, which carries out research on both plants and animals, and the Centre Salagnac in the Nippes department. In the past, the ministry had a network of 80 integrated research, extension, and training institutes dealing with different types of ecosystems (agriculture, forestry, agroforestry, etc.), but these establishments collapsed during the two turbulent decades after the 1986 ousting of former president Jean-Claude Duvalier.⁶⁵ In part because of the lack of research and extension services, agricultural practice in Haiti is mainly subsistence and of low productivity. There is little adoption of improved crop varieties or new cultivation practices. For example, Haitian farmers continue to use old bean cultivars, in spite of changing climate and soil conditions. If the country is to strengthen resilience and promote adaptation to climate change, it must reinvigorate and rehabilitate research, extension, and training structures.

Water resources management is also a critical issue, but there is a problem of coordination. The Ministry of Public Works and Communication is in charge of drinking water, and MARNDR has responsibility for irrigation. The latter is making efforts to improve the irrigation systems in the Artibonite department, but there are no policies aimed at adapting agriculture and agricultural water management to climate change. Lack of financial and human resources and widespread corruption undercut MARNDR's efforts to develop the valley.⁶⁶

Women make up 55 per cent of the population and are very involved in all agricultural activities: planting, harvesting, marketing, and processing. They are also responsible for supplying their households with drinking water. Yet women are woefully underrepresented in decision-making bodies at all levels. Women's education about climate change will help, especially for female heads of household. Female farmers whom we interviewed paid more attention than men farmers to the basic necessities of food and shelter and made agriculture and fisheries a higher

priority. Although they seemed less knowledgeable about climate change issues, they were deeply concerned by the potential negative impacts and showed a sincere yearning to learn more. They also showed more concern than the men farmers for environmental protection and preservation.⁶⁷

'Mesdames Saras' are women involved in wholesale sale and distribution of agricultural produce, seafood, and other household products across the country. Despite their wide marketing networks, they sometimes lack the capacity to collect and distribute all agricultural produce. In addition, the scarcity of food processing industries leads to significant post-harvest losses. To address these losses, MICT has recently encouraged the local elected councils and administrative committees to facilitate commercialization of agricultural and agroforestry products.

Haiti lacks an adequate system to collect data on weather, crops, and soils. Its weather station network is very poor, and with mountainous chains over 2,600 meters, remoteness is a problem.⁶⁸ In addition, in the agricultural region around the town of Cabaret in the Ouest department, the drainage and irrigation systems failed in large measure because of the antiquated data used to calculate the systems' capacity. Improved weather data and drainage and irrigation systems can limit the loss of crops, animals, and human lives.⁶⁹ But there is no culture of data collection in Haiti; some information is available only from historical accounts. In addition, there is a dire lack of information about climate change.⁷⁰ The government's effort in recent years to develop a comprehensive agricultural census, with donor support, is a major step toward overcoming some of the data problems.⁷¹

Civil society has a relatively weak presence in Haiti. Local government and NGOs can play an important role in increasing the capacity of civil society organizations, especially at the local level.⁷²

Civil society, including NGOs and universities, as well as such donors as the World Bank and the IDB, are taking steps to enhance agricultural adaptive capacity and resilience, and they have stepped up these initiatives following the 2010 earthquake. On the donor side, for example, the UN World Food Programme, France, Canada, and Brazil have sought to procure food for school meals from Haitian farmers as a way to boost local agriculture and marketing chains, as well as nutrition and education.⁷³

GOVERNANCE

Haiti faces many governance challenges. Donors do not always align their assistance with national plans or make efforts to strengthen national leadership, and coordination among donors is frequently lacking. The administration of President Michel Joseph Martelly was able to garner increased donor funding and technical aid after the earthquake. The administration has identified the environment as a top priority, but the financial needs continue to be enormous.

The state is poor and depends on a number of bilateral and multilateral financial arrangements; more than 50 per cent of the government budget comes from international aid. Most bilateral and multilateral aid goes to specific projects, with little assistance provided as budget support over which the government has greater discretion. Furthermore, these project-specific funds do not arrive in time; this reduces the effectiveness of mitigation measures and amplifies the destruction caused by hurricanes and droughts. The Ministry of the Environment should allocate more financial resources, promote more research, provide technical help, and promote decentralization and local involvement in environmental protection. Currently, however, only a very small proportion (less than 1 per cent) of the government budget goes to the ministry, and administrative costs eat up 75 per cent of the funds that it does receive.⁷⁴

The relationship between the state and its citizens is also problematic. The government seldom engages in serious consultations with citizens on public policy matters. But rural people should

be actively involved at the communal section (community) level in national adaptation action plans.

Decentralization can help ensure that public services respond to the needs and demands of citizens, but Haiti has experienced little progress on the decentralization of services and technical competencies. In addition, awareness of climate change issues is grossly lacking at the local level, because of a lack of research centres and the technical and social capacity to address questions related to climate change.⁷⁵

Women farmers in the Artibonite Valley whom we interviewed believe it is important to raise the issues of climate change adaptation and resilience with the national government, so that it will seek climate change funding. These women also believe that local-level adaptation plans are important, both in their own right and as a means to put pressure on national leaders to address climate change. Furthermore, they say that there is a need to increase public awareness of climate change through schools, churches, and community centres. Finally, they are concerned about wealthy countries' willingness to provide funds to poor countries such as Haiti to address the consequences of climate change.⁷⁶

6 PRIORITY RECOMMENDATIONS FOR PROMOTING CLIMATE CHANGE RESILIENCE

We have identified three areas of priority recommendations to address the issues raised in this report: 1) risk and disaster management; 2) increasing resilience in relation to energy use and deforestation; and 3) increasing resilience through agricultural development. Below we discuss how to enhance adaptive capacity and governance within the context of these three areas.

RISK AND DISASTER MANAGEMENT—FLOOD CONTROL

The government undertook a major agricultural development effort in the Artibonite Valley, a substantial portion of which is now irrigated. Although irrigation alleviates drought in the valley, this intensively cultivated zone suffers from flooding and erosion during the wet hurricane season, leading to crop losses.

We propose a flood control project for the Artibonite River Valley, which suffers flooding not only from intense rainfall and storm surges but also from deliberate water releases from the Peligre Dam and the Dominican Republic's upstream hydropower dams.⁷⁷ This project would require joint efforts by the Haitian and Dominican governments, with support from donors. It would create retention ponds and reservoirs adjacent to the dams, which would store excess water from behind the dams and serve as sources of water to maintain hydropower generation at full capacity and allow for optimal irrigation during the dry season. Previous plans to create such a system, designed to hold up to 10,000,000 cubic meters of water, never came to fruition.⁷⁸

The project would also focus on removing sediment from the Artibonite riverbed and using it to increase the soil cover and fertility of the valley's degraded lands, as well as for reforestation, which we describe in the next section. In addition, flood mitigation would also include cleaning and dredging the river, rectification/re-profiling of the waterway, and riverbank stabilization, so as to reduce rainy season inundations. Fortified and raised embankments and levees can protect coastal communes from severe flooding due to storm surges backing up the Artibonite River and overtopping its banks.

The proposal is likely to be very costly to implement and will require substantial contributions from the two governments and donors. Donors will also need to provide technical and institutional capacity-building support for a project of this magnitude, which is aimed at increasing the Artibonite Valley's resilience to current flooding and a future in which climate change is expected to worsen the problem. Given the valley's importance to food security in Haiti, however, the benefits of enhanced flood control more than justify the costs.

There are already some related projects underway. In February 2012, the Haitian government signed a contract with the French consortium Alstom-Comelex to retrofit and restore the Peligre hydroelectric plant. The IDB, the German Development Finance Agency, and the Organization of Petroleum Exporting Countries are providing funds for this three-year, \$48.8 million contract. This contract has the potential to raise the level of the dam so as to reduce the need for deliberate discharges. In addition, Oxfam, the UN Development Programme, and the Global Environmental Facility are partnering on the Bi-national Artibonite Watershed Management

Project. Our proposed flood control project would complement these efforts and go a long way toward addressing some of the flooding problems.

There are additional adaptive capacity and governance issues to address. First, MARNDR's Artibonite Valley Development Agency (Organisme pour le Développement de la Valley de l'Artibonite, ODVA) does not have the capacity to resolve flooding problems and manage disasters and risks. It has limited technical knowledge on flood control, and lacks political will and effective leadership skills. Second, institutional coordination across government agencies and ministries is extremely poor. Third, lack of coordinated activity among NGOs and other development partners limits the coherence of activity across all sectors.

The Haitian government needs to implement decentralized local governance to manage vulnerability at the municipal and rural community level. Donor assistance should include support for local municipalities, communal section councils, and grassroots organizations working to diminish watershed vulnerability to erosion and flooding. Assistance to local governments should include support for the creation and implementation of policies including improved building codes, the design of storm drainage systems, zoning of high risk flood zones, and partnerships to maintain rural services, including disaster preparedness and risk management.

National inter-ministerial agreement about land-use planning can also help reduce vulnerability. Donors should assist the government in creating a consistent policy agenda that reflects the consensus and buy-in of the relevant ministries, including support for the National Observatory of the Environment and Vulnerability. This assistance should include support for government initiatives to establish national watershed management guidelines and identify strategic watersheds to target for long-term interventions to diminish flooding vulnerability. Inter-donor and inter-agency collaboration is necessary, both at the policy and field operations levels.

INCREASING RESILIENCE IN ENERGY USE AND FORESTRY

Since there is little forest cover left, the question arises as to how Haiti will meet its energy requirements. In the short term, the solution is to move to cleaner technologies such as propane and kerosene. These are more costly than charcoal, and therefore less attractive, and also not readily available in rural Haiti, which continues to depend on wood energy.⁷⁹

For the longer term, plans are in place to create energy forests. Measures such as planting and cutting rotation, to maintain the forest stock, and planting trees that grow quickly, may prove advantageous.⁸⁰

Reforestation is important, and it is also important to build sensitivity and motivation among young people about planting trees.⁸¹ However, it is essential to recognize that Haitians cut trees to make charcoal and meet demand for building materials because these activities are one of the few ways for poor rural Haitians to earn income. The best way to encourage people to protect trees is to provide them with other livelihood options. Expanding Haiti's anaemic social protection system can help. In addition, the government should promote agroforestry based on fruit trees, which will help diversify agricultural production. Agroforestry projects should also focus on improvements to the quality and diversity of species planted.

Donors should help meet reforestation-related financial and technical needs. As one of the Least Developed Countries, Haiti would have preferential access to funds available for climate change mitigation and adaptation under the UN Framework Convention on Climate Change. For instance, it can leverage financing from the Adaptation Fund on the basis on building resilience against flooding through reforestation. The country can also access funds from the global Nationally Appropriate Mitigation Actions, REDD (Reduction of Environmental Degradation and Deforestation) and REDD+ programs to sequester carbon dioxide through reforestation. In

2009, Haiti and the Dominican Republic collaborated to obtain international climate change program funds. Despite this aid, Haiti is in sore need of resource persons with technical expertise and mechanisms to connect the government with donors and UN agencies via a cohesive strategy to mobilize funds for climate change resilience.⁸²

One way to support reforestation without tackling Haiti's difficult land tenure issues would be to prioritize other fundamental rural sector reforms, such as protected areas zoning.⁸³ As a report prepared for USAID in 2007 points out, development of a system of these areas would support the forestry sector, biodiversity, and resilience in the face of climate change. Current protected zones, such as Citadelle and Morne Salnave, have a strong emphasis on biodiversity conservation, and feature a large variety of fruit and forest trees and species of fauna and flora, together with national parks. Policies on protected areas should emphasize engagement of local people in the design and management of the zones.⁸⁴ The creation of protected areas could also create eco-tourism job opportunities.

The following ambitious and costly but achievable measures could enhance Haiti's resilience. The first step would involve removing sediment from the river beds, starting with the Artibonite River, and restoring the soil cover on the less steep (less than 20 per cent slopes) hills and mornes. This effort would include dredging sediment from the river beds using mechanical shovels and transporting it by truck and trailers up to the base of the hills and mornes as far as roads and trails permit. From there, the sediment would have to be transported manually, probably by buckets and shovels, and this would provide temporary local employment. But the soils have to be properly anchored so as they do not erode during the rainy season. Once anchored, they would offer planting beds for new trees. Additional temporary employment will be needed to progressively install soil conservation structures along the entire length of the slopes. These can be made with rock or soil, and include bench terraces, contour ditches, and rock walls of biodegradable hard plastic materials. However, soil will accumulate along contour ditches and terraces when it rains, and this accumulation can neutralize the benefit of the structures, and can even cause gullies to develop, unless there are efforts to get rid of the excess soil. Removing the build-up offers a good source of employment for women.⁸⁵

After the soil is properly anchored and trees are planted, the young trees will need adequate soil moisture levels at their roots to avoid desiccation and wilting. The construction of retention ponds at the base of the hills to collect runoff water during the wet season would provide an adequate water source. Using bucket irrigation or pumps and hoses, workers could apply water to the roots of the growing trees during the dry season. This likewise offers job opportunities for women.

Apart from the expected high cost, this ambitious project would have to jump additional hurdles. First is the question of fragmented land tenure, and private land owners who need to be convinced to plant trees. Of course the tree seedlings would have to be provided free of cost. On the hillsides, subsistence farmers plant leased land or sharecrop using terrace cultivation. Reforestation projects would deprive these producers of their livelihoods. A partial solution would be for the project to employ displaced farmers via cash-for-work and the creation of communal energy forests or cooperatives. If this is not feasible, the pilot project can take place on state lands. The state has to retake possession of deforested tracts and implement land management policies focused on reforestation, which it should develop via consultations with local residents and civil-society organizations. But the government lacks both the funds and the political will to implement these policies/recommendations.⁸⁶

Another major initiative would be to reduce charcoal demand and provide alternative energy sources that will protect against additional deforestation. Widely promoting energy-efficient cook stoves will lead to lower charcoal consumption.⁸⁷ Energy alternatives include bagasse and rice straw. In a previous effort to slow deforestation, the IDB financed a MARNDR pilot project to make briquettes from rice straw and husks. This project showed potential, but there has been little follow-up. Some development projects encourage the use of rice straw and bagasse as an energy source for distilleries, for example in St. Michel de l'Attalaye in the Artibonite department

highlands.⁸⁸ In addition, sweet sorghum can provide alcohol and compressed biomass for fuel, as well as food, feed, and syrup.⁸⁹

Another short-term option would be to promote and use biofuel crops, such as corn and sugarcane, for producing biodiesel and ethanol, and jatropha, rapeseed, coconut, and oil palm to produce plant oil. The jatropha plant, which is indigenous to Haiti and produces toxic, non-edible oil that has traditionally been used for medicinal purposes, has potential in this regard. These biofuel crops can be easily grown on marginal land and hillsides, and they would also contribute to reducing soil erosion. However, cultivation of biofuel crops does raise the issue of diverting land from food production or reforestation, as well as the use of some food crops for fuel, all of which may negatively affect food security. Therefore, the cultivation of biofuel crops requires careful regulation.

A more feasible long-term option would be the promotion and extensive use of renewable energy technologies, such as solar and wind, for which Haiti has a huge potential. Although the government does have plans along these lines, it has yet to take any significant concrete actions.⁹⁰

Finally, Haiti needs leadership and effective governance to promote and institutionalize reforestation and energy policy. In particular, the government needs to ensure the right balance between crop production for food and fuel, given Haiti's high levels of food insecurity.

TEN STEPS TOWARDS RESILIENCE IN AGRICULTURE AND FOOD SECURITY

Since most Haitians continue to rely on agriculture for their livelihoods, further development is essential, and specific practices can play an important role in achieving greater resilience to the effects of climate change. However, Haitian agriculture faces a host of serious problems, and policies and programs are needed to address these.

1. **Data collection must be strengthened, particularly at the local level.** Current data collection and dissemination methods are inadequate and antiquated. In order to strengthen agricultural resilience in the face of climate change, every community must have data agents who gather information on weather and agricultural prices and disseminate it to local farmers.
2. **Local civil society organizations should play a more prominent role in handling local land tenure and ownership issues.** These issues are major problems affecting agriculture and agroforestry. A large percentage of the land belongs to the state, but it has very little actual control over use and access rights. Land disputes, especially in the Artibonite Valley, are common. Absentee owners frequently fail to engage in forest and soil conservation measures, and theft of forest resources from their lands occurs frequently. Paying local civil society organizations to manage absentee owners' land and conserve the forest resources would address some of the issues involved with such land. Holdings of between 0.25 and 0.5 hectares per person are typical, in large part due to inheritance rules. Farmers often mortgage their land to other cultivators to raise cash in times of need, for example to pay school fees or funeral expenses. If the borrower fails to repay the loan, the lender keeps the land. In light of all these issues, there is an urgent need for collective consensus regarding land tenure and ownership.⁹¹
3. **Haiti needs new agricultural practices, including the use of new crop varieties suited to the changing climate, such as drought-resistant, short-cycle, and salt-tolerant varieties, as well as new cultivation methods.** Haitian agriculture has to confront a degraded environment that includes sloping land, deforestation, and rain-dependent, drought-prone farming at higher elevations on the mornes.⁹² Climate change also complicates the question of crop and seed storage, since greater variability in the level of humidity leads to significant losses. Soil fertility is an additional problem. Food security is not

only a question of land cultivation but also of protecting the natural resource base upon which agriculture depends. It is essential to shift agriculture away from steep slopes onto more intensively cultivated lowland plains and other sites less vulnerable to erosion. The government can provide farmers and traders with incentives to develop market links conducive to spontaneous adoption of sustainable natural resource management. Use of commercial fertilizer could address loss of fertility from erosion and crop rotation problems, but without subsidies, most Haitian farmers cannot afford it. Pest control is another problem: in 2004, hurricane winds brought diseases from Jamaica that wiped out the dasheen crop.⁹³ But farmers cannot afford synthetic pesticides either, and to complicate things even further, when they are used, if they are not used with care, they can pose risks to the environment and human and animal health. Due to the high cost of purchased inputs, a low external input approach to agricultural development makes sense in Haiti. This would rely primarily on biological pest control and organic fertilizers.

4. In the Artibonite Valley, which has some of the most fertile soils in Haiti, rice yields have increased in recent years as a result of farmers adopting new varieties and practices. The *Crete apibio* variety that was susceptible to disease was replaced in 1998 by the TCS10 variety from Taiwan, which produces higher yields (approximately six tons per hectare) and is disease tolerant. It now accounts for 60 per cent of the rice grown in the valley, and Artibonite rice farmers plant another 20 per cent of their fields to the improved Sheila variety. But valley producers face sharp competition from cheaper, subsidized US rice.⁹⁴ Rice produced in Haiti costs double the price of imports.⁹⁵ Finally, farmers cannot grow TCS10 in the badly drained or saline soils in the lower parts of the valley.⁹⁶
5. High production costs in the Artibonite Valley prevent farmers from using purchased inputs. According to a farmer to whom we spoke, it costs 35,000 gourdes per hectare just to prepare the land for planting. In light of these cost constraints and widespread rural poverty, local authorities and farmers need to work collaboratively on crop rotation and the use of crop varieties adapted to the changing environment.⁹⁷
6. Projects piloting the agro-ecological system of rice intensification (SRI), which requires less water and seed, and uses primarily organic fertilizer, have achieved promising results, with substantial yield gains.⁹⁸ Both USAID and Oxfam have separately worked with farmers on these projects, employing commonly used rice varieties such as TCS10 and Sheila. There is great potential to scale up SRI, provided that there is adequate public investment, donor support, and extension and training services for farmers.
7. **Haiti needs both to mechanize its agriculture and develop livelihood alternatives.**⁹⁹ But obstacles abound: smallholders cannot afford rice cultivation machinery; they find it difficult to obtain labour to till the fields; and there are few rural or urban job opportunities off the farm.¹⁰⁰ In addition, mechanization is not appropriate on the small parcels located on the steep slopes that many of the most vulnerable rural people cultivate. USAID's Feed the Future-West project has made tractors available to beneficiary farmers' organizations, in order to improve their yields and living conditions. These tractors, which cost USAID \$50,000 each, come with such needed accessories as a plough and harrow. However, preliminary findings from Oxfam research indicate that there are a number of problems, including requirements that the beneficiary organizations purchase additional expensive parts for the tractors.
8. **It is crucial to strengthen the agricultural distribution system.** For example, given the capacity constraints of Mesdames Saras and the current lack of processing enterprises, there is tremendous waste following the tomato and onion harvests. There is therefore a pressing need to develop food processing industries.¹⁰¹ Improved storage and processing and the strengthening of value chains will result in greater value added, new job opportunities (for both women and men), higher farm incomes, more investment in the agricultural sector, and more resilience among small-scale farmers.
9. **Smallholders in the Artibonite Valley urgently need better access to financial services such as credit and crop insurance (the latter is currently non-existent in Haiti).** These services should be equally available to both men and women farmers.

10. **Integrating river basin management is an important component in climate change resilience.** Integrated management will help substantially in overcoming both agronomic and socio-economic constraints. MARNDR believes that Haiti can boost agricultural productivity considerably; for instance, rice yields could readily double from the current level of 2.5 tonnes per hectare.
11. Cash-for-work resources should be used to rehabilitate irrigation and drainage systems. Constructing concrete-lined channels would allow more efficient movement of water, and considerably reduce the time needed to irrigate fields. Such channels are also easier to clean and maintain.¹⁰² If the funds and technical capacity are available, the use of pump, sprinkler, and centre-pivot irrigation systems that are more efficient and less time-consuming for farmers can be introduced.
12. **A system of payment for ecosystem services at the scale of watersheds will provide small-scale farmers with incentives to engage in reforestation and natural resource conservation.** Such payments could, for example, overcome the income constraints that farmers face in waiting for trees to mature, and help promote agroforestry.
13. **Programs to protect essential ecosystems will enhance resilience significantly.** For instance, programs that protect the ecosystems upon which fish depend, such as mangroves and coral reefs, will mean more resilient Haitian fisheries.
14. **Improved governance can pave the way to effective climate change adaptation.** Lack of political will, leadership, transparency, coordination, and consultation are major governance problems. Mayors from Artibonite Valley communes stressed the need for better leadership on addressing climate change. The national government can pass laws and enact policies that promote agriculture. Civil society and donors have important roles to play in both implementation and holding the state accountable.¹⁰³

7 CONCLUSION

This report has focused attention on climate change resilience in the areas of flooding, energy and deforestation, and agriculture, together with relevant adaptive capacity and governance issues. Lack of affordable energy alternatives has led to massive deforestation that has in turn caused flooding and crop losses.

However, the prospects for climate change resilience are now intricately tied to post-earthquake reconstruction. As Haiti turns its attention to preparing for more disasters and rebuilds significant portions of its infrastructure, there is a real opportunity to integrate climate resilience into these efforts.

But Haiti faces serious governance, capacity, and finance challenges. Resilience building requires information, capacity, and control at both the national and local level; at present, these are seriously lacking. Furthermore, finance priorities at the national and local level for building resilience are mainly short-term stopgap measures, such as cash-for-work projects, that are not sustainable. Capacity is weak because of a lack of sensitization to climate change, inadequate technical knowledge, and meagre finances. It is essential to disseminate information about climate change and variability and their impacts in order to press leaders to incorporate climate change resilience into development plans and policies.

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