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**CUMULATIVE IMPACT ASSESSMENT FOR REGIONAL DEVELOPMENT IN THE
CAP-HAÏTIEN TO OUANAMIN THE URBAN CORRIDOR**

FINAL DRAFT

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ACRONYMS

AIA	American Institute of Architects
ANAP	National Agency for Protected Areas
CBC	Caribbean Biological Corridor
CIA	Cumulative Impact Assessment
CIAT	Comité Interministériel d'Aménagement du Territoire
CNIGS	Centre National de L'Information Géo-Spatiale
CODEVI	Free Trade Zone in Ouanaminthe
DALYs	Disability-Adjusted Life Year
DINEPA	Direction Nationale de l'Eau Potable et de l'Assainissement
EEEEI	Enquete de Emploi et Economie Informelle
EDH	Électricité d'Haïti
EKAM	USAID-funded housing site in Caracol
EMMUS-IV	Enquete de Mortalite, Morbidite, et Utilisation des Services (2005-2006)
EPA	Environmental Protection Agency (U.S.)
GAFFSP	Global Agriculture and Food Security Program
FAO	UN Food and Agriculture Organization
FTFCN	Feed the Future for the Corridor of Northern Haiti
GEF	Global Environment Facility
GOH	Government of Haiti
IDB	Inter-American Development Bank
LICs	Low-Income Countries
LACs	Latin American Countries
MARNDR	Ministère de l'Agriculture, des Ressources Naturelles et du Développement Rural
MDE	Ministère de L'Environnement
MICT	Ministère de l'Intérieur et des Collectivités Territoriales
MPCE	Ministère de la Planification et de la Coopération Externe
MTPTC	Ministère des Travaux Publiques, Transports, Énergie et Communications
NATHAT	Analysis of Multiple Natural Hazards in Haiti Report
NGO	Non-governmental organization
PAE	Plans d'Aménagement et d'Extension
PAP	Port-au-Prince
PAR	Plan d'Aménagement Régional
PIC	Parc Industriel de Caracol
PMDN	Programme de Mitigation des Desastres Natureles
SAE-A	South Korean Textile Company
TOR	Terms of Reference
UE	Union Européenne
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNICEF	United Nations Children's Fund
URHC	Université Roi Henry Christophe
USAID	United States Agency for International Development
USG	U.S. Government
VES	Valued environmental systems
WHO	World Health Organization

EXECUTIVE SUMMARY

In an effort to strengthen northern Haiti as a development zone, the Government of Haiti, together with international agencies and donor countries, has made or will make significant investments along the northern coastline from the city of Cap-Haïtien to Ouanaminthe. As detailed in Part 1 of the report on the economic drivers of the region's growth (see Table 3), the most important – and potentially controversial – of these include the Parc Industriel de Caracol (PIC), a port, exploratory mines and 5,000 units of housing, as well as a new 10,000-student university, an upgraded highway, ongoing solid waste, water and sanitation master plans and investments, and regional agricultural programs. In trying to improve local incomes and well being, some major projects may nevertheless endanger the region's sensitive and unique ecological, historical and agricultural resources and undermine development gains.

Consequently, the GOH, IDB and USAID have asked the American Institute of Architects (AIA) to develop a Regional Management Plan (PAR) for the Cap-Haïtien to Ouanaminthe urban corridor and Local Growth Plans (PAEs) for eight towns along National Route 6 (not including Cap-Haïtien or Ouanaminthe) to help anticipate development needs and mitigate potential environmental and social impacts. As part of this planning process, the AIA has been asked to develop a cumulative environmental impact assessment (CIA) to examine the synergies and interactions of these impacts on the region expected from the economic growth. The goal of the CIA is to inform AIA's regional and local plans by identifying: cumulative impacts and interactions of existing and proposed developments, mitigation measures to control, reduce or avoid such impacts, and management strategies to guide future development in favor of sustainable outcomes.

To help assess future impacts, the CIA created two development scenarios, elaborated in Part 2 of the report. The baseline scenario envisions slowing rates of urbanization, with overall urban population rising by 55% to 599,000 in 2030 (64% of residents in metropolitan Cap-Haïtien and 13% in the towns closest to the PIC). The high-growth scenario projects elevated rates of urbanization, particularly in the small towns around the PIC with low existing populations. The high-growth scenario results in populations rising by 115% from 2009 levels, totaling 832,000 by 2030, or a 39% surge above the overall baseline condition and a 70% increase from the baseline population in the towns closest to the PIC. As these projections and the sectoral resource demand calculations are not exact, they can only serve to convey the order of magnitude of future impacts.

Future impacts presented by economic and population growth are evaluated in light of six major valued environmental systems (VES), presented in Part 3 of the report:

- | | |
|---|--|
| 1. Estuarine, Coastal and Marine Resources | 4. Air Quality |
| 2. Surface and Ground Water Resources | 5. Soils and Agriculturally Valuable Areas |
| 3. Highland Watersheds and Riparian Forests | 6. Culturally Valuable Areas |

The CIA examines the region's land use issues in Part 4, including the natural hazard risks, future land use demands and their spatial implications. Additional physical infrastructure needs to support demands for transport, water and energy and to manage waste stream creation in terms of air pollution, wastewater and solid waste are elaborated in Part 5. The cumulative impact assessment and proposed monitoring indicators are presented in Part 6, and management strategies are summarized in Part 7 of the report and in the Annexes.

Two comments should be made upfront. First, any assessment of development impacts must recognize that many of the region's natural resources are already degraded and that environmental management is almost entirely absent. Most of the 387,000 residents living in the corridor's towns and cities lack water, sanitation, wastewater treatment, affordable energy besides charcoal, and solid waste collection and disposal systems. As a result, they impose considerable pressures on the region's resource base. Present and historic settlements have led to the destruction of mangroves and native forests all along the coast; overfishing; surface water contamination; significant forest clearance that has left little remaining natural habitat; rivers clogged with solid and liquid waste; and litter conveyed by rivers and streams to estuaries and marine environments.

Second, demographic pressure on the region will lead to significant urban population growth. Even without the major investments such as the PIC and the port, the region's population will increase by 213,000 people by 2030, adding to existing unmet needs for environmental resources and management. Under any scenario – no growth, natural increase or high growth – immense investments in infrastructure, human resources and management and governance capacity are needed in the region to transform the current “vicious” cycle of poverty and environmental degradation into a cycle where human well-being and ecological sustainability are mutually reinforcing.

The following sections summarize the significant environmental concerns for the six major valued environmental systems (VES) due to continued urbanization in the Cap-Haïtien-Ouanaminthe corridor, together with proposed management strategies.

* * * * *

1. Estuarine, Coastal and Marine Resources

The PIC and surrounding urban communities will significantly elevate pollutant loading in the Baie of Caracol. In the past, the Baie of Caracol was relatively isolated due to the small size of upstream communities, which afforded the ecosystem some measure of protection. The proposed investments will make the Caracol-Trou du Nord-Limonade-Terrier Rouge region a new urban node on the corridor. By the end of Phase 1 (year 7) alone, the PIC is expected to generate 4,500 m³ of wastewater per day. In addition, even though the AIA plans will emphasize accommodating the influx of people to the region further upstream and away from the Baie's sensitive environment, the liquid and solid waste of Trou du Nord, Limonade, Terrier Rouge and EKAM will still eventually drain into the Baie of Caracol. Under the high-growth scenario, the upstream communities would generate an additional 2 million m³ of greywater, 6,000 m³ of sludge, and 24,000 tons of solid waste per year above the baseline scenario in 2030. Mining, after a decades-long hiatus, is under exploration again in the region, with the Majescor property between Terrier Rouge and Trou du Nord potentially leading to major impacts in the future.

Consequently, the role that the Caracol estuary and its connected rivers play as a refuge for the entire northern coastline could suffer increased environmental threats and become endangered. Degradation of the coastal environment would also threaten the livelihoods of coastal communities dependent on fishing and salt basin. Contamination of the salt would have wide-ranging health repercussions for the five departments where the salt is sold (Nord, Nord-Est, Nord-Ouest, Centre, Artibonite).

The IDB and USAID have repeatedly affirmed that they are committed to treating industrial wastewater to secondary levels. Experience has shown, however, that wastewater facilities in low-income countries are often poorly maintained over time. Furthermore, the decisions to date regarding the PIC's environmental issues, such as the lack of an environmental assessment prior to final site selection, the lack of precautions in elevating new factories above the flood line and late modifications to wastewater management, have detracted from the PIC's public image and its claims to meet environmental safeguards. Waste management and potential pollution of the Baie have become among the most important elements of the critique of the PIC.

Actions recommended: Significant efforts are being made to continue engagement with multiple stakeholders and to design a wastewater treatment system that offers layers of physical redundancies, including alternatives to discharging the final wastewater into the Trou du Nord River. Solid waste, water and sanitation master plans are being developed for towns in the region, and should be integrated rather than on a town-by-town and project by basis. Funding for the construction and operation of these systems, as well as development of human resources for their management and monitoring, should be prioritized for towns of the Baie de Caracol.

The larger coastal ecosystem could become ecologically degraded and fragmented. New investments all along the coast are beginning to enclose the coastline with industrial and traffic heavy land uses: the PIC will fully utilize the two roads that currently lead to the larger towns on the coast – Caracol and Jacquezy; an airport at Madras, should it be built, would utilize the third entrance to the Caracol marine park; and, a port, should it be built in the Baie de Fort Liberté, would require significant

dredging, coral reef cuts and shoreline reconfiguration and introduce heavy traffic of large cargo ships to this other major ecological and cultural tourism destination. The Baie of Cap-Haïtien is already highly polluted and impacted through industrial and port uses, an airport and dense urban settlements. This would leave the Baie of Limonade as the least urbanized and impacted coastal marine system, although its proximity to Cap-Haïtien suggests increasing development pressures. Taken together, these developments will have a large cumulative impact on the coastal environment, endangering ecological functions, fisheries and the livelihood of coastal villagers.

Actions recommended: Draft a regional plan of development that concentrates future development and public investments in and around urbanized areas, and avoid investments with significant negative impacts in the Parc de Trois Baies. Give preference to rehabilitating existing infrastructure such as ports and airports, and securing these from natural disasters before investing in new infrastructure elsewhere.

2. Surface and Ground Water Resources

Water quality will be a major concern for the region's surface and groundwater resources. Water reports done to date cite contradictory conclusions about the relative wealth and limitations of water resources in northern Haiti. Before the PIC begins to withdraw significant volumes of water, additional hydrological study may be needed to better understand the behavior of the aquifer in the Trou du Nord sub-watershed and how it relates to the broader Plaine du Nord aquifer. The proximity of the PIC to the coastline and its high rate of aquifer pumping pose a potential threat to saltwater intrusion. The impact of this would be long-term and initially most severely affect coastal communities that currently rely on well water.

The risks of groundwater contamination is greatest when the depth of the water table is less than 3 meters, groundwater recharge is greater than 25 cm/year, the topographic gradient is less than 2%, the aquifers consist of irregular limestone or fractured basalt, and the hydraulic conductivity is greater than 80 m³/day/m² – conditions that characterize much of the urban corridor. Urban latrines and “septic tanks” that sit in the water table are widespread and result in contamination. With DINEPA and other partners emphasizing water supply over sustainable sanitation, the region can expect that demand for water-flushed sanitation and untreated septage, sludge and greywater will increase. The continued contamination of surface and groundwater supplies, particularly given recent cholera epidemics in the region, is a danger to public health. Women and children who do their washing in the river, the poor who only have access to surface water, and communities dependent on informal shallow and unmonitored wells are most at risk. An increase in stormwater pollution levels due to proposed oil/energy/gas facilities, industrial sites and increased impermeable surfaces will also degrade water quality. Free roaming livestock and increasing agricultural inputs under the Global Agriculture and Food Security (GAFSP), the Feed the Future (FTFCN), and Programme de Mitigation des Desastres Naturels (PMDN) initiatives, could potentially also contribute to nonpoint source pollution. Deteriorating water quality affects fish and riparian species living in rivers, and ultimately, estuaries and marine environments and their productive assets to local communities.

Actions Recommended: The management strategies proposed in this report highlight the importance of long-term watershed management and monitoring programs, and of supporting integrated solid and liquid waste management – currently being studied separately through different master planning processes. Additional study of groundwater resources is needed, focusing in particular on saline intrusion. One of DINEPA's roles is to create and manage a data observatory, which would be extremely useful to monitoring and managing the region's water resources. Regional plan implementers should engage agricultural programs and the MTPTC to expand riparian habitat and roadway filtration buffers to minimize surface water pollution.

The corridor is located in a high-risk zone that is vulnerable to multiple natural hazards, especially flooding. According to the Analysis of Multiple Natural Hazards in Haiti project (NATHAT) assessment of natural hazards in Haiti, the entire corridor has a medium-level earthquake risk. Coastal areas are at medium to high risk of flooding, tsunamis, storm surges and liquefaction, and mountainous areas face medium to high risks of landslides. Flooding will be the most frequent natural hazard experienced by the

corridor's urban centers. Climate change could lead to more intense storms and storm surges, and will certainly raise the sea level with dramatic impacts on marine resources and human settlements. Increasing impermeability, insufficient drainage, poor grading, drain clogging will further exacerbate localized flooding. The tendency as cities expand will be for the poorest households to locate on the least desirable and most risk-prone areas, such as slopes, ravines and low-lying areas, as demonstrated in Cap-Haïtien. As the past rainy season has demonstrated, PIC, EKAM and University can be inundated even by minor storms. Cap-Haïtien and Petite Anse, with their concentration of people in flood zones and multi-story buildings that are almost certainly not built to code, are at the highest risk. Natural disasters in these areas could lead to significant displacement, and a surge in urbanization in surrounding towns in the corridor.

Actions Recommended: Conducting detailed topographical and drainage studies to establish flood maps for each of the urban centers in the area is a high priority. Future infrastructure, economic investments and housing should be located outside of the areas of highest flood risk. At a minimum, all public institutions should be built to withstand earthquakes and 100-year floods, and be designed to serve as centers of refuge and disaster relief in times of crisis. Major businesses, private investments receiving public subsidies, and donor-funded projects should meet new earthquake-proof building codes and flood avoidance standards. Additional study is needed to develop an integrated regional flood, drainage, irrigation, storage and aquaculture system that diverts, slows and absorbs floodwater and wastewater away from cities and sensitive habitats.

3. Highland Watersheds and Riparian Areas

Mining activities and increased removal of construction materials such as sand, rocks and wood from rivers and estuaries will damage the region's hydrology, exacerbate erosion and worsen water quality. With 127,000 to 177,000 new urban households expected in the corridor by 2030, the region will have a high demand for construction materials. Current practices of streambed excavation and mining for materials in ravines and beaches will likely expand and further damage in-stream habitat and watersheds' hydrological function. Major exploration efforts underway in the urban corridor, particularly if they result in full-scale mining extraction, pose a major potential concern to topsoil removal, erosion and water quality.

Actions Recommended: Local authorities, using a combination of enforcement and infrastructure investments that incentivize development in safer areas, should aim to restrict construction within 16 meters of waterways and in areas with slopes greater than 50%. Significant human and financial resources should be allocated at the national level to the Bureau of Mines and Energy under the Ministry of Transportation, Public Works and Communication to allow this entity to conduct local permitting, regulation and monitoring of extraction activities. Under the new national and regional agricultural programs (GAFSP, FTFCN and PMDN), efforts to stabilize river and stream banks – particularly those leading to the Baie de Caracol – should be prioritized.

An estimated 65-130% increase in charcoal consumption by 2030 would exert significant additional pressure on existing wood resources. Given that households using charcoal consume five times as much wood as those using wood fuel, the migration of rural households to urban settings will elevate the amount of wood needed to energize the region. Wood products for construction will add to this demand. Although charcoal and wood production in the region is currently not resulting in deforestation, with the possible exception of the mangroves, increasing per capita resource demands and growing urban populations will challenge the region's current levels of wood harvesting. In mountainous areas, excessive wood harvesting would worsen erosion and contribute to downstream flooding.

Actions Recommended: It is important to consider planning for this corridor in a broader watershed context, both ecologically and economically. The coastal plain is closely linked to the ecology of the larger watershed, with forest cover, silvicultural practices, agricultural activities, charcoal and wood production, and human settlements having a significant impact on erosion and flooding, water quality, aquatic systems, and energy and food costs downstream. To counter the pressures identified above, it will be critical to establish a sustainable land management program,

in particularly for the Trou du Nord sub-watershed, and work with the regional agricultural programs to promote sustainable tree and woody plant harvesting regimes. Alternative energy systems such as more efficient cook stoves, LPG, kerosene, ethanol and jatropha oil should also be aggressively promoted.

4. Air Quality

Air quality will deteriorate due to increased urban charcoal consumption, the generation of 40-54,000 pounds of air pollutants per day from burning solid waste, and high levels of vehicular exhaust. Air quality concerns would be most severe around Cap-Haïtien, but also in Ouanaminthe, around the PIC, and possibly near EDH and private power plants. At full-occupancy, the air around the PIC could be affected by some 800 tap-tap trips per day at each of two entrances, as well as cargo vehicles and emissions from the heavy fuel oil power plant. Women, who work most with charcoal for cooking, laundries and bakeries, and children would be most vulnerable to exposure to particular matter and other pollutants. Should mining extraction proceed, ore processing could lead to the release of heavy metals to the air. Over time, the mix of point sources and fugitive emissions from traffic, cooking and so forth, will likely cause air pollution to exceed WHO air quality standards for urban areas.

Actions Recommended: The spatial implications of these impacts suggest the need to design roads and transport networks to promote a high share of walking and biking to the various new employment centers; heavily invest in solid waste collection systems for recyclable and inorganic materials; and expand alternative cook stove programs, currently piloted in Port-au-Prince, throughout the northern corridor. USAID and IDB may need to conduct additional studies of air quality in the PIC area and “airshed” together with anticipated elevations of commuter traffic and domestic and other emissions sources to determine a regional approach to air quality management. If needed, the PIC may need to mitigate residual air quality impacts through standard pollution control methods, for instance by raising the stack height of process facilities discharging significant contributions of pollutants. Similarly, EDH will also need to consider cumulative impacts on air quality when designing their new facilities.

5. Soils and Agriculturally Valuable Areas

Urbanization in the region could result in the loss of some 750 to 2,660 hectares of prime agricultural land over the next 20 years. In a baseline population scenario, the corridor would consume 750 to 1,200 hectares of additional land; in the high growth scenario, this would rise to 1,600 to 2,600 hectares of additional land. The tendency to place major public investments on publicly owned lands, much of which has high quality alluvial soil, has accelerated this trend. More land will be lost to urbanization around Cap-Haïtien and the Trou-du-Nord/Caracol/Limonade Triangle than around more arid zones in the corridor. This has major implications for local food security. Furthermore, despite some compensation, the process of displacing rural farmers and ranchers could worsen rural poverty. As urbanization expands, increasing conflicts will take place due to the lack of clarity over land ownership.

Actions Recommended: Property mapping in towns and land surveys to clarify public and private ownership of land is a very high priority, and should be undertaken as soon as possible before land prices escalate even further. Proposed strategies to address the loss of agricultural land include concentrating future developments near existing urban centers in order to minimize land fragmentation, selecting sites with lower quality soils to the extent possible. Principles of smart growth should be applied in designing and building residential, commercial and industrial projects that create more vibrant urban environments and consume less land. Rural roads should be maintained, and projects should provide targeted investments in refrigeration and storage facilities in rural and urban centers to increase market access. USAID is undertaking a social assessment and resettlement plan for those displaced by the PIC.

To date, there appears to have been little dialogue between rural and urban development agencies. As a number of these impacts make clear, there is a strong relationship between urbanization and impacts on rural livelihoods. There is an opportunity to more clearly link the

major agricultural programs, which are embarking on their next cycle of investments, with the impacts cited in this report.

Dispersed investments are planting the seeds for extensive urbanization patterns that will raise infrastructure costs and reduce service quality. The PIC, EKAM, university, port, other housing projects have been sited far from existing sources of labor and infrastructure. The need to provide physical and social infrastructure at each of these sites, not least to reduce their environmental impact, will come at a cost to investing in existing communities that have long waited for public investments.

Actions Recommended: Future assessments for siting investments should consider both environmental and fiscal impacts. Though challenging, efforts should be made to apply strategies such as land swaps, development right transfers, creative zoning and public private partnerships to make land available in the appropriate areas.

The region's total waste generation could rise by 3.8- to 5.4-fold by 2030, totaling 1 to 1.4 million tons per year. In addition, there could be some 90-95,000 m³ per year of combined domestic and industrial sludge. Currently, 50-58% of waste ends up in nature, 25% on vacant land in informal dumps, and the remainder is burned or landfilled. If these practices continue, drainage systems, riverways, mangroves, and marine habitats throughout the Caribbean will be significantly endangered. In particular, the towns closest to the PIC could see an increase of 64 tons of solid waste per day above the baseline condition – or a total of 156 tons of municipal waste per day.

Actions Recommended: Solid waste management plans are ongoing for the region. These will likely propose efforts to compost organic waste, promote recycling, which is a growing business in the region, and build disposal facilities. The AIA's town plans should designate sites for solid waste transfer and disposal, and identify current open dumps that should be cleared. Solid waste management should be integrated with sludge and septage management. Shared services and facilities between small towns will likely help reduce costs and management and staff requirements.

6. Culturally Valuable Areas

New development pressures pose a threat and an opportunity for the region's built cultural heritage. The location of the PIC and the port – if located at the Baie de Fort Liberté – would endanger the two most significant sites of natural (Baie de Caracol) and cultural (town and fort of Fort Liberté) heritage in the corridor. In addition, the tendency for development to spread along either side of the RN6 highway and the roads leading from the RN6 to the coast will visually impair the region's landscapes. Within cities such as Fort Liberté, Limonade and Quartier Morin, development pressure could result in the demolition of neglected and deteriorating historic residential buildings. All of these forces would dampen the region's tourism potential and the strongest economic rationale for heritage preservation.

Actions Recommended: A multi-sectoral preservation strategy is proposed to address the visual, cultural, natural and built heritage of the region, including the implementation of the tourism master plan, applying existing measures of protection and promoting historic core rehabilitation in new town plans.

A matrix of cumulative impacts on the environmental systems is shown in Table 33 of the report. It demonstrates that the interactions of the environmental impacts are most intense for surface water quality, air quality, valuable agricultural land, and the visual beauty of the region's landscape. Coastal estuaries, mangroves, and marine life will also be acutely affected, and large populations and economic infrastructure are likely to be vulnerable to flooding. Growing populations and urban demands for resources, the PIC, and mining activities (if fully exploited), and a port at Fort Liberté would impose some of the most intense and wide-ranging impacts.

With all the present and future impacts layered across space and time, the cumulative assessment paints a grim picture of the region's environmental outlook. The challenges are particularly daunting in light of the limited human, financial and governance resources to address them. At the same time, the

assessment also highlights a number of opportunities where investments can have a positive impact on communities and natural ecosystems across different sectors. With a number of major investments still under consideration, it is timely to consider adjustments in investments decisions and management strategies.

It is critical to build the capacity of cities and rural settlements to accommodate current and future residents. This requires a strategy to leverage existing institutional structures and legal frameworks, strengthen local municipal governance, and foster new regional planning and management capacity. At the local level, the legal framework for *communes* (municipalities) provides them with the authority to promulgate and implement local development plans, including zoning requirements for construction, land use and flood control. Urban plans can be issued by municipal *arrêté* (city ordinance), thereby endowing local development and zoning plans with the force of law. *Communes* also have the authority to establish inter-communal agreements, which could serve as a legal framework for regional planning. Despite critical weaknesses and deep dependence on the central government, the *commune* is the most feasible point of entry for on-the-ground implementation of local and regional plans.

Strengthening *commune* capacity to provide basic infrastructure, enforce growth management, augment local revenue streams and conduct public education campaigns about the new regional and local plans requires additional support from key central agencies. This includes training, funding devolution, and technical support. The Ministry of Interior could augment FGDCT funding to local *communes*, and appoint more departmental and engineers and planners to the *Agences Techniques Départementales* and provide them with the resources to do their job. There is also an opportunity to devolve responsibility to departmental directors of the *services techniques déconcentrés*. Conducting a local property census, strengthening tax collection, mapping state and private lands, mapping town and *commune* boundaries and strengthening tax collection, and increasing and training a cadre of staff to manage updated information systems are key first steps to building local financial stability.

Beyond local plan implementation and urbanization management, this CIA points to a number of broader regional or shared infrastructure needs and management of short and long-term environmental impacts. These challenges require the technical study, planning, implementation, funding, and monitoring and evaluation of regional authorities. This could take the shape of central authorities, inter-departmental entities, or new planning offices. This CIA recommends the creation of a new regional planning office under the auspices of CIAT to promote and accompany the implementation of the regional and municipal plans, and to monitor and evaluate development progress and the health of the natural environment. There is a clear need to harmonize, coordinate and augment investment funding and international projects in the region to help address the challenges cited in this CIA. The regional planning office could play a key role in coordinating donor aid, developing a pool of potential priority projects for donor consideration, and more directly linking local development needs with international funds. For instance, it could supervise a small grants and technical assistance program that would begin to fund and incentivize local development priorities. These investment decisions will be more effective than relying primarily on coercive enforcement measures to achieve development that conforms to regional and local plans.

The management strategies and structures proposed here, which are further detailed in Part 7 (see Table 35) of the report, will be discussed in a September workshop that includes mayors, chambers of commerce, providers of *services techniques déconcentrés*, departmental *délégations*, the Université de Roi Henri Christophe, ministry representatives, in particular those from the MICT and its *Agences Techniques Départementales*, MPCE, MOF and CIAT, and donor organizations. A dialogue among these diverse stakeholders will help shape a strong and feasible strategy for strengthening local governance and protecting the region's natural resources for future generations. Following this discussion, the final management strategies will be included in the AIA's regional and local master plans.

I. GOALS AND OBJECTIVES

The American Institute of Architects (AIA) has been contracted to develop a Plan d'Aménagement Régional (PAR) and Plans d'Aménagement et d'Extension (PAEs) of the corridor from Cap-Haïtien to Ouanaminthe in northern Haiti. The goal of the PAR and PAEs is to create regional and local spatial development frameworks for the urban corridor along the National Route 6, an area that is receiving a significant number of major investments. As part of this planning process, the AIA has been charged with developing a cumulative impact assessment (CIA). These assessments expand beyond project-specific environmental impact assessments to examine the synergies and cumulative impacts of discrete incremental changes.

In many ways, the components of a CIA overlap with those needed for planning purposes, which require a similar understanding of economic development, population dynamics, demand for services and governance capacity. To effectively use limited team staff and time, the AIA has nested the regional planning diagnostic and embedded it into a CIA analytical framework.

Given data limitations as well as the ultimate focus of this project on creating a spatial planning framework, much of the CIA is qualitative. However, in an effort to move beyond past environmental assessments that have already discussed at length impacts from a qualitative perspective, this CIA attempts to quantify, where possible, the future demand for basic infrastructure, pollution loads and their impacts. Given significant uncertainties about future investment decisions and the lack of recent, disaggregated data, these estimates only serve to convey the order of magnitude of future impacts on the following valued environmental systems (VES):

- | | |
|---|--|
| 1. Estuarine, Coastal and Marine Systems | 4. Air Quality |
| 2. Surface and Ground Water Resources | 5. Soils and Agriculturally Valuable Areas |
| 3. Highland Watersheds and Riparian Forests | 6. Culturally Valuable Areas |

The ultimate goal of the CIA is to advise the PAR and PAE in terms of where to place growth, how much land to allocate, what kinds of land uses to plan for, the levels of infrastructure needed to serve existing and future populations, and the management and governance considerations of implementing such plans.

II. SCOPE

The PAR takes as its limits of study the east-west regional corridor spanning 60 kilometers between the cities of Cap-Haïtien and Ouanaminthe within the Departments of Le Nord and Nord-Est. This is primarily an urban analysis that seeks as an end result an urban growth management plan for the regional corridor as well as each of the eight towns and cities on the corridor: Quartier Morin and Limonade in Le Nord, and Sainte Suzanne, Caracol, Trou du Nord, Terrier Rouge, Fort Liberté and Ferrier in Le Nord-Est. Although Cap-Haïtien and Ouanaminthe are considered within the regional planning context, the AIA has not been tasked with developing master plans for these cities. The CIA includes them in the analysis of impacts on the VES, but focuses primarily on the towns along the corridor.

Priority is placed on understanding the spatial implications of efforts to mitigate impacts on valued ecosystems. Likewise, the identified management strategies emphasize those with impacts on regional territorial management, and do not attempt to summarize or reiterate much more comprehensive management plans that already exist or are under development.

A major limitation of this study is that it is limited to environmental impacts; it is expected that social impacts and calculations for service demands will be addressed through the AIA's local urban plans.

Much of the information critical to accurate planning and environmental assessments is missing or out of date, including population and income data, and property and topographical maps. Several important ongoing studies will be completed after the present regional planning exercise, including: DINEPA water and sanitation master plans for most of the cities along the corridor; IDB solid waste management plans

for the region; earthquake risk mapping for the region; and a master plan for Cap-Haïtien. The regional corridor plans will likely need to be updated following their completion.

Figure 1 General Extent of Urban Corridor of Study



III. PROCESS AND METHODOLOGY

This assessment process draws on information from existing reports and literature and stakeholder consultations in communities and among government agencies. The departments of Le Nord and Nord-Est, Cap-Haïtien, Ouanaminthe, Fort Liberté, Caracol and other *communes* and communal sections have witnessed numerous planning initiatives in the past decade. Despite significant changes in Haiti in the last several years, particularly in the aftermath of the earthquake, many of the plans, priorities and strategies, which often drew upon public inputs, still stand. The CIA reviews these reports and synthesizes their findings and proposals to develop a baseline assessment of the present situation. A list of referenced documents is listed in the bibliography.

The team also conducted a series of site visits, discussions with the mayoral and local leadership, and focus group discussions with community members on priority development needs and concerns. These consultations took place from December 13, 2011, to March 4, 2012, in Quartier Morin, Limonade, Caracol, Trou du Nord, Ste. Suzanne, Terrier Rouge, Fort Liberté, Derac, Acul Samedi and Ferrier. In Cap-Haïtien and Ouanaminthe, the consultations included meetings with municipal leaders. In addition, the team consulted a number of departmental and national public agencies, private associations, donor groups, church groups and nongovernmental organizations.

The cumulative environmental assessment incorporates these streams of data into the following analytical methodology:

- Assessing drivers of regional growth and compiling a list of major initiatives in the region;
- Projecting two future development scenarios with a time horizon to 2030: a baseline scenario that assumes anticipated investments do not take place and that urban population growth gradually declines; and a high growth future in which planned investments do take place, attracting large inflows of migrants;

- Understanding the main Valued Environmental Systems (VES) and creating maps of areas to protect for their high natural, agricultural and cultural value as well as areas that are important to avoid due to high natural hazard risks;
- Determining future land consumption needs based on an evaluation of the major economic development drivers in the region, population projections and existing patterns of land use and development density;
- Assessing the need for various physical infrastructure services and their impacts on the VES;
- Assessing cumulative environmental impacts by VES, and making recommendations on management strategies and governance structures for inclusion and development in the regional and local master plans.

PART 1: PERSPECTIVES DE DEVELOPPEMENT ÉCONOMIQUE DU NORD, UNE REGION A LA VEILLE DE GRANDES MUTATIONS ÉCONOMIQUES

1.1 Contexte

Le Nord constitue l'un des quatre pôles de croissance retenus par le gouvernement haïtien dans sa stratégie de développement économique (DSNCRP). Comme conçus par les autorités, ces grands espaces d'investissements, de par leurs effets d'entraînement, constitueront des engins de croissance pour le reste de l'économie. Dans cette perspective, quatre grands projets, à des phases différenciées de mise en œuvre, auront des implications certaines sur la production des biens et services, la circulation des marchandises, et le financement des entreprises dans la région du nord. Il s'agit du Parc Industriel de Caracol (Département d'état Américain, BID, la firme coréenne SEA, et le gouvernement Haïtien), de l'Université Roi Henri Christophe à Limonade (RD), du projet Tourisme de la BID, et du projet Couloir Economique du Nord (FTFCN) de l'USAID. Les décideurs politiques haïtiens, et les institutions de financement internationales, engagés de manière concertée dans ces initiatives, anticipent déjà des mouvements de populations, de nouvelles formes d'occupation des sols, et l'émergence de nouvelles entreprises industrielles et commerciales, qui redéfiniront l'espace compris entre Cap-Haïtien et Ouanaminthe, identifié depuis tantôt comme « **Le Couloir Économique du Nord** » (see Table 3 for a list of projects in the region).

Cette mise en place, pour être effective, en termes d'opportunités économiques et de création d'emplois, doit être supportée par des infrastructures appropriées:

- Port qui puisse répondre aux besoins des transactions internationales du PIC et des nouvelles entreprises de la région;
- Aéroport qui facilitera les relations du nord avec le reste du monde. Important pour la diaspora, les touristes étrangers et pour les croisiéristes en cas d'évacuation;
- Routes pour une meilleure circulation des marchandises et des biens;
- Transport public qui permette le déplacement décent de la population, des travailleurs et des étudiants en particulier;
- Électricité pour faciliter le développement des entreprises, et améliorer les conditions de vie;
- Infrastructures d'Irrigation pour augmenter la productivité du secteur agricole.

Dans ce cadre-là, il est prévu dans le plan du gouvernement, des investissements en infrastructure de l'ordre de 1,8 milliards de dollars pour les cinq prochaines années pour supporter les secteurs agricoles, de l'habillement et du textile; des interventions qui laissent anticiper la création de plus de 120,000 emplois.

Cette section du plan régional étaye les perspectives de développement économique au niveau des secteurs industriel, agricole, touristique, et commercial, en rapport avec la mise en route de ces grands projets, et définit les mécanismes institutionnels qui puissent soutenir cette transformation de l'économie. Le gouvernement haïtien, les institutions internationales impliquées dans le processus (BID/USAID/BM/UE), au travers des mécanismes d'accompagnement du secteur privé, tels, la formation professionnelle, l'incubation d'entreprises et leur financement, anticipent une croissance de l'économie qui déplacera à terme, de manière significative, les frontières de possibilités de production.

La projection, dans ce texte, est amorcée en prenant comme point de départ la situation actuelle de la grappe de communes se situant dans l'aire d'influence immédiate d'implantation de ces grands projets – Quartier Morin, Limonade, Caracol, Trou du Nord, Terrier Rouge, Fort Liberté et Ferrier, avec un clin d'œil sur Sainte Suzanne située dans le bassin versant surplombant les plaines de Limonade et de Trou du Nord. Cette section synthétise les activités économiques les mieux appropriées à la valorisation des ressources au niveau de chaque commune en regard de leurs potentialités; et de fait, *priorise une*

exploitation des potentialités en rapport au caractère identitaire de chaque commune. Il aboutit sur la projection des taux d'activités régionaux, des projections relatives au marché du travail, et les mouvements de populations qui découlent nécessairement de cette mouvance et souligne l'ensemble des mesures budgétaires, fiscales et monétaires permettant d'asseoir sur une base durable ces transformations anticipées.

1.2 Situation Actuelle de la Région

La région du nord se caractérise actuellement par un secteur agricole à très faible productivité liée aux contraintes de financement, d'encadrement technique, de carence en outillage moderne, et d'intrants améliorés. De fait, au niveau national, de 37% du PIB en 1990, la contribution de l'agriculture au PIB réel a chuté à 28 - 32% en 2008 (FAO, 2008). Il absorbe néanmoins près de 60% de la main d'œuvre active dans la région nord. Cet état de fait se manifeste en un revenu per capita extrêmement faible par rapport au reste du monde. En effet, Haïti accuse un revenu per capita de 1,156 dollars/an, tandis que les pays de l'Amérique Latine et des Caraïbes se situent au niveau de 10,077 dollars/an et le reste du monde à 9,972 dollars/an (OIT, 2010). Le revenu d'Haïti représente un dixième du revenu des pays de l'Amérique Latine comme le souligne l'OIT. Il en ressort une base taxable très faible et par voie de conséquence, des revenus insuffisants au niveau de la gouvernance locale pour faire aux exigences de service de la population.

Table 1 Département du Nord-Est Budget Consolidé 2009-2010

	Ouanaminthe	Trou du Nord	Fort Liberté
Recettes Fiscales	797,240	516,180	1,401,545
Recettes Non fiscales	426,770	25,500	60,583
Recettes ordinaires	8,084,010	9,621,680	9,022,128
Dons	3,550,000	490,125	4,078,217
Subventions	9,375,500	6,950,000	13,450,000
Total des ressources	21,009,510	17, 061, 805	26,550,345

Importations. La faible productivité agricole se traduit par des importations importantes de la République Dominicaine et du reste du monde, pour combler le déficit en produits alimentaires de base. Un rapport de 2008 du groupe Ginsa situe les importations à 250 containers de 40 pieds le mois en provenance de la RD, à 1250 containers le mois, en provenance de Port-au-Prince, et à 250 containers le mois, les importations qui arrivent au port du Cap-Haïtien (GINSAs, 2008). Les informations recueillies lors des visites de terrain auprès des douaniers et commerçants de Ouanaminthe ont permis de réaliser que ces données ont grandement évolué au cours de ces 5 dernières années. Avec l'augmentation du pouvoir d'achat des consommateurs dans la région que charrie le développement du Pole de croissance, la pression sur l'offre agricole sera plus importante et le trafic des containers provenant du reste du monde plus intense.

Secteur Agro-Industriel. L'espace défini comme le couloir économique du nord ne comprend actuellement que quelques entreprises industrielles.

- **Habitations Sucrière et Distilleries.** L'usine Welsh, dans le temps, absorbait la plus grande partie de la production de canne à sucre de la région Nord. Avec sa disparition, l'usine Nazon, les sucreries et petites distilleries du département constituent la principale clientèle de ces plantations. Les petites unités, pour la plupart artisanales, produisent du sirop et le « clairin »¹. D'autres unités s'adonnent à la production du « RAPADOU », un produit qui remplace bien souvent le sucre dans la consommation au quotidien de la paysannerie (Jean, 2008). Lors de la préparation du document suscité, l'usine Nazon, la plus grande distillerie du département, et plus moderne par rapport aux installations de la région, produisait 2,500 gallons le jour, une seule entreprise de taille moyenne subsistait avec une capacité de 300 gallons/jours, et les autres plus petites, 100 gallons/jour. Le prix du gallon était lors de 35 gourdes. Actuellement le prix du gallon

1 Clairin : boisson alcoolisée dérivée de la canne à sucre.

est de 75 gourdes. Cependant, mis à part les installations modernes de Nazon, pour les plus petites entreprises avec une machinerie artisanale, les coûts de production sont estimés entre 50% et de 65% du prix de revient. Les rencontres avec les propriétaires de ces petites entreprises artisanales ont permis de bien établir les conditions de production et les interventions nécessaires à des stratégies de croissance qui pourraient certes apporter des améliorations à la qualité aussi bien qu'au volume de production.

- **Autres unités de transformation: Cassaveries.** Les cassaveries se retrouvent dans les zones bananières où le manioc est cultivé en association avec d'autres cultures. Plusieurs unités de production sont rencontrées à Quartier Morin et à Limonade. Plusieurs variétés de cassaves sont disponibles. Elles constituent souvent des spécialités qui se vendent très bien sur les marchés du Cap-Haïtien. Toutefois, une amélioration des conditions de production et de marketing pourrait permettre d'élargir le marché, avec des produits standardisés et une présentation plus hygiénique. La route nationale #6 permet l'écoulement de ces produits en République Dominicaine. C'est un espace de grands consommateurs de produits dérivés du manioc.
- **Autres unités de transformation de manioc, de Banane, et de maïs en farine.** Les farines de manioc, de banane et de maïs (qui sont très utilisées particulièrement dans la préparation de bouillie pour bébé), et constituent des apports calorifiques et en protéine d'importance dans leur nutrition. Une ou deux unités de transformation artisanale ont été repérées au niveau de Ferrier et de Trou du Nord.
- **Cointreau:** Une très grande ferme d'orangers amères essentiellement utilisés pour la production d'essence exportée vers l'Europe pour les maisons Grand Marnier et Cointreau. Cointreau détient aussi bien une grande plantation d'orangers à Limonade. Pour les deux opérations, seul le zeste de l'orange est retenu. La pulpe est utilisée dans la production de fumier et le jus jeté. Parfois des habitants de la zone viennent se procurer du jus pour leur consommation et la production artisanale de vinaigre. Toutefois, cette quantité importante de jus généré par cette plantation, pourrait facilement être utilisée de manière industrielle pour la mise en boîte de jus ou de vinaigre qui pourrait desservir le marché national.

Le Marché. Somme toute, un marché de 1,328,772 consommateurs (970,495 pour Le Nord et 358,277 pour Le Nord-Est), desservi dans sa grande majorité par les entreprises agricoles et industrielles dominicaines (IHSI, 2009b). De fait, la stratégie d'affaires des entrepreneurs de la plaine du CIBAO est en grande partie élaborée en fonction de l'évolution de la demande haïtienne. Que ce soit pour la consommation de poulets de chair, d'œufs, de certaines légumineuses, et de produits agroindustriels comme la patte tomate, et spaghetti, les marchés haïtiens regorgent de produits en provenance de cette plaine. Déjà en regard des anticipations du pôle de croissance Nord, les entreprises dominicaines se positionnent. Elles sont très présentes dans la construction². Les visites de prospection en provenance de cette zone sont nombreuses, et les propositions de venture plus fréquentes. Dans cette perspective, le marché transfrontalier et les infrastructures pour l'accueillir doivent être analysés en regard de cette nouvelle dynamique.

Par rapport aux transactions observées entre les deux pays, ces recettes ne reflètent que partiellement le volume réel transigé. Des efforts au niveau de la gouvernance permettront une gestion mieux appropriée de ces entités.

2 La Firme Estrella au PIC, et en assure actuellement la construction des infrastructures de base.

Table 2 Recettes Douanières 2010-2011 en Gds

	Droits de douane	Frais de vérification	Vente de formule	Amendes et pen. à l'impôt
Oct	4,473,614	4,572,912	5,650	446,145
Nov	4,096,859	3,706,343	7,500	110,415
Dec	5,911,619	4,255,204	8,250	202,728
Janv	6,292,503	5,323,681	7,700	202,848
Fev	3,795,776	4,289,152	10,250	820,998
Mars	4,183,873	4,344,646	7,650	428,857
Avril	5,305,551	6,280,464	6,350	256,091
Mai	8,419,575	7,470,385	8,750	414,314
Juin	5,737,917	4,853,066	5,000	325,216
Juillet	7,647,770	5,898,816	5,250	304,536
Aout	5,410,513	4,778,213	6,150	408,744
Sep	7,581,361	4,810,029	2,500	408,744
Total	68,856,931	60,582,912	81,000	4,076,466

Source : Ministère de l'Economie et des Finances, Administration Générale des Douanes

1.3 Les Grands Projets Déclencheurs du Nord et Leurs Effets Induits

La mutation économique envisagée dans la région du nord est perçue au travers de ces projets considérés comme des projets déclencheurs. De par leurs effets induits, ces projets favoriseront l'instauration d'un environnement propice à l'investissement au niveau de plusieurs secteurs d'activités. Par voie de conséquence, aux environs de 2020, le gouvernement haïtien et les institutions internationales impliquées dans leur réalisation, anticipent une augmentation de l'emploi d'importance et une migration vers cette grappe de communes autour desquelles se concentrent les activités les plus achalandées. The following list of major investments comprises the core impacts assessed in this study.

1.3.1 Secteur Industriel. Le Parc Industriel de Caracol (PIC), un investissement de 276 millions de dollars, supporté par la BID, le Département d'État Américain, avec comme premier client la firme coréenne SEA, est un projet déclencheur qui dans sa phase de démarrage mobilisera près de 8,000 employés, pour atteindre 42, 800 employés à maturation de l'ensemble du parc (KOIOS, 2011). The PIC requires supporting infrastructure, including potentially a new port, as well as new energy, solid waste, and wastewater facilities that have their own investment, employment and environmental impacts.

Considérations d'emplois directs : 42, 800 emplois

Considérations d'emplois indirects : 120, 000 emplois

1.3.2 Université Roi Henry Christophe. Estimée à 35 millions de dollars, cette université de 72 salles de classes, et autres espaces de laboratoires et de bibliothèques, devra être à même de recevoir dans le long terme près de 10,000 étudiants. Elle comble un déficit majeur dans l'enseignement supérieur au niveau de la région ; et par externalités, les profs qui seront affectés à cette université pourront assurer des cours de formation de maitre et peut-être eux-mêmes enseigner au niveau des autres institutions d'enseignement supérieur ou participer à des conférences au niveau du secondaire.

Considérations d'emplois directs : avec 25 étudiants par employé, $10,000/25 = 400$.

Considérations d'emplois indirects : $400 \times 2 = 800$ emplois indirects.

The mayors of Limonade, Trou du Nord and Sainte Suzanne have developed a pact to jointly promote research, development and education, centered on this university. Limonade and Trou du Nord have also proposed to build a reference hospital by the university, which would also serve Caracol and the region.

1.3.3 Nord comme destination touristique. Au travers du Plan Directeur Tourisme, le gouvernement haïtien considère le nord comme une destination touristique. C'est une manière de replacer Haïti sur la carte du tourisme mondial, et permettre au nord d'exploiter pleinement ces potentialités touristiques. La BID a déjà engagé une agence canadienne CECI pour la mise en place d'une Organisation Gestion Destination (OGD).³ Le coût de cette première phase est de 2,7 millions de dollars. La Banque Mondiale a alloué une enveloppe de 65 millions de dollars au développement du tourisme dans le nord.

Deux triangles sont pris en considération : Un plus petit qui comprend comme sommets les fortifications de Fort Liberté, Le Parc National Historique (PNH), et Labadie. Et un plus grand qui circonscrit le plus petit, conserve les sommets de Fort Liberté, du PNH et s'étend jusqu'au môle St Nicolas. Les patrimoines tangibles comme la Citadelle, le palais Sans Souci, et le plus grand village Taino du côté de Grande Saline à Limonade y résident, mais y tiennent lieu également des traditions de grande portée culturelle comme les fêtes champêtres de Limonade, de Bord de Mer de Limonade, et de Plaine du nord ; des manifestations qui réunissent des centaines de milliers de touristes religieux provenant des autres départements, de la diaspora et de la République Dominicaine.

1.3.4 Major Agricultural Initiatives. Durant les cinq prochaines années, il est prévu que des sommes conséquentes soient allouées au développement de la production agricole et à la protection de l'environnement dans les départements du Nord et du Nord-Est. On dénombre quatre projets d'envergure, totalisant plus de \$150.000.000, et qui toucheront différents domaines.

Le projet Global Agriculture and Food Security Program (GAFSP), financé par la banque Mondiale et la BID, cible prioritairement le corridor et dispose de montants de l'ordre de US\$90 million pour le renforcement des services de recherche, de vulgarisation et des appuis directs aux producteurs de la zone sous la forme de subventions à l'investissement. Le projet Feed the Future de l'USAID est d'un montant de US\$75 million. Il devra renforcer certaines filières vivrières et d'exportation, améliorer les revenus de 40.000 ménages agricoles dans le corridor, entreprendre des travaux d'amélioration des infrastructures (routes de desserte, irrigation) et appuyer les entrepreneurs agro-industriels. Le Programme de Mitigation des Désastres Naturels (PMDN) financé par la BID est en phase de démarrage de ses activités d'aménagement du bassin versant de la Grande Rivière du Nord dans lequel se trouve la commune de Sainte Suzanne. Le FIDA appuie le Provincial Performance Improvement Initiative (PPII), deuxième phase d'un programme de développement des petits périmètres irrigués dans le Nord-Est et envisage l'aménagement de périmètres plus importants dans le Bas Maribaroux.

1.3.5 Mining. Since the signing of the Mining Convention in 2005, mining companies have once again initiated exploratory drilling for copper, copper-gold and gold in northern Haiti, which holds potentially US\$20 billion worth in mineral wealth (*The Guardian*, 2012). Newmont, Majescor and VCS Mining are the main companies exploring in Haiti, with the latter two having properties near the towns of Limonade, Trou du Nord and Terrier Rouge. Majescor could be investing over US\$3.3 million in Phase I and II exploration programs (Majescor, 2009). Given that the companies are still at the exploratory stage, it is unclear how much mineral extraction and at what pace will take place, but the high concentration of copper deposits as evidenced in tests to date suggests that the region could witness major mining-related infrastructural investments, employment opportunities as well as environmental impacts. As a comparison, in the 1950s and 1960s, the extraction of 600,000 tons of bauxite per year in Miragoane created 900 low-wage jobs in Haiti (*The Guardian*, 2012).

1.3.5 Supporting Investments. In addition to these four major initiatives, a number of other international and national projects are underway to address gaps in existing service demands and needs and to support the potential for future economic development. Some of these initiatives will help to reduce overall environmental impact, although few initiatives are without some kind of social or environmental impact. It is important to note that this assessment cannot document all the numerous international and domestic initiatives along the corridor due to time and data constraints for an assessment of such a large project boundary and 15-20-year time horizon.

3 Selon Bedard, et al., 2010, un OGD est un regroupement d'entreprises touristiques d'un territoire géographique, responsable du développement et de la promotion du tourisme au sein dans leur région.

Figure 2 Map of Existing and Potential Major Investments in the Region

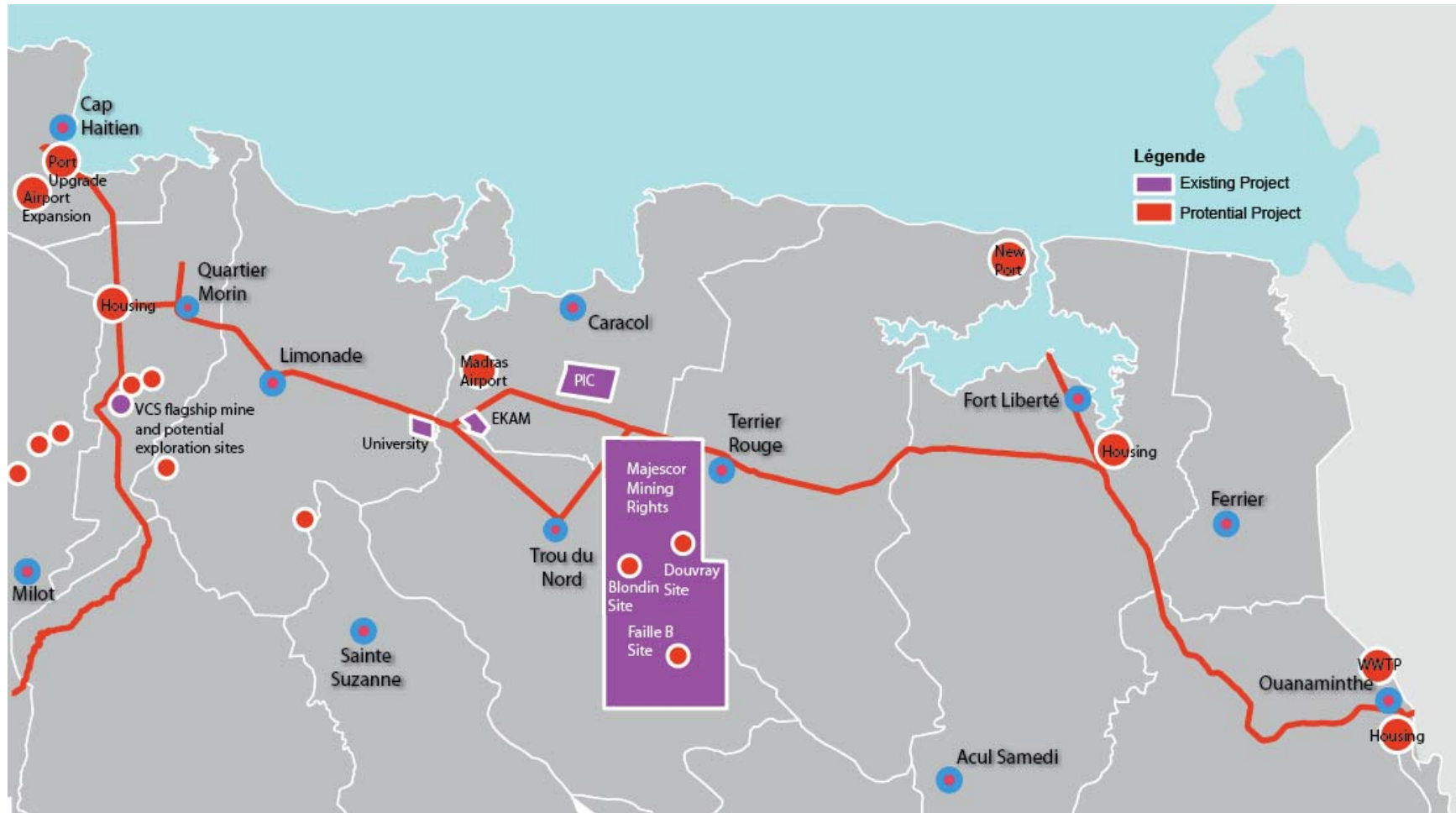


Table 3 Summary of Major Projects in the Region

Project	Location	Pop Impact	Status	Investment, funder
Parc Industriel de Caracol (PIC)	Caracol Commune	18,000 jobs by 2014, 120,000 direct/indirect jobs at build out	Launch in 2012	\$308 million (w/ support infrastructure) \$55 million facility only (IDB, USAID, SAE-A)
Universite Roi Henri Christophe	University with 72 classrooms in Limonade Commune	10,000 students, 1,200 jobs	Built in 2012 Not yet open	\$50 million (Govt of DR)
Container Port serving PIC and region	3 options under study: 1) Port at Cap-Haïtien with new access bridge bypassing downtown; 2) Pepillo Salcedo in the Dominican Republic; 3) New port on Baie de Ft Liberté.		Under study	USAID
Airport Expansion/New Airport	Existing runway extension into a jetport and/or a new airport east of Cap-Haïtien		Under study; delayed	GOH
Tourism Strategy	PNH, Labadee, Fort Liberté, Taino village on side of Grande Saline, corridor-wide improvements			\$65 million (WB) \$2.7 million (IDB)
Agricultural Programs (country-wide)	Global Agricultural and Food Security Program			\$90 million (IDB,WB)
	Feed the Future for Corridor of Northern Haiti	40,000 HHs		\$75 million (USAID)
	Programme de Mitigation des Desastres Naturels			(BID)
	Provincial Performance Improvement Initiative			(FIDA)
Massif du Nord Mining Exploration	Majescor exploring for gold, copper-gold, and copper in 50km ² SOMINE property in the Trou du Nord Department located between Trou du Nord and Terrier Rouge		Exploration	Majescor
	VCS Mining holds numerous permits including 55 km ² each in Terrier Rouge and Ouanaminthe, but is focusing on the 50km ² Morne Bossa property south of Cap-Haitien and Limonade for oxide and sulfide gold.		Exploration	VCS Mining
Sustainable Watershed Project	Reforestation and training on both sides of border for the Massacre River and Pedernales Rivers to show potential for sustainable production and bi-national management.		2012-2016	\$3.125 million (MDE/UNDP/UNEP/WPF/Norway)
Parc de Trois Baies	Establishment of a marine and coastal protected area from Limonade to the Massacre River		Consideration in parliament	US\$500,000 (GEF, UNDP, IDB), MDE
Road Upgrading and Maintenance	RN6 Upgrade from Cap-Haïtien to Ouanaminthe (60km)		Achevée en 2010	\$50,000,000 (EU)
	Cap-Haitien Rues de la ville		En cours / En exécution	\$7,580,000 (GoH, IDB)
	Haut du Cap - etude rocade		Presqu' achevée	\$309,000 (IDB)
	Cap-Labadie - etude incl. raccordem. au village des pêcheurs		En exécution	(IDB)

Project	Location	Pop Impact	Status	Investment, funder
	Ft Liberte adoquinage et drainage de rues (1km)		90% achevé	\$190,000 (GOH)
	Trou du Nord - Adoquinage de Rue La Croix – 800m		30%	\$190,000 (GOH)
	Caracol - Bétonnage de routes (1 km)		10%	\$190,000 (GOH)
	Ouanaminthe - Revêtement Rue Liberté (Phase 1)	Route 90% ; Ponceau 0%		\$2,700,000 (GOH)
	Ouanaminthe - Revêtement routes urbaines (5 km)	En Programmation		GOH
Drainage	Urban drainage canal cleaning and water supply		Ongoing	MINUSTAH
Water	Cap-Haitien - Réhabilitation réseau AEP Centreville; Equip. de forage et raccordement hydraulique à Balan; Ligne de refoulement 12" à Balan (Pont Hyppolite) ; Construction Chateau d'Eau à Balan; Extension réseau Vertières et Charrier; Raccordement au réseau des 2 nouveaux puits; Mise en service ligne électrique des 4 forages de Balan		Various: 50% to Acheve	\$235,000 (IDB), EU, OIM, IDB other
	Cap-Haitien (Bel Air) – Construction de 2 réservoirs ; Extension Réseau AEP (CV./ Ste Philomène)		20-45% complete	\$1,503,132 (OPEP)
	Cap-Haitien (Pet. Anse) – Construct. réseau à Ft St. Michel	Réseau: Achevé; C.d'Eau en constr.		(OXFAM)
	Caracol – Construct. réseau et installation pompe éolienne			(BM, EU)
	Le Nord-Est - Construction d'un bâtiment inter CAPEA pour gestion de 5 réseaux (Terrier Rouge, Trou du Nord, Quartier Morin, Limonade, Caracol)		100%	\$10 million (EU)
	Quartier Morin - Renforcement réseau; Limonade - Construction système d'Eau Potable; Trou du Nord - Construction système d'eau potable; Terrier Rouge - Réhabilitation du réseau; Ouanaminthe - Reconstruction du système d'alimentation en eau de la ville		En cours; 80-99%	EU
	Water study conducted by WASSER for 65 towns/cities in north and central Haiti to develop strategic plans; Fort Liberté to receive construction ready documents		Study ongoing Feb 2012-Sumer 2013	DINEPA, AECID
	280 trained technicians (2 per commune) in Haiti to provide water education, outreach and monitoring services		2012-2019	DINEPA, USAID, US CDC
Wastewater	Pilot sewerage network, treatment system in Ouanaminthe		Proposed	DINEPA
	PIC temporary wastewater treatment plant; permanent wastewater treatment plant under bidding as of Aug, 2012		temporary – to be completed 2012	IDB/UTE
	Setpage disposal facility in Quartier Morin used by GOLSA, a local company, for Estrella and other regional customers	one year operational contract Oct 2011-2012		IDB, UTE

Project	Location	Pop Impact	Status	Investment, funder
Solid Waste Management	Temporary waste facility (disposal, organic waste, recycling and septage) for PIC in Madrasse, 2km west of PIC			IDB
	National solid waste plan includes new landfill serving Cap, Limonade and Quartier Morin		Studies ongoing	IDB , USAID, AFD
	Plastic recycling company based in Cap, working with USAID to establish collection systems in towns along RN6		Planning	Broder Shutt's Pearl One Plastics
Energy	10MW heavy fuel oil plant in PIC to serve Caracol, Trou, Terrier Rouge and Limonade	Construction from Sept. 2011 to June 2012		\$14,000,000 (USAID, UTE)
	Cap-Haïtien – power plant near the port; Routine Revision of Petion Centrale / Bolivar / Marti; 2-4 MW solid waste to energy methane facility		Complete; Planning	ESD with Korean support, BMPAD
	Limonade Town Electrification, Ferrier Commune Electrification, Ouanaminthe Line Extension		Limonade 60% done, rest 0%	\$200,000 each (GOH)
	Terrier Rouge Town Electrification.	Generator complete; Network 55%		\$240,000 (GOH)
	Fort Liberté 6.9 MW Power Plant (others cite 16MW)		Construction	\$1.8 mill. (EDH/GOH)
	Ouanaminthe - 2.4 MW generator			
	Trou du Nord - Rehabilitating 2km and building 3km of lines			
Social Assessment	Social assessment and Re-settlement Plan (occupational, health, life restoration) for people displaced by PIC			IDB, UTE
Schools/Training	Leve Project; Korean school building in Caracol			USAID, CHF
Health	Hospitals, clinics; regional hospital at Ft. Liberte and Caracol			
Housing	EKAM housing at Fort Liberté	2,660 units	Planned	USAID, IDB
	EKAM housing at Limonade, Caracol, Trou, Terrier Rouge	750 units	Construction	USAID, IDB
	EKAM housing at Quartier Morin	540 units	Planned	USAID, IDB
	Demonstration village near Ouanaminthe on the RN6	200 units		Digicel, EU
	Numerous housing projects along the RN6		Ongoing	Food for the Poor
Governance	Locale Plus – national governance support project (much reserved for northern corridor); CHF municipal support			USAID, CHF
Sécurisation Foncière	Projet de sécurisation foncière de la BID sur le bassin versant de Grande Rivière du Nord, incluant Sainte Suzanne et Quartier Morin		Doit démarrer en 2013	BID

1.4 Effet d'entraînement des projets déclencheurs

Les grands projets en considération susciteront des mouvements de populations, de nouvelles formes d'occupation des sols, et l'émergence de nouvelles entreprises industrielles, agricoles et commerciales, qui redéfiniront l'espace. L'augmentation du pouvoir d'achat des consommateurs de la région stimulera la demande pour les produits alimentaires et aussi pour une série d'autres biens et de services. Les déplacements des migrants vers ces zones de grandes promesses d'emplois exigeront la création de nouveaux espaces de vie (logements, services sociaux). Les investissements nécessaires à l'accompagnement de cette nouvelle dynamique doivent être soutenus par un système financier ouvert et inclusif qui permet le déploiement de grandes, moyennes et petites entreprises tout le long du couloir.

1.4.1 Logements

La problématique du logement est au cœur de la transformation de la région. Elle répond à des préoccupations de différents niveaux. Le tout premier fait référence aux besoins d'habitat qui seront exprimés très prochainement avec l'ouverture des usines du PIC, et le fonctionnement de l'Université Roi Henry Christophe. Mais parallèlement, avec l'accroissement de la population, les services de voirie, par exemple, qui sont déjà un défi majeur pour les mairies deviendront encore plus difficiles à gérer pour préserver un minimum de salubrité dans les villes. Donc, la gouvernance locale est sollicitée d'une part pour la collecte des taxes, donc un élargissement de l'assiette fiscale, et également devra s'équiper, en ressources humaines et matérielles pour des services correspondant à une population grandissante. On peut aussi bien envisager la pression sur les terres pour les aménagements résidentiels et d'affaires, et la pression sur les mairies de contrer de manière efficace cette nouvelle donne sans un apport significatif en ressources humaines et matérielles.

Effets économiques induits : Élargissement de l'assiette fiscale

Exigences : Ressources humaines et matérielles au niveau du gouvernement local

Actions en cours : l'USAID est en cours de construction de 5,000 unités de logements. Ces unités répondront aux besoins de la clientèle du PIC.

Actions à encourager : En rapport aux mouvements de populations, faciliter le développement d'entreprises de construction de logements au travers de facilités de financement et du foncier.

Prévisions de revenu : A partir des calculs de densité de populations et les plans retenus par les urbanistes. Toutefois, des révisions au niveau de la législature devraient être envisagées pour permettre une marge de manœuvre plus grande aux autorités locales. Certaines lois sont dépassées, non seulement en termes de pénalités qui ne sont pas des sanctions dissuasives, mais aussi ça peut être le cas de classification d'immeubles taxables ou non – par exemple, les immeubles non peints ne sont pas taxables. Une révision qui inclue la révision de la définition de campagne et ville pour la classification des immeubles taxables permettrait d'augmenter la base taxable.

*Communes dans le couloir retenues pour les projets de logements:
Trou du Nord, Limonade, Quartier Morin, Terrier Rouge, Fort Liberté.*

1.4.2 Agriculture et Pêche

La demande agricole augmentera de manière significative avec le déploiement de ces projets. Déjà, comme susmentionné, même avec ce niveau de chômage, la région est en train d'importer 55% de ces besoins en produits alimentaires. Le projet FTFNC de l'USAID devrait permettre d'améliorer la productivité du secteur au cours de ces 5 années à venir au travers des dispositifs de modernisation de la production et d'appui à la formation. La BID intervient déjà du côté du Bassin versant de la Grande Rivière du Nord. L'objectif de toucher 40,000 ménages avec ce programme permettra d'enclencher la mise en place de cette masse critique d'entrepreneurs agricoles, outillés d'instruments modernes leur

permettant de mieux comprendre les mécanismes d'un marché changeant. A terme, les relations de ces nouveaux entrepreneurs d'avec les autorités locales se modifient avec la nécessité de formalisation de leur rapport qu'exigeront leurs besoins de transactions.

Pour un marché de plus d'un million de consommateurs, tout au cours de l'année, la demande reste généralement insatisfaite. La Pêche s'organise de manière artisanale et les méthodes de conservation du produit ne sont pas à la portée des acteurs du système, comme l'ont fait remarquer les pêcheurs de Caracol et de Bord de Mer de Limonade. En bonne saison de pêche, il faut immédiatement trouver les revendeuses pour acheminer les produits vers les hôtels ou les marchés de la ville. Autrement, ce produit extrêmement périssable, ne peut être gardé au-delà de la journée.

D'autre part, dans les cas de marée haute, les petites embarcations utilisées ne peuvent prendre la mer. De plus, cette pêche ne peut s'organiser en haute mer, compte tenu de la fragilité des instruments utilisés. Un encadrement de plusieurs ordres est donc nécessaire pour permettre une rationalisation de cette industrie porteuse. Des projets d'organisation de pêche en haute mer, avec des bateaux plus robustes, et des techniques modernes de conservation sont considérés.

Avec un encadrement adéquat des coopératives de pêche rencontrées, la production de cette industrie pourra facilement faire face à une demande grandissante avec les investissements dans :

- Des Bateaux motorisés, avec petit système de réfrigération
- L'Installation de chaîne de froid
- La Mise en place de structure de séchage de poisson

Communes dans le couloir pour la pêche et l'agriculture: Caracol, Fort Liberté, Phaéton, et Bord de mer (Pêche), Ferrier, Ouanaminthe (riz), Limonade, Quartier Morin, Terrier Rouge.

1.4.3 Usines de transformation : Distilleries et les installations artisanales de production de sirop et de « rapadou » existantes

La modernisation de moyennes et petites unités de transformation de canne-à-sucre en « « clairin » », et autres sous produits de la canne, avec des espaces de dégustation servira certes à la fixation sur des terres de certains producteurs de la zone, mais aussi à créer un espace qui puisse être valorisé à un double niveau : le produit en tant que tel, et aire de visite pour touristes ;

Communes dans le couloir susceptibles d'accueillir ces investissements : Quartier Morin, Limonade, en tout premier lieu, et Trou-du-nord.

1.4.4 Des unités de transformation de manioc, de Banane, et de maïs en farine

Une bonne partie de ce marché est maintenant comblée par des importations de la République dominicaine. La production agricole existe et sera supportée par le FTFNC. L'encadrement technique adéquat permettra de répondre aux besoins de cette transformation (alimentation importante pour les enfants).

Communes d'accueil dans le couloir : Trou du Nord, Limonade, Terrier Rouge, Ferrier, Acul Samedi, en tout premier lieu. Et Quartier Morin.

1.4.5 Production de lait, de yaourt et de fromage

L'activité des laiteries locales avec l'appui de Veterimed est loin de répondre aux besoins du marché ⁴; La baisse de rendement des cultures incite les agriculteurs à manifester de l'intérêt pour une intégration plus poussée des activités d'agriculture et d'élevage. Ceci est favorable à la production laitière.

Commune dans le couloir : Ferrier, Limonade, Terrier Rouge.

4 En ajoutant le lait produit et vendu localement, on estime le marché des produits laitiers à 50 millions de dollars annuellement.

1.4.6 Mécanique et autres

La disponibilité de fruits variés dans la région facilite la transformation industrielle et semi industrielle. De plus, l'augmentation de la circulation automobile exigera de nouvelles installations d'auto mécanique.

Communes dans le couloir : Ouanaminthe, Terrier Rouge, Acul Samedi

1.4.7 Le commerce Transfrontalier

Deux considérations sont à envisager. A un premier niveau, il faudrait bien situer le problème de gouvernance à adresser pour permettre une amélioration des rentrées douanières. Ceci revient au ministère des finances et à la banque centrale. Mais à un deuxième niveau plus stratégique et plus important, on ne peut penser ce pôle de croissance NORD en dehors d'une réflexion plus globale qui prend en considération le commerce transfrontalier. Ceci inclut les problèmes de compétitivité des ports haïtiens, les problèmes d'aéroport, les problèmes de l'absence de centres de formation supérieure d'excellence et bien sûr les problèmes de production locale.

Les investisseurs de l'autre côté de la frontière savent très bien que les consommateurs arriveront avant l'ajustement de la production agricole. Ceci implique pour eux une augmentation de la demande de plusieurs produits. Et ils se préparent. Le trafic transfrontalier va donc probablement doubler au cours des deux prochaines années, et également la pression sur les infrastructures routières. Il devient donc urgent de statuer sur la porte d'entrée.

Dans le cadre de cet aménagement régional, Ouanaminthe comme porte entrée doit offrir des facilités qui répondent aux exigences et des entrepreneurs et des consommateurs des deux côtes de la frontière. Peut être ne sera t-il plus possible de fermer la frontière la nuit? La structure de la ville sera certes repensée avec des milliers de gens qui y traverseront chaque jour dans deux à trois ans. Il sera certes obligatoire d'organiser un système de péage pour les véhicules qui épuiseront les infrastructures routières que les poids lourds commencent déjà à abîmer. Une partie de l'argent peut-être utiliser pour un fonds d'entretien routier régional et non municipal, car ces poids lourds traverseront tout le corridor.

Table 4 Les Communes du Couloir et les Activités Economiques Induites

Secteur/ Communes	Agriculture/ Pêche	Industrie	Tourisme	Com/service	Formation
Caracol Ville historique	Production de sel Pêche	Constr. et repar. de bateaux	Auberge Bar/Resto	Cal sec Clinique Logements	
Trou du Nord Ville de services et de logement	Agriculture	UST	Hôtel Resto/bar Auberge	Marché Public Supermarché Hôpital réf Petits services Serv. Fin	Professionnelle • Textile • Agrindus • Tourisme • Construct. • Entrep.
Limonade Ville universitaire et touristique	Pêche Agriculture	Distillerie UST UTDL	Opér. de Tours, Guides Hôtel, Bar/resto, Boutique, Spectacles	Petits services Clinique Logements Serv. Fin Hôtel Auberge	Professionnelle • Tourisme • Textile • Construct. • Agrindus • Artisanale
Quartier Morin Extension du Cap	Agriculture	Distillerie UST		Logements Auberge Supermarché Garage C. stockage	Professionnelle • Construct. • Artisanale • Textile • Entrep.
Fort Liberté Ville	Pêche		Hôtel Bar/resto	Services publics	Professionnelle • Comptable

historique			Auberge	Serv. Fin.	• Tourisme • Secrétariat
Terrier Rouge Pole Mécanique	Agriculture Élevage	UST UTDL C. Triage	Silos	Boutique agricole Logements Garage	Professionnelle • Mécanique • Textile • Menuiserie
Ferrier Ville agricole	Riz Élevage	UST UTDL	Auberge, Resto, Silos	Boutique agricole	Professionnelle • Mécanique
Acul Samedi Ville agricole	Agriculture	UST	Silos	Boutique agricole	
Ste Suzanne Ville agricole Villégiature	Agriculture			Logement Boutique agricole	Professionnelle • Construct. • Agric

Sources: From Prof : Formation professionnelle ; UST : usines de transformation ; UTDL : Usine de transformation du lait ; Hôpital réf : hôpital de référence ; C. Triage : Centre de Triage ; C. Stockage : Centre de Stockage ; Serv. Fin : Services Financiers ; Entrep. : Entreprenariat

These investments provide much needed economic development and infrastructure improvements. At the same time, they will be located in areas of medium to high ecological risks, create significant new demands on natural resources and impacts on sensitive ecological areas, and attract high immigration into the region from Cap-Haïtien, Ouanaminthe, surrounding rural areas in Le Nord and Nord-Est, and from outside the region. An assessment of future impacts requires a basic understanding of current and projected population in the region.

PART 2. DEMOGRAPHIC CHARACTERISTICS AND DEVELOPMENT SCENARIOS

2.1 Current Population Estimates

Accurate demographic data is fundamental to planning analyses of current conditions and efforts to project future trends. Unfortunately, Haiti and its regional administrative divisions lack up-to-date local population estimates, given that the last two censuses were in 1972 and 2003. The 2005-06 Enquête de Mortalité, Morbidité, et Utilisation des Services (EMMUS IV) included a survey of 8,593 people in Le Nord and Nord-Est and provides a detailed portrait of household health and access to services, but not population numbers. These datasets are the basis for the country's population estimates, particularly at the local and sub-regional level.

At the national level, various international organizations provide their own estimates of population. According to World Bank estimates, Haiti's total population grew at a rate of 1.9% a year from 1980 to 2010 (World Bank Development Indicators). Haiti's urban population grew by 5.2% a year in the 1980s, 4.4% a year in the 1990s, and 4.7% a year in the 2000s. During the same periods, rural population growth fell from 1.3% in the 1990s, to 0.87% in the 1990s, to -0.78% in the 2000s. Metro Port-au-Prince comprised the bulk of the country's urban population, and almost quadrupled in size from 700,500 in 1980 to 2.6 million in 2009, and grew at a rate of 4.9% in the 1980s, 4.1% in the 1990s, and 5.1% in the 2000s (World Bank Development Indicators). In comparison, cities and communes along the present day RN6 corridor grew at a rate of 2 to 3% from 1982 to 2003 (see sources below), compared to 5.2% for the national urban growth rate over the same period (World Bank Development Indicators). The exceptions were Limonade, which grew by 4.8% during this period (although this may be an error). Anecdotally, it is reported that Ouanaminthe, grew by 5% following the establishment of CODEVI.

Since the 2000s, anecdotally the north appears to be urbanizing at a faster rate, as fewer people leave the area and national and international organizations have targeted the region for investment as a way to de-concentrate PAP. Since the 2010 earthquake, many families in the region have absorbed members of their extended family who were refugees from Port-au-Prince, although a national report from 2011 suggests that 85% of refugees had returned to PAP. The last population estimates by IHSI are for 2009 and likely underestimate actual urban populations in the corridor.

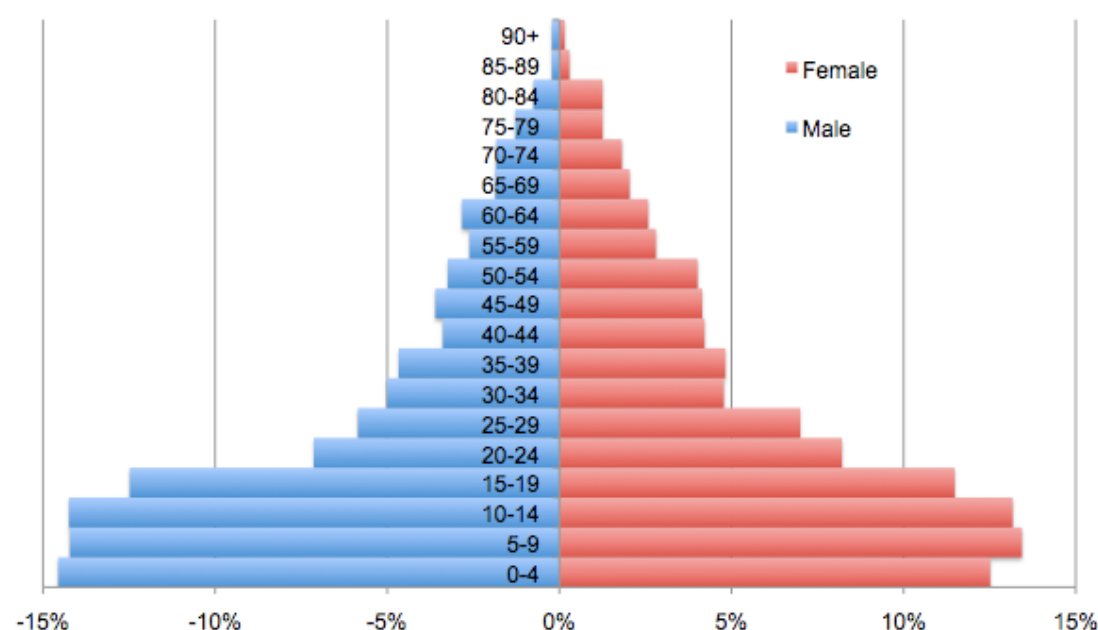
Despite the flaws of the 2009 estimates, this study takes these for lack of better data as the basis for the planning analysis and population projections. According to IHSI's 2009 estimates, the two departments have a combined population of 1.3 million people or 13% of Haiti's population, with about 45% of the population living in urbanized areas. The population of the major towns and cities along the corridor – including Petite Anse (Metro Cap-Haïtien) – totaled 387,300. The population was 48% male, 52% female, with 41% of the population under the age of 15 and 61% under age 25. The population pyramid reveals a greater number of male children under age 20, while women significantly outnumber men in the 20- to 30-year age range, suggesting a high exodus of men from the region for work. The latest estimates of fertility rates range from 2.98 (CIA, 2012) to 3.4 (UNICEF, 2009). Estimates of the crude birth rate range from 24 (CIA, 2012) to 27 (UNICEF, 2009) and of the death rate from 8.1 (CIA) to 9 (UNICEF, 2009). Life expectancy is 61 (UNICEF) to 62.5 (CIA).

Table 5 Tailles des Ménages Urbains (non-Metropolitaine) en 2007

Une personne	2-3 personnes	4-6 personnes	7-9 personnes	10+ personnes	Moyenne
8.8%	26.3%	45.1%	15.9%	3.9%	4.7

Source: IHSI 2010a

Figure 3 Population Pyramid for Le Nord and Nord-Est (2005-2006)



Source: EMMUS IV

Table 6 Estimated Population in the Corridor in 2009 by Département

	Total	% Under Age 18	% Urban
Le Nord	970,495	45%	46%
Ville	335,604	42%	
Quartier	107,096	44%	
Sections Rurales	527,795	46%	
Le Nord-Est	358,277	48%	44%
Ville	143,387	46%	
Quartier	13,464	47%	
Sections Rural	201,426	49%	
Total Le Nord & Nord-Est	1,328,772	45%	45%
Ville	478,991	43%	
Quartier	120,560	45%	
Sections Rural	729,221	47%	

Source: IHSI 2009b; % urban derived from Ville and Quartier populations

Table 7 Estimated Population in the Corridor in 2009 by Commune

	Total	% Under Age 18	Area (km ²)	Density (people/ha)			Growth Rate (%)
				'82	'96	'09	
Le Nord							
Commune de Cap-Haïtien	249,541	42%	52.32	14.3	23.2	47.7	3.5
Ville de Cap-Haïtien	155,505	40%				2,500	3.36
Quartier de Petite Anse	89,155	44%					
Commune de Quartier Morin	24,881	42%	61.5	2.2	2.9	4.0	2.0
Ville de Quartier Morin	3,500	40%					2.28
Commune de Limonade	50,150	45%	113.1	2.5	3.5	4.4	2.4
Ville de Limonade	14,886	43%	2			53-168 ('03)	5.57

Le Nord-Est							
Commune de Fort-Liberte	31,315	45%	259.6		0.96	0.7	
Ville de Fort-Liberte	18,417	45%					
Ville Industrielle de Derac	2,046	41%					
Commune de Ferrier	13,315	48%	73.3		0.53	1.8	
Ville de Ferrier	7,371	46%					
Commune de Ouanaminthe	96,515	48%	225.7		2.24	4.3	
Ville de Ouanaminthe	58,250	47%					
Commune de Trou du Nord	44,498	47%	125.1		0.46	3.4	
Ville de Trou du Nord	21,805	45%				275- 690	3%
Commune de ste Suzanne	25,492	49%	142.0		0.56	1.8	
Ville de Sainte Suzanne	1,488	45%					
Commune de Terrier Rouge	27,577	45%	184.4		0.99	1.5	
Ville de Terrier Rouge	12,226	43%					
Commune de Caracol	7,015	46%	0.26		0.64		
Ville de Caracol	2,690	45%				100-200	3%

Source: IHSI 2009b; MPCE 1997a, b; IHSI 1997; LGL 2007b, c, d

Table 8 Total Population in Cap-Haïtien - Ouanaminthe Corridor in 2009

Population of Communes along the Corridor	570,299
Population of Villes / Quartiers along the Corridor	387,339
Urban Population on Corridor as % of Commune population	68%

2.2 Socio-Economic Characteristics

The employment base varies across the towns in the region, which can be characterized in broad brush. Coastal Caracol is highly dependent on fishing and salt basins, with around 155 salt basins in Caracol, 350 in Jacquezy, and 8 in Madras based on a 2010 aerial. Ferrier relies on rice plantations, Quartier Morin on plantains and sugar cane for clairin production, and Terrier Rouge on livestock and garages (mechanics). Sainte Suzanne, which also has growing numbers of second homes for the wealthy and middle class, relies on fruit, coffee and cocoa production. The lowland cities of Limonade, Trou du Nord and Fort Liberté feature much greater reliance on commerce, trade, markets, and small-scale industries, as well as on traditional agriculture, livestock and fishing.

Le taux net d'activité⁵ pour les hommes se situe à 57.3% dans le rural et à 50.4% en milieu urbain. Pour les femmes, il est estimé à 41.1 au niveau du rural et à 36.9 au niveau de l'urbain. It was particularly high among the youth and declined with age; the rate of unemployment increased with level of education up to the secondary level; urban unemployment for people with university educations was similar to those with 2nd and 3rd primary educations. The 2007 LGL reports based on 2004 data suggest 64% unemployment in Limonade and 68% in Trou du Nord.⁶ The majority of households had only one income earner; 17% of households in Caracol and Limonade had two income earners; and 38% of households in Caracol had no working family members. In Limonade, 76% of households had 1 to 4 unemployed members. These households survive through strong community ties and the generosity of relatives (LGL, 2007b, c, d). These numbers may have become more elevated since 2010 and the influx of migrants from PAP.

5 Taux net d'activité : population active (occupée et en chômage) et population en âge de travailler (10 ans et plus). Définition de l'IHSI 2010a.

6 The original statistics cited in the LGL 2007 reports are: 18.7% of the urban population in Trou du Nord was employed, and 26.5% of people 10 and older in Limonade was employed. To convert this to comparable numbers, this study converted employment numbers to a share of employment opportunities as a share of a working population age 15 to 64, based on the 2005-06 age break down for Le Nord and Nord-Est (IHSI, 2006).

Surveys in 2004 for Caracol and Limonade provide a more detailed glimpse into the socio-economic profile of the region. It is a tremendous challenge to quantify household income given the subsistence nature of some of the fishing and agricultural activities. Haiti's current minimum wage is 150 gourdes (US\$3.75) per day, although in the apparel sector this is scheduled to be raised to \$5.00 to \$7.25 in October 2012 (Muller-Poitevien, 2012). Due to local unemployment rates, many families earn less than this as a whole, although as Tables 9-12 show, some fishing, agricultural and commercial jobs pay above the minimum wage.

Table 9 Caracol Income Profile

Economic Activity	% of Employment	% Men/ %Women	Income (in gdes unless noted)	
			Pay per day	Pay per month
Salt Basins		300 men, many women	225 for men, 175 for women	owner 5,250,
Fishing	39%	98% men	500-2,500, average 1500	
Agriculture/Silviculture/Animal Raising/Hunting	23%	95% men		1,250
Commercial Activities	23%	90% women		
Boulangerie	2%	5 people	2875 GDS	
Remittances	most families			US\$50-70
Public administration	1%	3 people		
Average household income				3,000

Source: LGL 2007c

Table 10 Limonade Income Profile

Economic Activity	% of Employment	Pay per day (gds)*	Pay per month (gds)
Processing (Transformation)	10%	120	2,660
Agriculture/Silviculture/Animal Raising/Hunting/Fishing	37%	172	3,780
Commercial Activities		210	4,633
Merchants (imported foods, etc)		455 or more	10,000 or more
Teachers and factory workers		136-227	3,000 - 5,000
Cassava makers, others		32-114	700 – 2,500
Education	4%		
Remittances			
Public administration (103 people)	5%		

Source: LGL 2007a; * estimated based on 22 work days per month. *The figures provided by the relèves is for average monthly income – average daily income is back calculated here as 22 work days per month for comparison with other towns.

Table 11 Income Profile of Agricultural and Commercial Activities

	Quantity per day	Revenue per quantity or per per day	Number of days	Average Income per day (Gds)*	Average monthly income in Gdes
Gratteur de manioc	20-25 sacs	25 gdes/sac	2/week	209	4,600
Faiseur de cassave	n/a	25-35 gdes/day	6/week	33	720
Marchades produits agricoles	n/a	25-75 gdes/day	7 days	64	1,400
Marchandes produits alimentaires importes	n/a	250-500 gdes/day	7 days	477	10,500
Marchandes fripes	4 balles/mois	500 gdes/balle	n/a	91	2,000
Eleveurs	3 gallons lait/jour	45 gdes/gallon	7 days	172	3,780

Source: INESA. (Mars 2006) Relèves de Terrain as cited in LGL 2007c; *The figures provided by the relèves is for average monthly income – average daily income is back calculated here as 22 work days per month for comparison with other towns.

Table 12 National Urban Average Monthly Income en Gds

Secteur Institutionnel	Urbain	Rural	Ensemble	Population estimée	Echantillon
Privé Formel	8,541	13,817	9,285	50,430	258
Privé informel	4,309	3,630	3,968	1,415,473	4,969
Secteur public	9,174	5,091	8,222	80,688	418
Associations et ONG	10,166	3,195	7,927	11,472	45
Ménages	2,350	1,699	2,125	44,896	184
Agriculture, pêche	3,295	3,184	3,192	680,229	1,276
Ensemble	4,783	3,476	3,988	2,283,188	7,153

Source: IHSI 2010a

2.3 Employment Generation

As noted under Part 1.3, the PIC will generate 120,000 direct and indirect jobs at full build-out. Given high levels of local unemployment and underemployment, nearly all the direct jobs could be filled by current residents of Caracol, Trou du Nord, Limonade and Terrier Rouge, assuming they could qualify for the positions. It is uncertain what percentage of workers at the park will ultimately come from the immediate vicinity of the park, and how many will come from outside the immediate areas. The experience of the CODEVI park suggests that those who do migrate to the park for work often leave their families at home and rent a single room near the place of employment.

The University campus has adequate facilities to educate 10,000 students, which likely requires around 400 faculty and direct staff and 800 indirect jobs. But given the lack of rollout plan for launching the actual university, it is difficult to project its population impacts. If and when the university opens, it will require student and faculty housing located in the nearby communities and vicinities, as there are neither plans for nor a tradition of student dormitories.

The Port of Cap-Haïtien, which uses 20-30% of its 1,000 twenty-foot equivalent units (TEU) potential (confirm), currently employs 50 stevedores. Studies in other modern ports suggest a ratio of roughly 20 direct, induced and indirect jobs per 1,000 TEU. In the absence of any information on the proposed port, one can estimate that a new port would generate not more than a few hundred direct jobs.

2.4 Projected Population

A detailed population estimate usually involves a breakdown of total population by age and gender and multiplying each age cohort by a crude growth rate based on birth minus death rate, together with employment and migration analyses. Given the number of uncertainties as to whether, when, where, and to what scale the various investments will take place in the region and their implications for population growth, the CIA's proposes two development scenarios (see Figures 4 and 5):

1. A baseline scenario in which planned investments do not take place and cities grow according to past trends. Urban population growth rates drop to 1.5% a year by 2025. Total urban population of the main urbanized centers along the corridor will increase to 600,000 in 2030, up from 387,000 in 2009.
2. A high growth scenario in which all the proposed economic development projects (industrial park, university, port, and others) take place to their full. The towns of Limonade, Caracol, Trou du

Nord and Fort Liberté will be most affected by planned investments in the region. Given their small population base at present, the study conceives of rates of growth rise to 6% from 2012-2024 in these areas, assuming that efforts to concentrate growth in these areas are successful. Other smaller towns that are farther from the areas of investment, as well as the large cities of Cap-Haïtien and Ouanaminthe will see a lower rate of growth. By 2025, the study foresees a decline in population growth rates. Total population under the high-growth scenario would increase to 832,000, or 139% above the baseline. By 2030, the towns closest to the PIC could hold an addition 56,000 people above the baseline level. These estimates make clear that significant investments are needed in public infrastructure and job creation in either scenario.

These urban population growth figures are indicative of the future magnitude of urban population sizes but not necessarily their exact location. For instance, Limonade's future urban population of 39,279 in 2030 under the high-growth scenario could mean that most growth will grow around Limonade. However, some portion of this may be clustered around the URHC, where there are current no residents. This will depend on the infrastructure and planning proposals of the PAR.

Figure 4 Growth of Urban Population along the Project Corridor (2009-2030)

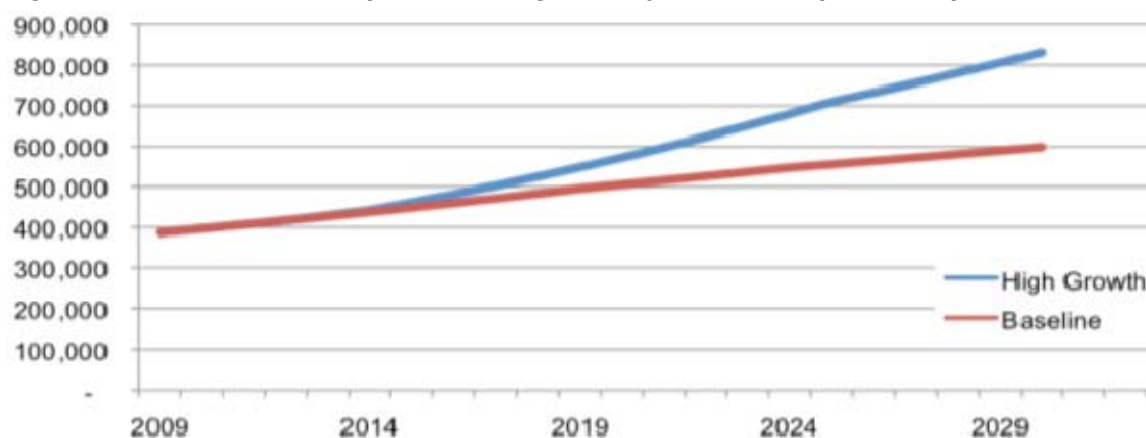
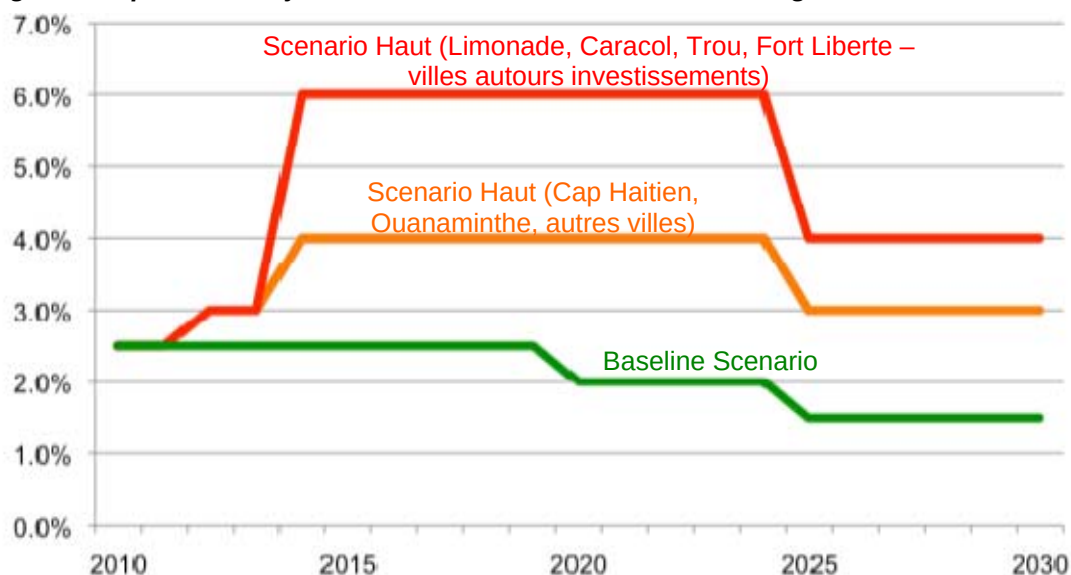


Figure 5 Population Projection Growth Rates in Baseline and High Growth Scenarios



According to the EMMUS IV, average household size in Le Nord and Nord-Est was 6.4 in 2005. The Enquête de Emploi et Economie Informelle (EEEI), which surveyed 5,080 households outside of

Metropolitan Port-au-Prince, estimates the average urban household size as 4.7 and the average rural household size as 4.5 in 2007. This CIA uses the national urban household estimate of 4.7. Table 14 estimates the number of households in 2030 as 127,000 under the baseline scenario and 177,000 under the high-growth scenario. Around the PIC, the high-growth scenario would require an estimated 12,000 units of housing. A detailed housing analysis is required, however, given the tendency for migrants to be single-person households who rent out rooms from existing families.

Table 13 Baseline Scenario Population and Household Growth

POPULATION	2009	2020		2030	
		Baseline	High Growth	Baseline	High Growth
Ville de Cap-Haïtien	155,505	203,041	224,797	240,315	317,061
Quartier de Petite Anse	89,155	116,408	128,882	137,779	181,779
Ville de Quartier Morin	3,500	4,570	5,060	5,409	7,136
Subtotal for the Cap-Haitien Urban Node	248,160	324,019	358,739	383,503	505,976
Ville de Limonade	14,886	19,436	24,125	23,005	39,279
Ville de Caracol	2,690	3,512	4,359	4,157	7,098
Ville de Trou du Nord	21,805	28,470	35,338	33,697	57,535
Ville de Terrier Rouge	12,226	15,963	19,814	18,894	32,260
Subtotal for PIC Node	51,607	67,381	83,636	79,753	136,172
Ville de Sainte Suzanne	1,488	1,943	2,151	2,300	3,034
Ville de Fort-Liberté	18,417	24,047	29,847	28,461	48,596
Ville Industrielle de Derac	2,046	2,671	2,958	3,162	4,172
Ville de Ferrier	7,371	9,624	10,655	11,391	15,029
Ville de Ouanaminthe	58,250	76,056	84,206	90,018	118,767
TOTAL	387,339	505,743	572,191	598,587	831,745

Table 14 Number of Households in Baseline and High Growth Scenarios

	2009	2020		2030	
		Baseline	High Growth	Baseline	High Growth
Ville de Cap-Haïtien	33,086	43,200	47,829	51,131	67,460
Quartier de Petite Anse	18,969	24,768	27,422	29,315	38,676
Ville de Quartier Morin	745	972	1,077	1,151	1,518
Subtotal for the Cap-Haitien Urban Node	52,800	68,940	76,327	81,596	107,655
Ville de Limonade	3,167	4,135	5,133	4,895	8,357
Ville de Caracol	572	747	928	884	1,510
Ville de Trou du Nord	4,639	6,058	7,519	7,170	12,242
Ville de Terrier Rouge	2,601	3,396	4,216	4,020	6,864
Subtotal for PIC Node	10,979	14,336	17,796	16,969	28,973
Ville de Sainte Suzanne	317	413	458	489	646
Ville de Fort-Liberte	3,919	5,116	6,350	6,056	10,339
Ville Industrielle de Derac	435	568	629	673	888
Ville de Ferrier	1,568	2,048	2,267	2,424	3,198
Ville de Ouanaminthe	12,394	16,182	17,916	19,153	25,270
TOTAL	82,412	107,604	121,744	127,359	176,968

PART 3: VALUED ENVIRONMENTAL SYSTEMS

The island of Hispaniola lies within the Caribbean Islands Biodiversity Hotspot and has a high level of species endemism due to its geography, geologic history and range of microclimates (Hilaire, 2009). Haiti alone has over 5,000 species of flowering plants and 600 species of ferns, and 36% of all plant species are endemic to the island. Of the country's over 2,000 species of vertebrates, 75% are endemic, and it is estimated that 75% of the animal species have never been described (GEF, 2009). Within Le Nord and Nord-Est, the coastal mangrove and marine areas including the Lagon aux Boeufs are of international ecological importance.



Figure 6 Map of Caribbean Islands Biodiversity Hotspot

Despite significant impact on forest cover and river water quality, these areas remain important ecological systems with high value to biodiversity and human wellbeing.

Given Limonade's history as the first place Christopher Columbus that came to shore, the northern region is rich in cultural patrimony. Haiti's coastal plains are rich in alluvial soils that made it the jewel of France's colonies in the 17th and 18th centuries, and are of great importance today to the country's food security.

The importance of these ecological, agricultural and cultural systems underlies efforts to develop a regional plan and to assess the impacts of future growth in the region. The CIA establishes six valued environmental systems:

1. Estuarine, Coastal and Marine Systems
2. Surface and Ground Water Resources
3. Highland Watersheds and Riparian Forests
4. Air Quality
5. Soils and Agriculturally Valuable Areas
6. Culturally Valuable Areas

To protect these natural and cultural resources, Haiti has developed an extensive body of law (Victor, 1995). Particularly after the 1992 Rio Summit, the Haitian government embarked upon a promising national sustainable development strategy by creating a Ministry of Environment (MDE) in 1995, ratifying a number of international treaties, formulating an Environmental Action Plan in 1999, and publishing a Décret-Cadre sur l'Environnement in 2006. Today, the most important laws governing watersheds and natural resources in Haiti include:

- o Avant-projet de le Décret Organique du Ministère de l'Environnement, January 2006, although this appears to not have been legally promulgated;
- o Décret du 12 octobre 2005 sur la Gestion de l'Environnement, *Le Moniteur No. 11 en date du 26 janvier 2006*, which prescribes the development of watershed management plans as a priority for each watershed or hydrographic district in the country and the adoption of urban management plans by municipal ordinance (*arrêté*), a provision consistent with the 2006 decree on local governance, which provides for environmental action plans at the *commune* level;
- o *Politique du MARNDR pour la Gestion des Bassins Versants*, Ministry of Agriculture, Natural Resources and Rural Development (MARNDR) Direction des ressources naturelles, Service de défense et restauration des terres, Décembre 1999;
- o *Plan d'Action pour l'Environnement*, MDE, 1999;

- o *Loi Cadre Portant Organisation du Secteur de l'Eau Potable et de l'Assainissement 2009;*
- o *Proposition de loi établissant le cadre d'organisation et de fonctionnement des collectivités territoriales*, April 2009, which was never passed by parliament;
- o *Décret sur la Pêche*, published in Le Moniteur No.81, 27 October 1978, still in force, sets out the policy concerning the management of coastal and marine resources;
- o *La Constitution de 1987 et le Décret cadre sur la décentralisation*, February 2006, on natural resource planning at the *commune* and communal section levels of local government, including commune-level environmental action plans, as noted earlier (see Décret Organique de 2006).
- o *Code Rural François Duvalier de 1962*, which includes restrictions on the use of slopes, and environmentally oriented directives on soil conservation, water, irrigation and drainage, forests, tree harvest and roadways.
- o *Décret du 6 janvier 1982, "fixant par rapport aux exigences imposées par l'environnement écologique et conformément à l'évolution économique et sociale du Pays, les règles spécifiques relatives quant à l'habitation et à l'aménagement de nos cités et agglomérations rurales et urbaines."*

In reality, however, these laws have not translated into successful resource management. For instance, although 80% of existing legislation by 1995 concerned trees and protected areas, less than 2% of Haiti is presently covered in forest or protected areas (MARNDP, 2010; CAR-SPAW-RAC, 2011). Several issues contribute to the challenge of achieving sustainable development. First, the lack of economic development has resulted in high levels of poverty that has led to vicious cycles of overexploitation and degradation of environmental resources, particularly on the coasts and in the highland watersheds. Second, given Haiti's recent urbanization, there has been a historic dearth of policies and management capacity on issues particular to cities, namely water, wastewater, solid waste and air, the last two of which still lack national policies and legislation. Third, there is a lack of clarity as to the roles and responsibilities of governing and implement agencies. Although the 2006 Décret transferred many of MARNDP's responsibilities to MDE, the Décret did not make funds available to MDE, nor did staff from MARNDP ultimately move to MDE (USAID, 2009). In addition, while the 2006 Decentralization Décret Cadre authorized communes to prepare and implement environmental action plans, a move supported by both MDE and MARNDP, this decree has subsequently been suspended. Finally, MARNDP, MDE and communes lack the human and financial resources to fund field staff or implement projects on the ground. As an example, the Commune of Limbé with 70,000 people had a budget of Gds 68,000 to implement watershed management for fiscal year 2006, or less than one gourde (US\$0.02) per person (USAID, 2009).

In 2006, the government passed a decree to establish a National Agency for Protected Areas (ANAP). Since then, with UNDP and GEF support, the Ministry of Environment has been working to establish a financial sustainable ANAP and the corresponding National System of Protected Areas (SNAP) under its jurisdiction. From 2011 to 2015, this project has a budget of nearly US\$9 million (UNDP, 2011). At present, the country has eight established national parks and protected areas, covering less than 2% of the country (CAR-SPAW-RAC, 2011). The Citadelle, Sans Souci, Ramiers Natural National Park is the closest existing protected area to the region of study.

3.1 VES 1: Estuarine, Coastal and Marine Systems

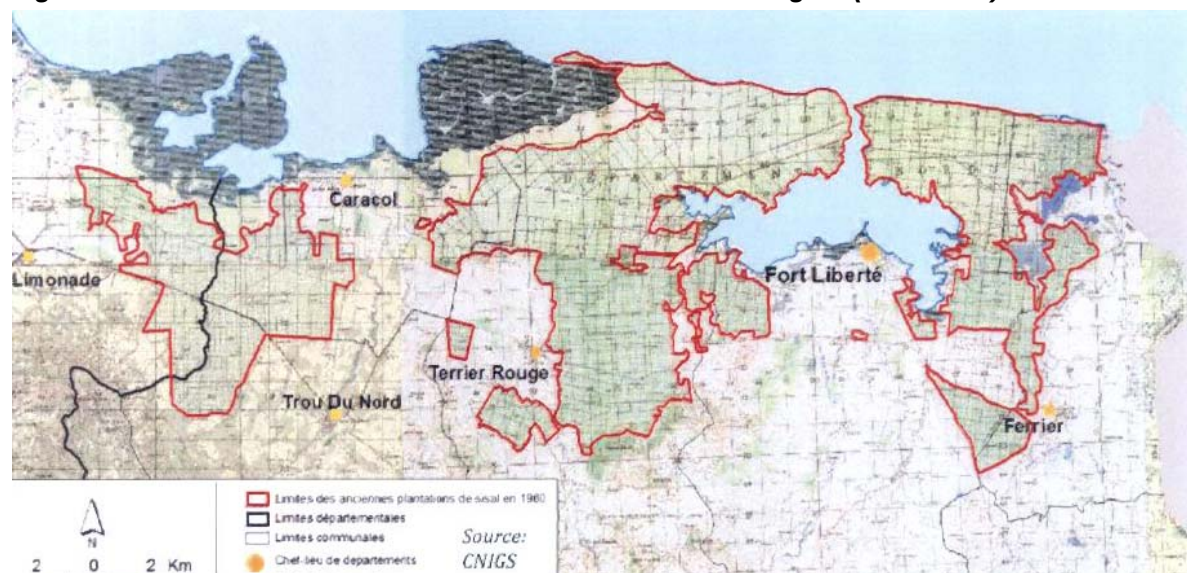
The northeast coast of Haiti is part of the Central Caribbean Marine Eco-region. Within this coastline, the Bay of Caracol holds the country's largest remaining mangrove forest as well as its longest uninterrupted barrier reef, which stretches over 40 kilometers between Cap-Haïtien and Fort Liberté (KOIOS, 2011; Toussaint, 2011). The bay contains brackish water that is fed primarily by the Trou du Nord River, as well as the Moulin and Ti Couline Rivers and surface runoff from Bor de Mer to "Four à Chaux" (or Foulachon / Foulachon). It is unique on the entire island of Hispanola. The Bay of Caracol's 3,900 hectares of mangroves represent 18% of the country's mangroves, second only in size to those at the Delta of the

Artibonite River (Toussaint, 2011). These mangroves shelter 13 species that are threatened or seriously in danger of extinction. According to a 2007 study, the Bay provides around US\$110 million a year in ecosystem services (FroProBiM – ReefFix, 2009).

The Bay of Fort Liberté has an additional 450 hectares of mangroves. To the east lies the Lagon-aux-Boeufs, a brackish lake of 450 hectares in the Commune of Ferrier. A body of water that was likely connected to the Bay of Fort Liberté and the Massacre River, this estuarine lake can be considered part of the eco-region of the Siete Hermanos islands, Laguna Saladilla and Laguna Salinas in the Dominican Republic (BirdLife International, 2008). Bird diversity is significantly higher at this lake than anywhere else in the coastal plains of Le Nord-Est.

As the first country to be colonized in the New World, this region's landscape has long been altered by human settlement, agricultural cultivation and exotic species introduction. Between the 1700 and 1800, as many as 200,000 people worked in the area of study on a substantial number of sugar, indigo and coffee plantations. After the revolution, historical records suggest that much of the coast was set on fire, with major impacts on terrestrial habitats, soils and rivers. In the first half of the 1900s, most of the area the Baie de Caracol and Baie de Fort Liberté was used for sisal production, which required the obliteration of native habitat and introduction of a foreign mono-crop that exhausted the soil.

Figure 7 Boundaries of the Former Sisal Plantations in the Region (as of 1960)



Source: CNIGS

These coastal ecosystems are also important sources of income for coastal communities, including the over 3,000 residents around the Baie de Caracol, and the nearly 20,000 people who live around the Baie de Fort Liberté and the Lagon-aux-Boeufs. Though residents rely on coastal waters for fish, on mangroves for charcoal and housing construction, and on coastal lowlands for salt production by clearing mangroves and building salt basins, communities have tended to overexploit natural resources, which have eroded over time.

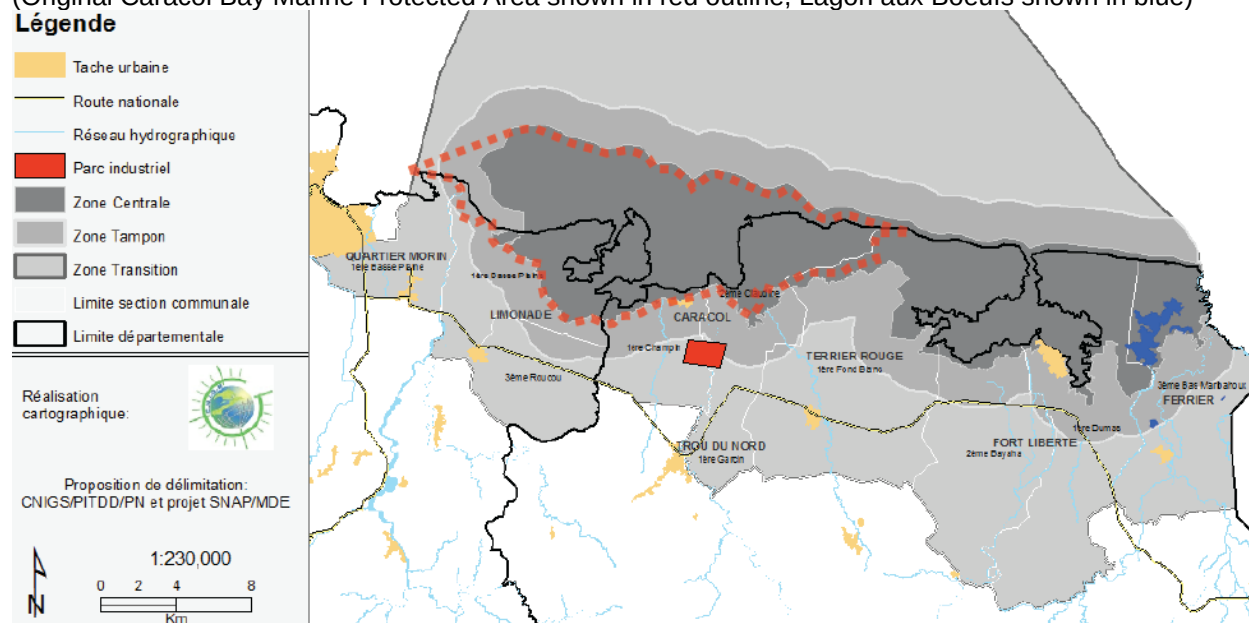
Since 1957, on average 30 hectares of the region's mangroves have been lost each year (MDE, 2012). Major deforestation of the mangroves began in 1986. White mangroves are used for housing construction and fencing, while red mangroves are used to produce lime for bakeries and laundries, and to make oars for canoes. Although there are ongoing projects to reforest mangroves, with nurseries of 45,000 red mangrove seedlings in Caracol and Derac, the projects' promoters have been disappointed with results to date and fear loss and waste of plants (SNAP-CNIGS, 2011). Fisheries have also been overharvested, with seine nets destroying marine resources, particularly when they catch juvenile fish that hatch and mature in the mangroves. Birds in the Lagon-aux-Boeufs are hunted by outsiders who come to the lake, while locals sometimes eat the birds or use toxic oils to poison birds that each pigeon peas (SNAP-

CNIGS, 2011). Locally generated solid waste, solid waste washed downstream and marine litter also cover the beaches and marine environments (UNEP, 2008).

The gradual decline of this critical ecosystem has motivated growing conservation efforts. In support of the Convention for the Protection and Development of the Marine Environment of the Wider Caribbean Region (the Cartagena Convention, which Haiti has not ratified), the European Commission is funding the Caribbean Biological Corridor in Cuba, the Dominican Republic and the Republic of Haiti through the MDE. This program has a funding of US\$42.7 million and began in 2009. It identified the Baie de Caracol and other coastal areas in Le Nord-Est for conservation due to their importance to the Caribbean region (Toussaint, 2011).

Figure 8 Map of the Proposed Parc de Trois Baie

(Original Caracol Bay Marine Protected Area shown in red outline, Lagon aux Boeufs shown in blue)



Sources: CNIGS, 2012; KOIOS 2011

In 2009, the MDE, GEF and UNDP proposed to establish a Baie de Caracol Marine Protected Area given its high ecological and fisheries value (Barbut, 2011). More recently, the MDE has enlarged the proposed area of protection to cover the bays of Limonade, Caracol and Fort Liberté as well as the Lagon-aux-Boeufs under the Parc de Trois Baies. The central protection zone would fall under strict control of the MDE and cannot be exploited without express permission of public authorities designated by the MDE. The buffer zone permits the use of natural resources and development of physical infrastructure, but requires public approval. The transition zone requires impact assessments in order for projects to move forward. A presidential decree to establish the park is under consideration.

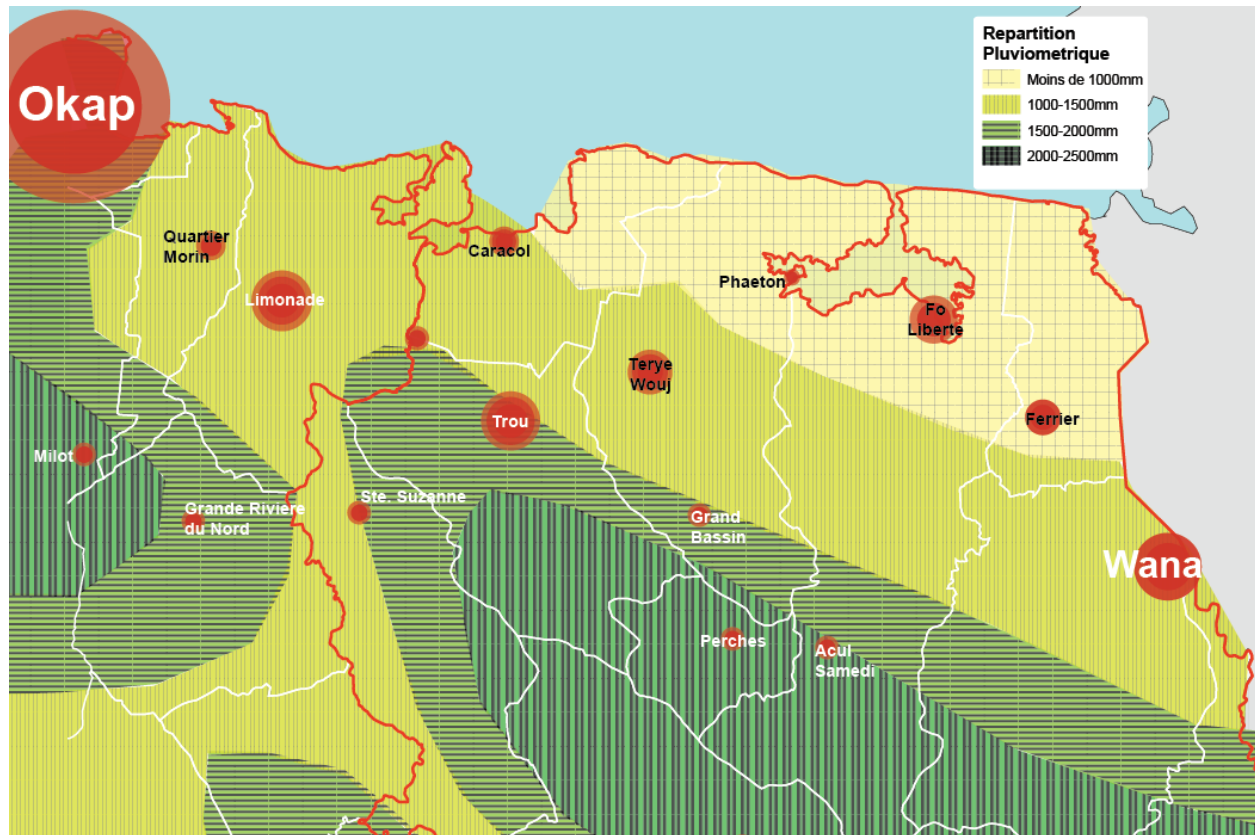
Within this planning exercise, the central zone of protection proposed under the Park of Three Bays is designated as a no-build or highly restricted construction zone.

3.2 VES 2: Surface and Ground Water Resources

The northern coast of the Departments of Le Nord and Nord-Est lies within the sub watersheds of Cap-Haïtien (325 km²), Grande Riviere du Nord (680 km²) and Limonade/Ouanaminthe (1,085 km²) (see Figures 9 and 10). These watersheds are characterized by major rivers that run from the mountains (Le Massif du Nord), which rise up to 1,210 meters above sea level in Le Nord, down to the coastal plains (MPCE, 1997a). The first two watersheds are characterized by significant land area in the mountains and piedmont, while the Limonade/Ouanaminthe watershed is mostly coastal. The primary rivers in the project study region are the Grande Rivière du Nord (serving Limonade and Quartier Morin), Rivière Trou du

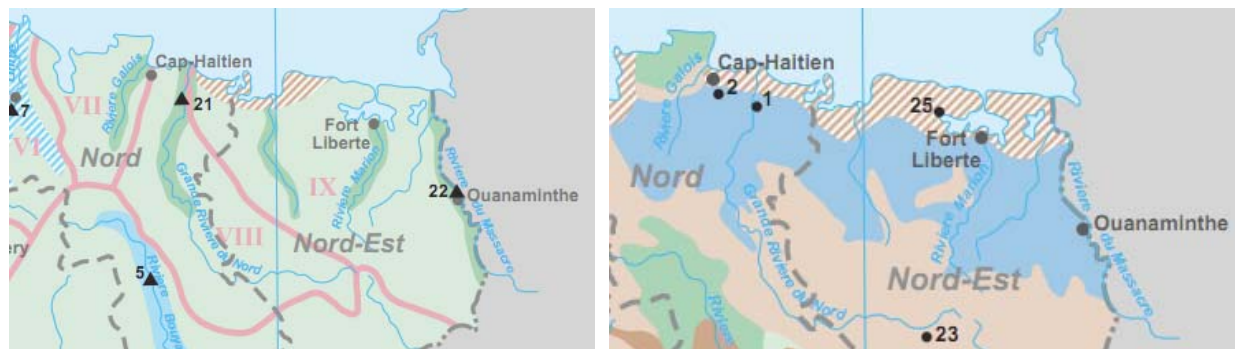
Nord (serving Trou du Nord and Caracol), Rivières Malfety and Marion (serving Fort Liberté), and Rivière Massacre, Jassa and Lamatry (serving Ferrier). Underscoring its arid conditions, Terrier Rouge is served only by a secondary river, the Ti Couline.

Figure 9 Rainfall Zones in the Region



Source: author, based on map from KOIOS, 2011

Figure 10 Water Resources in Le Nord and Nord-Est (Right: Plaine du Nord Aquifer shown in blue)



Source: US Army Corps of Engineers 1999

The 1991 study “Développement et Gestion des Ressources en Eau” found that the Department of Le Nord (when Le Nord and Nord-Est were still combined) had an average rainfall of 3,800 million m^3 per year (Mm^3/yr), 74% of which was lost through evapotranspiration. Of the remaining 1,000 Mm^3 , 880 Mm^3/yr entered the sea via surface runoff, 100 Mm^3/yr evaporates from the alluvial aquifers, 10 Mm^3/yr entered the sea through subterranean groundwater flows, and 10 Mm^3/yr for irrigation. Domestic and industrial water use was less than 4 $Mm^3/year$ (as cited in MPCE, 1997a). Numerous sources cite the Plaine du Nord as having 250 $Mm^3/year$ of water.

La pluviométrie et le relief divisent schématiquement la région en quatre bandes parallèles. Ces bandes s'étendent dans une direction sud-est nord-ouest :

- Une zone de plaine semi-aride partant de la côte et limitée par l'axe Jacquezy- Ferrier au sud. La pluviométrie se situe entre 900 et 1100 mm. par an et les sols sont constitués de calcaires coralliens sur la bande côtière, de vertisols basaltiques argileux et aussi d'alluvions plus ou moins fins le long des rivières qui coulent en direction nord-sud. En dehors des périmètres irrigués autour de Ferrier et Fort-Liberté où le riz et la banane sont cultivés (près de 2.000 hectares au total), la production agricole est marginale pour l'instant. L'élevage, la production de charbon à partir des peuplements d'épineux de forêt sèche et la pêche y sont les activités dominantes.
- Une bande de plaine plus au sud, limitée par l'axe Ouanaminthe-Bord de Mer Limonade en passant au sud du bourg de Terrier Rouge. La pluviométrie est de l'ordre de 1100 à 1300 mm. Malgré des sols fertiles, la production agricole porte surtout sur des cultures relativement résistantes à la sécheresse : manioc, arachide, pois nègre (vigna) et occupe une place secondaire. Les productions végétales demeurent encore risquées ici du fait d'une pluviométrie faible et de variations inter-annuelles prononcées. Les ressources abondantes en eaux souterraines sont peu exploitées pour l'irrigation. Aux activités extra-agricoles citées plus haut s'ajoute une importante production de sel sur la côte qui est commercialisée dans quatre départements du pays.
- Une bande au relief ondulé s'allongeant sur l'axe Capotille (à la frontière) - Trou du Nord en passant par l'Acul Samedi et Grand Bassin et une aire de plaine à l'ouest (axe Quartier Morin-Trou du Nord). Des précipitations de l'ordre de 1300 à 1400 mm. permettent une plus grande diversité de productions végétales et de meilleurs rendements. Les cultures vivrières y sont associées à un couvert arboré plus ou moins dense à base de mangue, noix de cajou, chêne et de campêche. Le maïs, le haricot, la patate douce et l'igname complètent la gamme de cultures déjà mentionnées. Le sciage de bois d'oeuvre est une ressource significative qui s'ajoute au charbon fabriqué à partir de raks de campêche, d'acacia et de mangue. Avec des densités de population faibles en dehors de la plaine, les surfaces d'exploitation sont relativement étendues.
- Une aire de basse montagne (400-600 mètres d'altitude) de Sainte-Suzanne à l'Oiseau (pointe sud de la commune de Fort-Liberté). La pluviométrie est élevée, se situant généralement entre 1500 et 1800 mm. Le couvert boisé y est encore important sur des sols basaltiques ou dioritiques assez profonds. Dans la commune de Ste-Suzanne et ses environs, des systèmes agroforestiers intègrent de la mangue et du bois d'oeuvre et des cultures de banane, haricot, igname et autres tubercules sous couvert. Le riz pluvial occupe les dépressions et fonds de ravine.

Northern Haiti has a large unconfined aquifer that by some estimates provides 250,000,000 m³ of water per year (ENVIRON, 2011). This is a highly valuable resource given the freshwater constraints faced by many islands. In the coastal plain, from Cap-Haïtien to the Massacre River, aquifers are mostly less than 0.5 to 2 meters below the surface, and are rarely more than 20 or 30 meters below the surface. Given the alluvial and sandy soils of most of the plain, the coastal aquifer is highly porous and easily contaminated, particularly from salt water, latrines, unsanitary landfills, gas stations and transport hubs (MPCE 1997a). It also poses a challenge to farmers whose soils tend to become waterlogged. The growing impermeability in Cap-Haïtien is preventing aquifer recharge (Smucker et al., 2007).

For this planning exercise, primary and secondary rivers are given a 16-meter buffer on either bank, in line with the *Décret du 6 janvier 1982*, which sets a 16-meter buffer for littoral areas. These best practices promote riparian habitat, which help to ameliorate river flow rates, absorb floodwaters, minimize human settlement risks and provide habitat. By law, water reservoirs are given a 5-hectare protected area. The ongoing DINEPA water and sanitation studies will identify these and propose new points. These sources should be added to the map of protection / no-construction once identified.

The present assessment of impacts will pay particular attention to planned urbanization that has the potential to contaminate the aquifer given its porosity, as well as to river water quality given that they

drain into the coastal marine ecosystem. As the aquifer is unconfined, it is much harder to protect, although at a minimum wells should be located at a safe distance from latrines and landfills. A number of ongoing water studies and investments depend on the unconfined nature of the aquifer. This CIA recommends that an aquifer mapping study be conducted for the region to understand the underground availability and the flow dynamics of water in the development corridor, especially given the danger of saline intrusion.

Figure 11 Map of the Corridor's Watersheds, Rivers and Lakes



Source: CNIGS

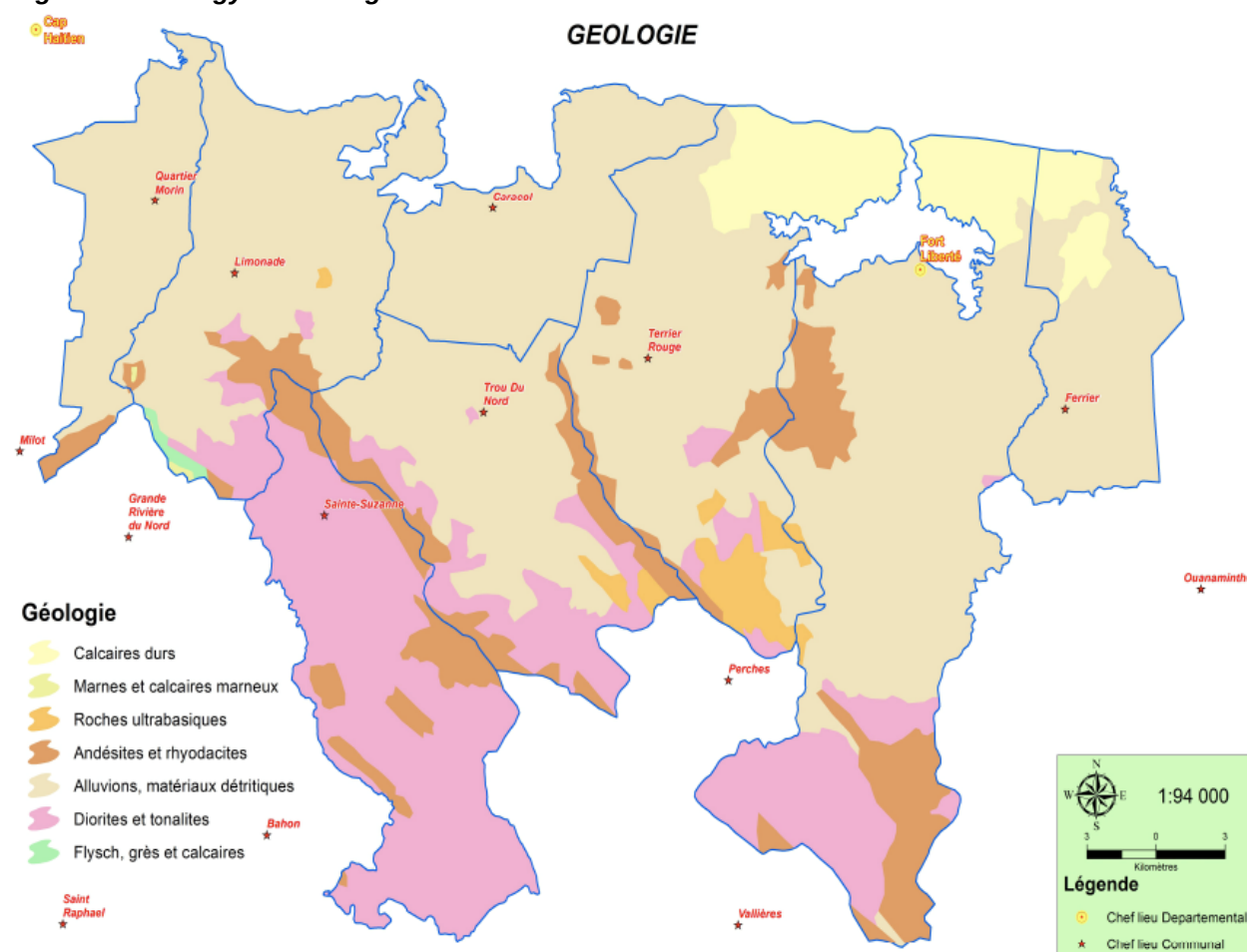
3.3 VES 3: Highland Watershed and Riparian Habitat

Like much of the rest of the country, the mountains of the northern coast have been heavily deforested due to growing pressures for agricultural land and for multiple harvests. In the 1980s and 1990s, intensifying demand for charcoal and construction materials for use in the region, Port-au-Prince, Gonaïves and other countries also drove deforestation. By 1997, forest cover in Le Nord accounted for just under 1% of the land area in the plain and piedmont (need to get more recent numbers, and for montane areas, Le Nord-Est). The overall decline in forest cover has increased surface runoff and the formation of troughs and gullies, and has increased downstream flooding and rivers overflowing their banks in Quartier Morin and Limonade, located within the floodplain of the Grande Rivière du Nord.

Even so, it is important to note that these northern watersheds have more tree cover than most areas in Haiti. Rural communities in these mountains tend to grow a polyculture of coffee, bananas, vegetables, manioc and other fruit trees, a mix that has helped keep the northern mountains among the most forested in the country. In an important change from previous decades, communities now sustainably harvest tree trimmings to produce wood fuel and charcoal. Smucker, et al.'s 2007 assessment of watershed vulnerability in Haiti found that "In many areas [including Perches and Grande Rivière du Nord], farmers have demonstrated a vested economic interest in shifting away from annual cropping to heightened reliance on perennial polycultures on hillsides. In retrospect, the distribution of free or highly subsidized seedlings has proved to be a successful strategy for transforming local landscapes." Through an investment of \$665 per hectare over five years by a PADF/PLUS pilot project, farmers now reaped \$220 per hectare per year. Strong local focus on multiple rural concerns, coupled with long-term NGO commitment, social science and technical assistance facilitated the success of these efforts.

At present, however, there are no watershed management plans for watersheds in the Cap-Haïtien-Ouanaminthe region. However, the Government of Haiti did initiate in 2009 the Natural Disaster Mitigation Program in Priority Watersheds, a program supported by a US\$30 million grant from IDB. The program works in three watersheds, including the Grande Rivière du Nord, and aims to promote “the adoption of economically viable technological packages that promote agriculture intensification, soil conservation and sustainable resource management among 11,000 farmers (IDB Technology Transfer to Small Farmers, 2010). This represents the main “bassin versant” project in the Cap-Haïtien-Ouanaminthe region.

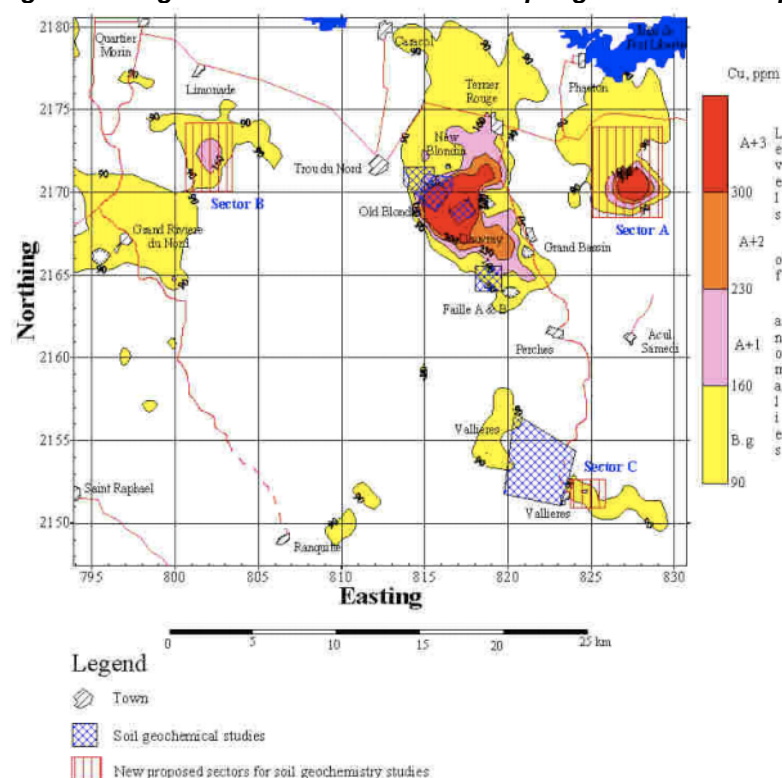
Figure 12 Geology of the Region



Source: CNIGS

Although the urban corridor lies largely on alluvial soils, the Massif du Nord mountains and foothills reach into the coastal plains and featuring andesite with basalt and other sedimentary rocks. Northern Haiti possesses gold and copper mineral wealth, known to the western world since the 15th century. According to the prime minister, some US\$20 billion worth of copper, silver and gold are buried in the hills of northern Haiti (*The Guardian*, 2012). Mining in Le Nord/Nord-Est began in the early 20th century with limited copper exploration near Limonade before 1924, followed by the extraction of 2 million tons of grading 2% copper in Mémé from 1960 to 1971 (Majescor, 2009). The 1960s to 1980s saw a number of exploratory studies by private companies as well as by UNDP and the German Government, showing significant copper, copper-gold and gold prospects, centered on the Douvray and Blondin deposits (between Terrier Rouge and Trou du Nord), where copper exists at greater than 200-400 parts per million, as well as the Faille B quartz vein gold in the area of Grand Bassin (Majescor, 2009).

Figure 13 Regional Stream Sediment Sampling Results for Copper



Source: Valls, 2004 as cited in Majescor, 2009

3.4 VES 4: Air Quality

The issues of both atmospheric and indoor air quality remain largely neglected in Haiti, where there are no known environmental and public health regulations or air quality standards. Due to the country's low level of economic development, energy consumption are very low, even compared to other low-income countries. On average, Haitians use 272 kg of oil equivalent per year in energy, with 76% of this is in the form of biomass products. Electricity consumption is only 37 kWh per year, compared to 309 kWh/year in other low-income countries (LICs) and 1,808 kWh/year in other Latin American and Caribbean (LACs) countries (World Bank, 2009). In Haiti, around 53% of electricity is generated through fossil fuels and 47% is generated through hydropower (World Bank, 2009). In Le Nord/Nord-Est, the only hydropower facility is a 0.9MW facility on the Caracol River serving communities in Grand Riviere du Nord, suggesting that electricity in the region of study draws mainly on fossil fuels, and to a very minor extent on solar and wind.

Indoor air quality is the primary issue of concern, given the reliance on wood fuels and charcoal for cooking. Smoke from stoves includes particulate matter, carbon monoxide and carcinogens and increases the risk of pneumonia and other acute lower respiratory infections (the number one cause of death among children under five in Haiti), as well as chronic obstructive pulmonary disease, with women and children who spend long hours near the fire at particular risk (Smucker et al., 2007). According to a WHO 2004 assessment, indoor air pollution in Haiti is attributable to 1,497 disability-adjusted life years (DALYs) per 100,000 and 11,098 DALYs per 100,000 children under the age of five, pointing to the high level of impact indoor smoke has on children in particular (WHO-GHO). In 2004, indoor air pollution was attributable to 297 deaths per 100,000 children under age 5 and 40 deaths of those over age 5; today, those same rates in the northern corridor's urban population would translate to 3,000 child deaths per year. These levels correspond with rates in countries with similar Human Development Index rankings. An earlier UN study estimated that indoor air pollution shortens lifespan in Haiti by 6.6 years (Smucker et al, 2007). The government of Haiti, in partnership with international organizations, is working to transition towards more efficient cook stoves and alternative fuels to mitigate this risk.

Given low levels of energy consumption, Haiti's per capita CO₂ emissions are low, at 0.2 metric tons per capita per year, compared with 0.6 in other low income countries and 2.5 in other LAC countries. Accordingly, the rate of growth of emissions is extremely high, rising 78% from 1990 to 2005, roughly double that in LICs and LACs. Since the 1990s, particulate matter has decreased, falling to 33 micrograms per cubic meter in urban areas in 2012 from 43 in 2002 (World Bank Development Indicators). However, other pollutants such as nitrogen and sulfur oxides and toxic pollutants, which are currently not measured, may likely increase as the northern corridor urbanizes.

Although no studies have been done on the relative contribution of different sectors to emissions in Haiti, one can deduce that in the northern corridor the main impacts can be attributed to vehicular exhaust, dust from unpaved roads and the burning of solid. Around half to three-quarters of trash is organic in the north, much of which decomposes, is composted, or is eaten by animals. The remaining trash that is burned is mostly plastics and other non-biodegradable materials. Their incineration in low-temperature open fires releases large amounts of common pollutant such as sulfur and nitrogen oxides, carbon monoxide, volatile organic compounds, particulate matter and methane, as well as toxic pollutants such as persistent organic pollutants (POPs, such as dioxins and furans), acetone, styrene, phenols, PCBs, polycyclic aromatic hydrocarbons, formaldehyde, hydrogen chloride, hydrogen cyanide and heavy metals. The ash, which then enters waterways and the food chain, can also be toxic.

3.5 VES 5: Soils and Agriculturally Valuable Areas

Une zone à fort potentiel agricole mais encore faiblement valorisée. La région d'étude comprend plus de 30.000 hectares de plaine. Il s'agit donc d'une aire équivalente à la surface de la Vallée de l'Artibonite, principale aire de plaine du pays. Les sols de plaine du Nord et Nord-Est sont majoritairement argileux, profonds et potentiellement très productifs. Cependant, à la différence de l'Artibonite, les ressources en eau de surface des départements du Nord et Nord-Est sont limitées, en dehors des eaux de la Grande-Rivière du Nord à l'ouest et des rivières Lamatrie, Jassa et Marion à l'est. Moins de 2.000 hectares sont irrigués actuellement dans l'aire d'étude et, du fait d'une pluviométrie globalement faible et irrégulière, les ressources en sols sont peu valorisées.

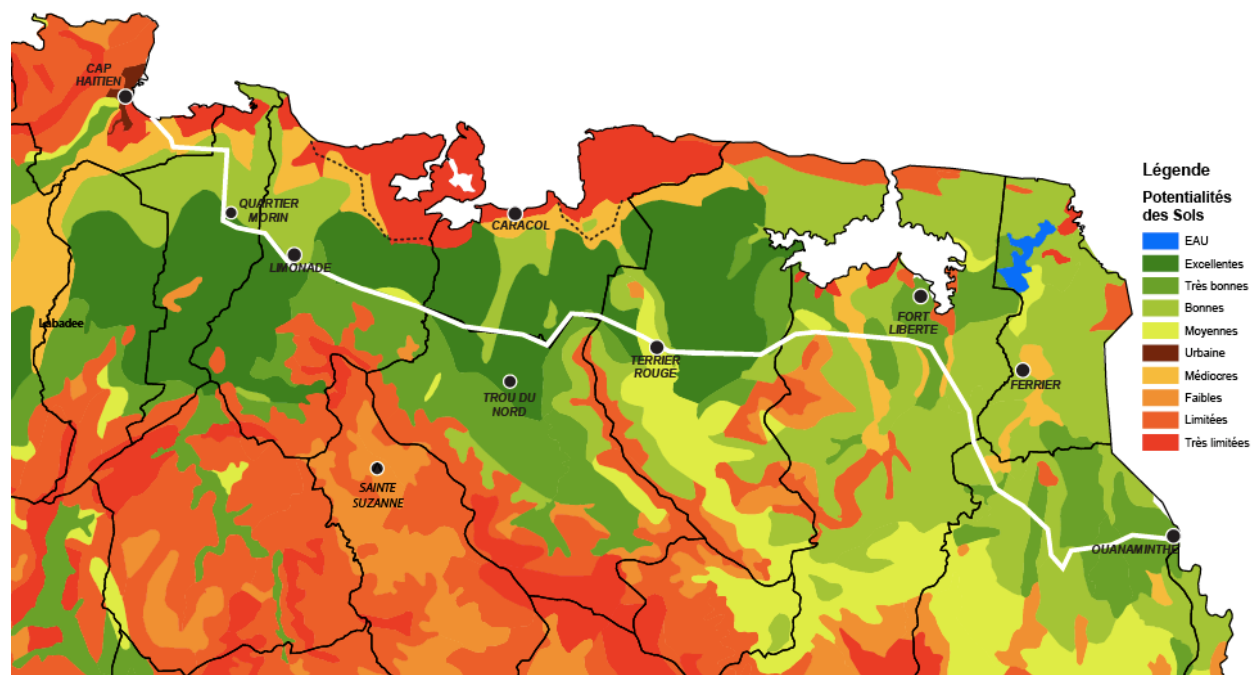
Les surfaces potentiellement irrigables par les eaux de surface sont au total de l'ordre 10.000 hectares. Cette surface se compose de 8.000 hectares dans le Nord-Est, situés principalement dans le Bas-Maribaroux sur la frange est, et d'environ 1.500 hectares à l'ouest. Les quantités d'eau souterraines n'ont pas été évaluées avec précision jusqu'à présent mais paraissent abondantes, avec une nappe se situant à moins de 40 pieds de profondeur en saison sèche sur de larges étendues du territoire. On peut raisonnablement estimer que 2 à 3.000 hectares supplémentaires puissent être irrigués par pompage de la nappe.

Ces surfaces irrigables sont d'une étendue proche de celle de la plaine des Cayes (sud du pays). Avec irrigation et en supposant des cultures intensives sur deux saisons de l'année, les terres de plaine de la région pourraient fournir régulièrement plus de 40.000 TM d'équivalents-céréales, soit près de 10% des quantités de céréales (toutes catégories confondues) produites actuellement à l'échelle nationale. En supposant par ailleurs une saison de haricot associée en fin d'année aux cultures de maïs, plus de 10.000 TM de légumineuses s'ajouteraient à ce total. Les enjeux sont ainsi importants sur le plan de la sécurité alimentaire future du pays car les plaines du Nord et du Nord-Est concernées pourraient ainsi nourrir environ 250.000 personnes de plus qu'elles ne le font actuellement.

La région est présentement largement déficitaire en céréales, riz et maïs (le sorgho n'est pas planté ici en raison du régime des pluies). Elle est toutefois excédentaire en tubercules. La production de manioc amer, culture résistante à la sécheresse, alimente un réseau de cassaveries (galettes de manioc) qui sont commercialisées jusqu'à Port-au-Prince. Des surfaces importantes en igname, du taro et patate douce sont cultivées dans les montagnes de Sainte Suzanne et Trou du Nord ainsi que dans la plaine dans la commune de Limonade. Les aires de culture de banane sont étendues depuis Trou du Nord jusqu'à Quartier Morin. Les communes de Quartier-Morin et Limonade constituent aussi une des plus importantes zones de culture de canne du pays. La canne est transformée par une unité industrielle de production d'alcool et plus d'une cinquantaine de petites distilleries. Celles-ci sont également importantes

pour la transformation du sirop de canne en provenance du Plateau Central en alcool. Une production significative de cacao existe également dans la plaine de la commune de Trou du Nord et les montagnes de basse altitude des communes de Quartier Morin et Limonade.

Figure 14 Map of Corridor's Soil Potential



Source: CNIGS

Même les plaines arides à sols pierreux et séchants entourant Fort-Liberté à l'est et à l'ouest (les « fredoches » coloniales) ont une fonction productive. Elles possèdent des réserves de bois étendues et contribuent à rendre la région plus auto-suffisante pour ses besoins énergétiques. La gestion qui est faite du couvert boisé, avec des espèces qui produisent des rejets après coupe pour la fabrication de charbon (bayahonde (*Prosopis juliflora*), « watapana » (*Caesalpinia coriaria*), et « cambon » (possiblement une espèce d'acacia)) constitue un mode de conduite durable du couvert arboré. Ces parties plus sèches sont aussi valorisées par un troupeau bovin et équin important pour la satisfaction des besoins en viande des villes et des besoins en animaux de bât pour le transport.

Actuellement, les cultures sont conduites essentiellement sous régime pluvial, avec une pluviométrie annuelle dans l'ensemble faible dans la plaine. Elle varie entre 900 et 1300 mm selon le lieu et présente de fortes variations inter-annuelles. Ceci rend certaines productions végétales risquées (maïs et haricot particulièrement). La pluviométrie des parties montagneuses est toutefois assez importante. Elle atteint près de 1800 mm dans les hauteurs de Sainte Suzanne. Ce niveau de précipitations dans les mornes constitue à la fois un atout et une contrainte pour la région car en même temps qu'elles alimentent des réserves en eaux souterraines considérables, ces pluies entraînent aussi un risque élevé d'inondation par les eaux de surface lors des orages à forte intensité qui se développent en saison chaude.

Annex 2 lists priority actions to help boost agricultural productivity and conserve water and soil.

3.6 VES 6: Culturally Valuable Areas

The northeastern region of Haiti has the longest and debatably richest historic heritage on the entire island of Hispaniola. Its built, cultural and religious resources have been widely documented through numerous field surveys and historical research.⁷

The northeast has documented evidence of the earliest Pre-Columbian Amerindian sites, not only in Haiti, but possibly in the West Indies. The areas in and around the region of Ft. Liberté hold a significant number of early lithic (stone tools of hunters and gatherers) sites (Archaic). These early Pre-Columbian sites, possibly as old as 4,000 B.C., flourished as evidenced by the equally large number of known later (Arawak and Taino) archaeological sites of large agricultural villages throughout the region. These are valuable archaeological finds, not just for Haiti itself, but for the entire Greater Antillean Basin, and the possibilities remain of early Amerindian contact between Haiti and the Mississippi Valleys of North America.

Figure 15 Regional Map of Cultural and Natural Heritage Sites



See Section 6.6 for a complete list of sites, not all of them could be located on a map

The earliest known European settlement in the New World also occurred in this corridor. Christopher Columbus' first settlement attempt in the newly discovered lands was La Navidad, a known archaeological site east of Cap-Haïtien, near Limonade/Caracol.

The region was the location of the earliest and most successful slave revolts in the New World, fighting against Spain and France, including the armies of Napoleon. This resulted in the first free Black Republic in the New World, Haiti. The colonial rule of this region and later military endeavors resulted in a rich archaeological heritage in the forts, fortifications and military canons that the history of these struggles has left along the northeastern landscape. No other part of Haiti can lay claim to as rich a military history as the northeastern corridor.

7 See for instance: Millet, Jeanine L. Summaries for the towns of *Caracol, Ferrier, Ft. Liberté, Limonade, Quartier Morin, Ste. Suzanne, Terrier Rouge* and *True du Nord*, CIAT and AIA, 2012. Moore, Clark and Nils Tremmel. *Settlement patterns in Pre-Columbian Haiti: an inventory of archeological sites*. Ms. 1997. Rainey, Froelich G. and Irving Rouse. *Excavations in the Ft. Liberté Region, Haiti*. Yale University Publications in Anthropology 23-24, New Haven. 1941. Rouse, Irving. *Prehistory in Haiti: study in method*. Yale University Publications in Anthropology 21, New Haven. 1939.

The early parts of the 20th century saw the introduction of North American investments into Haiti, with the development and operation of the large sisal industries of this corridor. The remains of these facilities, as well as the sugar and indigo plantations of the 18th and 19th centuries, likewise constitute a rich potential for the use of these historic and tourism resources.

The corridor's potential is not only limited to land-based historical resources. The maritime history of this region is also a significant resource including underwater archaeology, traditional shipbuilding, fishing traditions, and the historical implications of maritime trade throughout the Caribbean Basin. Although traces no longer exist, the coast off of Limonade and Caracol is the final resting place of Christopher Columbus' Santa Maria ship.

The built environment of the northeast corridor of Haiti is likewise characterized by an extremely rich architectural heritage. Structures and buildings that date from the 16th through the 20th centuries include a variety of construction technologies ranging from the traditional wattle-and-daub and wood typologies, to rubble and ashlar masonry colonial structures, to the present-day cement block and reinforced concrete prototypes. Hybrid examples of these buildings exist as well, and oftentimes include the unique and colorful decorative expressions of Haitian culture.

The touristic potential of these resources, which remain largely untapped, as well as the inherent value in reestablishing and fortifying the cultural identity of the Haitian people should, and can, be a valuable research area, economic and cultural resource base for the harmonious and successful development of this part of the island.

Haiti has legislation regarding historic patrimony dating back to 1940:

- Law of 23 April, 1940 on the historical, artistic, natural and archaeological heritage
- Law of 1 July, 1983 creating the Haitian National Institute of Culture and Arts
- Law of January 1995 creating the Ministry of Culture and Communication
- Law-decree of 31 October 1941 creating an Office of Ethnology
- Decree of 4 August 1950 on the National Museum
- Decree of 10 May 1989 creating the National Heritage Commission Ministerial order classifying the building and objects of the Printing House Museum (project) as belonging to Haitian national heritage.
- National legislation on "The Emergency Red List of Haitian Cultural Objects at Risk" published by ICOM, 2010:

Recent initiatives have continued important preservation processes necessary to identify and document important historic Haitian architecture throughout the country under the Republic of Haiti's National Heritage List coordinated by the Institute for the Conservation of National Heritage (ISPAN). Since the earthquake, the U.S. has helped fund the publication of a catalog of historic sites and UNESCO has helped revise Haitian law on the protection of built heritage.⁸ New government initiatives focus on building strong public institutions and modern legal frameworks to protect built heritage in Haiti.

Despite these laws and policies, the lack of funding on the ground has led to the continued neglect and deterioration of the region's architectural and urban heritage. New development in the northeast corridor threatens what is left of the cultural heritage unless special efforts are made to highlight and restore each town's unique resource. As the northeast corridor considers new investments to upgrade towns along the corridor, it has the opportunity to leverage historic legacies for new economic growth.

8 For more information, see UNESCO's "UNESCO in Action: Working Together for Haiti" brochure (available online at: <http://tinyurl.com/cmxxvjf>). The inventory also received US\$41,500 in support from the U.S. Embassy in December 2011 (see: <http://tinyurl.com/8o5jv3f>).

PART 4: LAND USE CONSIDERATIONS

4.1 Natural Hazards and Risks

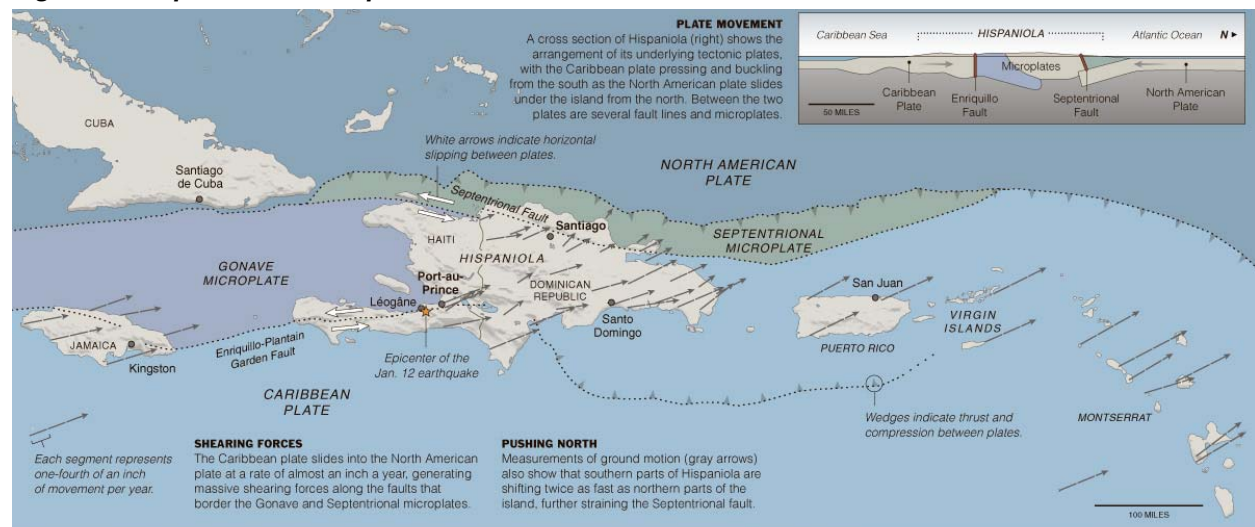
The corridor is primarily vulnerable to a number of natural hazards: intense precipitation and earthquakes, which in turn trigger flooding, liquefaction and landslides. In Le Nord-Est, some communities are also vulnerable to drought, and cannot afford to install groundwater pumps and irrigation systems that would make their economic base more resilient and productive. Hurricanes cross the region, although the north is less vulnerable than other parts of the country. Few, if any, areas along the corridor have no or low physical vulnerability to natural disasters.

In this context, it is important to identify areas that are more suitable for growth and present the fewest risks to communities without resources to build safeguards. All projects in the region should pay particular attention to public infrastructure provision and construction siting, design and quality in light of earthquake hazards and flood vulnerability. The following section reviews the major risks to the region: earthquakes, tsunamis, liquefaction, floods, droughts and landslides. It draws extensively on the 2011 *Analysis of Multiple Natural Hazards in Haiti* (NATHAT).

4.1.1 Earthquakes, Tsunamis and Liquefaction Risks

In the past 500 years, the region of Puerto Rico, the Virgin Islands and Hispaniola has witnessed 13 earthquakes with a magnitude greater than 7.0 (Dawicki, 2005), at an average rate of one major earthquake every 40 years. The island of Hispaniola is located between two major parallel coaxial left lateral moving slip faults. To the north, the Septentrional Fault traverses the Cibao Valley in the Dominican Republic and lies just off the northern coast of Haiti. The last major earthquake along this fault in the Dominican Republic was around 800 years ago, while the part that lies above the northern coast of Haiti last ruptured in 1842, when it destroyed much of Cap-Haïtien. A 2003 study of the fault in the Dominican Republic concluded that adequate stress had accumulated to produce a destructive – possibly 7.5-magnitude – earthquake in the future (Prentice, et al., 2003; Rowan, 2010). Scientists expect that the portion north of Haiti, if it were to erupt completely all at once, would be a 6.9-magnitude earthquake (Rowan, 2010).

Figure 16 Map of Coastal Septentrional Fault

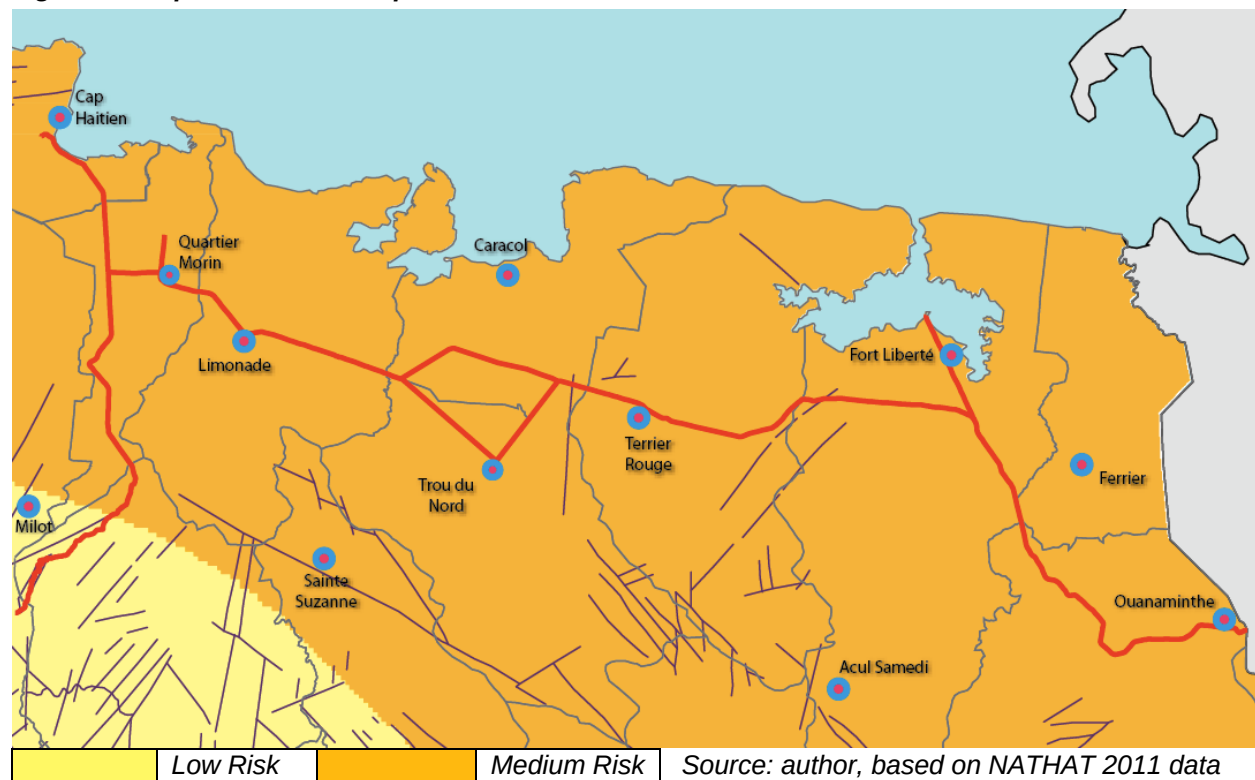


Sources: Paul Mann, University of Texas at Austin; Eric Calais, Purdue University; Geological Society of America; American Geophysical Union; U.S. Geological Survey; Gebco; Collins Bartholomew

JONATHAN CORUM/THE NEW YORK TIMES

Source: Fountain, H. New York Times 2010

Figure 17 Map of Inland Earthquake Faults and Seismic Risk



To the south lies the Enriquillo-Plantain Garden Fault, the rupture of which resulted in the 7.0-magnitude earthquake of January 12, 2010. The last major earthquake along this fault took place 240 years ago, part of a century-long series of earthquakes that began in 1751 in the Dominican Republic at the eastern end of the fault and gradually moved westward. There is a possibility that the 2010 earthquake is the first of a new series of earthquakes along this fault. Although of minimal direct risk to the north, such earthquakes could cause migration to the region, as was seen in 2010.

The region between the two faults comprises a number of minor platelets that create a maze of smaller faults, whose relationship with the larger faults is unclear. None of the cities in the corridor, with the exception of Sainte-Suzanne, are located along an inland earthquake fault. According to NATHAT's evaluation, the entire region of study lies in an area of moderate risk to earthquakes.

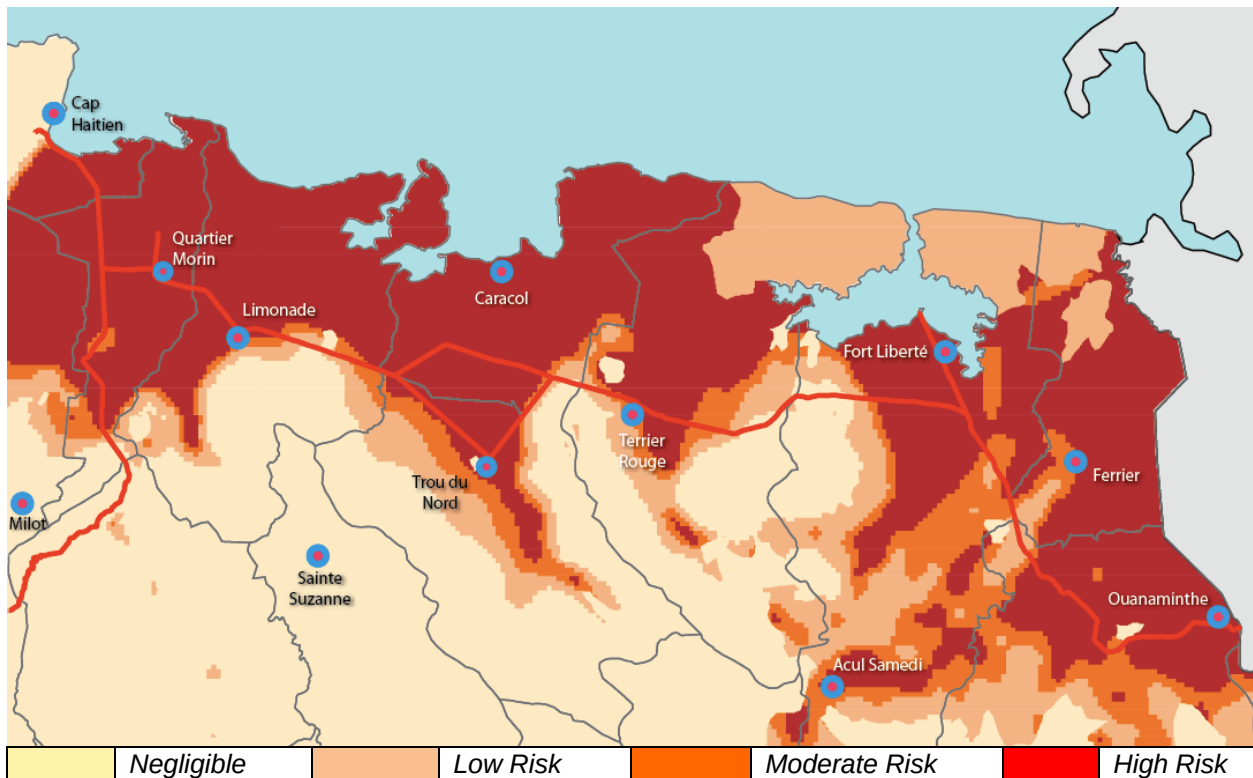
Tsunamis are much rarer in the region. Smaller tsunamis can occur after earthquakes of magnitude 7.0 to 7.5, while tsunamis of greatest concern usually follow earthquakes with a magnitude above 7.5 (Gill, 2010). The 2010 earthquake in Haiti led to a small tsunami with 3-meter waves that hit the coast and killed three (Dell'Amore, 2010). Before that, the last tsunami took place in 1946 after an 8.1-magnitude earthquake struck the northeast coast of the Dominican Republic. That tsunami generated 2.5- to 5-meter waves that killed 1,600 (Dawicki, 2005). Historical accounts also indicate there was a tsunami felt after the 1842 earthquake on the Septentrional Fault, with 2-meter waves. The 1860 earthquake in Port-au-Prince and Anse à Veau was also reported to have caused the sea to withdraw and break with a crash on the shore. Given foreseeable magnitudes of earthquakes off the northern coast of Haiti, a severe tsunami is less a concern than the structural security of buildings in the face of a 7.0 earthquake. Nevertheless, a study mapping coastal elevation and risks to tsunamis is needed.

Figure 18 Map of Tsunami Risk in the Region



Source: author, based on NATHAT 2011 data

Figure 19 Map of Liquefaction Risk in the Region



Source: author, based on NATHAT 2011 data

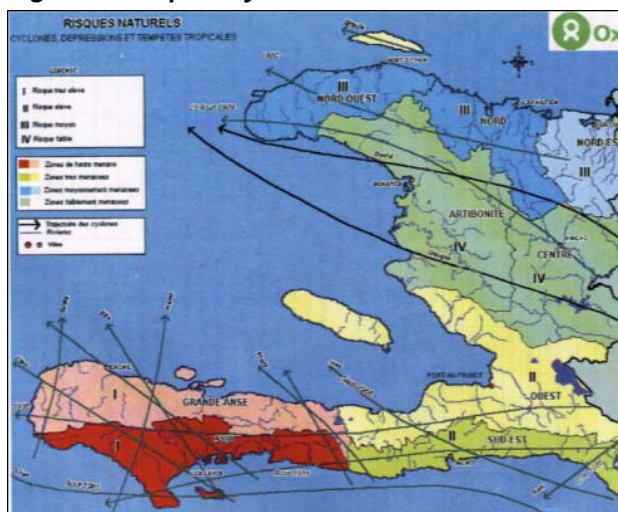
The geotechnical aspects of the region's alluvial plain increase its vulnerability to seismic risks. Liquefaction presents the biggest risk because it has no obvious morphological signature but it can be identified through geotechnical procedures. Areas with a shallow water table such as river basins, coastal deltas and areas where the groundwater aquifer is close to the surface are particularly risky. The mixed the intermittent layers of saturated clay, sand and water in the subsurface structure quickly loose their load bearing and shear capacity during a seismic event causing the ground to well and flow. Tall heavy structures, ports, airport and roads are particularly vulnerable and have been known to sink or topple over. Unreinforced multi-story buildings are particularly vulnerable to liquefaction. Geotechnical study of soils and properly engineered structures and infrastructure can reduce the risk to liquefaction.

4.1.2 Flood Risks

Cyclones, tropical waves and local convective storms all contribute to flooding in the region. Each of these poses a flood hazard of varying intensity and propensity.

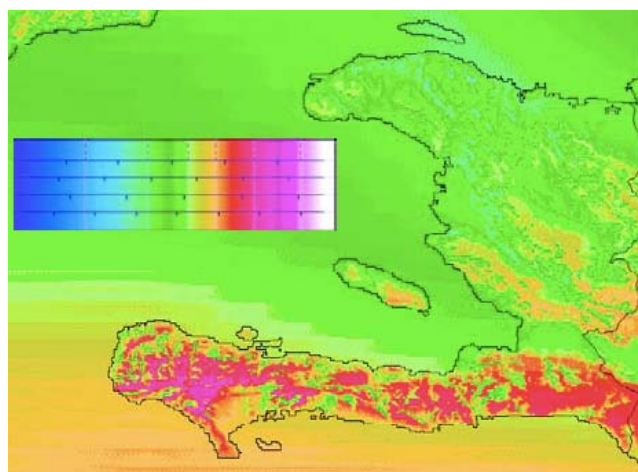
- Cyclones (storms and hurricanes) can produce as much as 600 mm, and can affect the entire country. Historically, the northern coast faced fewer hurricanes than the rest of the country, the last two taking place in 1900 and 1979. Although climate change may increase in the severity and frequency of these storms, such storms fall into the exceptional hazard range.
- Tropical waves relate to much larger disturbances, with accumulations of 400 mm in a 24-hour period. They fall into the less frequent and somewhat rare hazard range.
- Convective storms, as assessed by the Meteorological Centre of Haiti, can produce as much as 200 mm of rainfall in a few hours over very localized areas. This type of precipitation falls into the frequent hazard range.

Figure 20 Map of Cyclone Paths and Risks



Source: Mathieu et al., 2001 as shown in Louis, 2003

Figure 21 Map of Maximum Likelihood of Return of 50-Year Hurricanes



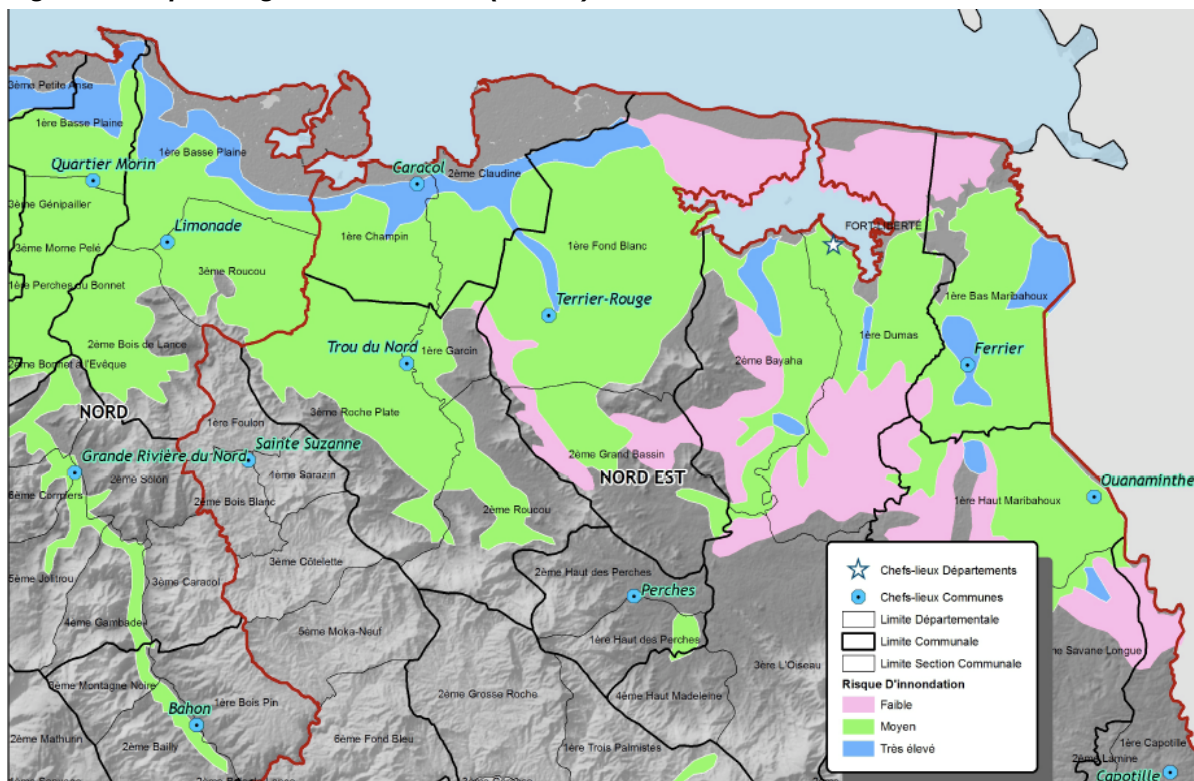
Source: Wagenseil, 2000 as shown in Smucker et al., 2007

The northern plain lies at very low elevation, and slowly rises from sea level to 175 meters above sea level at the piedmont. Historical accounts of devastating floods in Trou du Nord and Limonade from the 1700s indicate that these floods took place even before widespread changes to the forest cover (Moreau de Saint Mery, 1797). Combined with the region's high precipitation profile, these factors make the northern coast prone to flooding from the rivers draining the Massif.

Flood risk can only be estimated since topographical maps exist only at the 90-meter level. According to the National Center for Geospatial Information (CNIGS), most of the coastal plain of Le Nord and Nord-Est faces medium to high risk of flooding. The NATHAT evaluation is more generalized, and places the

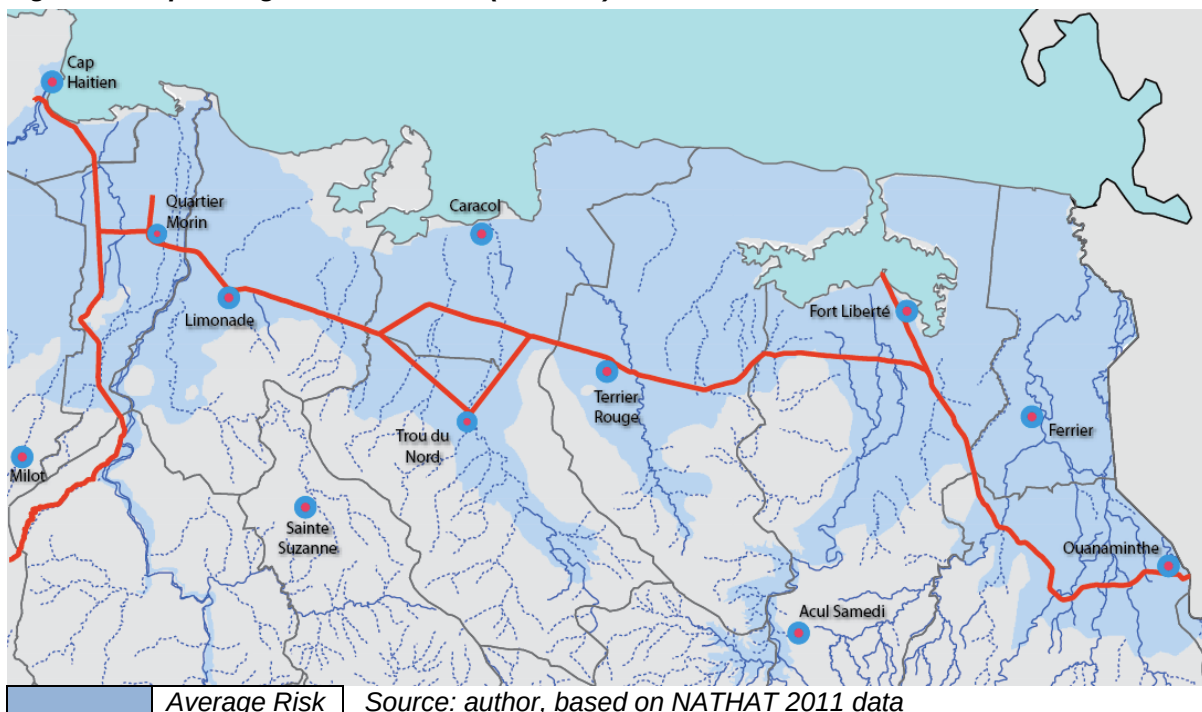
entire region at average risk, in comparison with the rest of the country. Detailed topographical and flood mapping should urgently be addressed.

Figure 22 Map of Regional Flood Risk (CNIGS)



Source: CNIGS

Figure 23 Map of Regional Flood Risk (NATHAT)



Source: author, based on NATHAT 2011 data

All cities in the study area, with the exception of Sainte Suzanne, lie within 90 meters or less of sea level, and most are situated alongside or near primary rivers in the region. These towns and cities are vulnerable to both flooding caused by overflowing rivers as well as undrained stormwater running off the city's impermeable surfaces. Oxfam, Plan International, the EU and others have developed flood risk maps for Cap-Haïtien as well as cities in the Nord-Est.⁹ These maps show that, in most cases, the historic cores of cities were located outside the areas of greatest flood risk. As cities expanded, however, the increasing demand for land often led poorer households on the periphery to build in areas of higher risk. This is most obvious in Cap-Haïtien where Petite Anse and other *quartiers* have built on swamps and floodplains. In the community workshops, local residents were usually well aware of the areas of risk and could identify areas of lower risk for urban expansion. Land ownership patterns, however, have not always made it possible for new households to build in these areas.

The region's watershed has increasingly lost its ability to maintain the normal water cycle of the region as:

- Deforestation increases as trees are cut for fuel and construction destabilizing slopes.
- Waterways lose their absorptive capacity as they become altered by gravel and sand mining for construction and storm water run off contains high quantities of silt from slope failures.
- Impermeable surface areas are steadily increased through sprawl development and critical urban green spaces are eliminated with anarchic growth.
- Waterways and limited drainage systems are used for refuse disposal reducing their ability to carry water and maintain aquatic life. In Cap-Haïtien, for example, the stormwater system was built in the 1950s, and its design capacity cannot accommodate current levels of stormwater.

These compounding factors have led to severe floods even during short, minor storms (MPCE, 1997a).

With ongoing and planned investments in the coastal corridor, the region will continue to witness and slow to negative population growth in the mountains, and an outmigration into coastal cities. According to Smucker, et. al. (2007), the depopulation of the mountainous areas is the most fundamental strategy for enhanced watershed sustainability by decreasing the use of slopes for unprotected annual crops, and promoting the establishment of high-value perennial crops on slopes, including silviculture, fruit trees and farm forestry. If adequately supported, these changes would have a positive long-term effect of reducing downstream flooding. At the same time, these population movements concentrate population in coastal areas, where they will be at greater risk to flooding, cyclones, and multi-story buildings that are susceptible collapse in the event of an earthquake unless built to standard. Rural to urban migrants will also shift from using fuelwood to charcoal, a product that takes more wood to produce the same amount of energy. Without initiatives to increase charcoal stove efficiency and to shift energy reliance towards alternative fuels and increased production of sustainable forms of charcoal, urbanization could destabilize current reliance on sustainable charcoal production practiced in the northern plains (such as the use of *Prosopis juliflora* and other re-coppicing species) and exacerbate the decline of forest cover in the region.

Northern Haiti sees some of the least tidal fluctuations in the world – less than 30cm per day (Ray, 1999), and the offshore coral reefs, bays and mangroves protect much of the coast from sea surges. Thus, tidal waves are less of a concern for coastal flooding. The NATHAT study developed scenarios of coastal waves and storm surges. Under a 10-year storm, waves could be as high as 2.8m, and coastal storm surge could be 0.3m. Under a 100-year storm, waves could be as high as 4.7m, and storm surge could be 1.1m. Cap Haitien and Caracol are most at risk to these events (Mora, et al., 2011).

4.1.3 Drought Risks

Despite the overall abundance of rainfall in Haiti, sections of the Department of Le Nord-Est face periodic drought. As seen in the rainfall distribution map, precipitation is the lowest in the northern plains of Le Nord-Est. Almost all of Ferrier receives less than 1,000mm of rainfall per year, as does most of the land

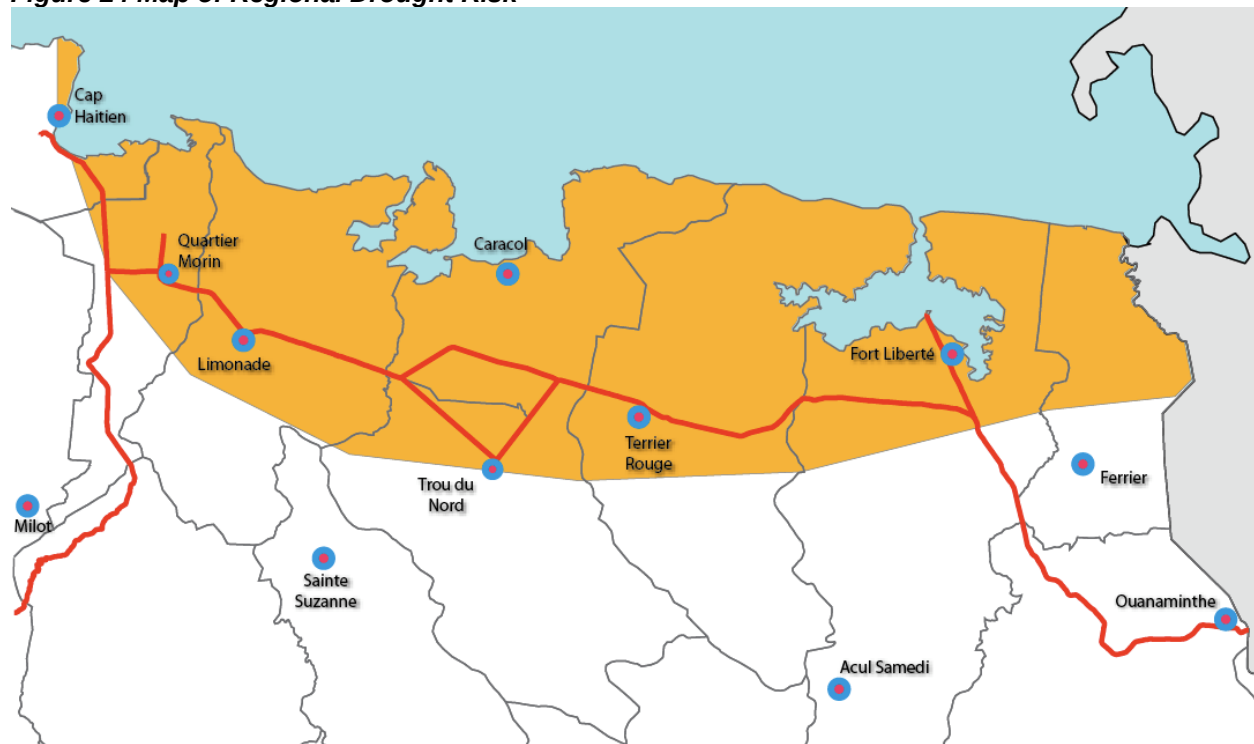
9 Jpeg versions were obtained for towns in Le Nord-Est, and will be included in the local AIA plans; the original GIS files could not be obtained, nor could the files be found for Cap-Haitien.

north of the RN6 highway in Terrier Rouge and Fort Liberté. Some projections predict an overall decrease in precipitation of up to 20% in the summer by 2100 (Smucker et al. 2007). Already, farmers report longer dry seasons and wetter and shorter rainy seasons. Somewhat in contrast to local reports, the NATHAT study categorizes almost all of the northern coast as being at some risk to drought.

At least in the 1990s, Le Nord and Nord-Est used 1.35% of their annual renewable supply of 1,000 Mm³ of water. These numbers indicate that the region suffers more from economic water scarcity – the lack of water infrastructure – than from physical water scarcity. Although most communities in these areas have access to wells for drinking water, there are almost no irrigation systems in this region. Le Nord and Nord-Est combined use less than 1% of their available water for irrigation.¹⁰ Severe or chronic drought therefore poses a particular risk to the rural communities and towns that depend on farming and livestock in this region, such as Terrier Rouge and Ferrier.

Agronomists believe that Le Nord has some of the country's best agricultural soils, which also benefit from ample volumes of rainfall. However, the continued growth of Cap-Haïtien, and the placement of new investments such as the Roi Henri Christophe University, EKAM housing project, and Caracol Industrial Park on alluvial soils in areas of high rainfall suggest that future urban growth in this corridor will continue to consume large amounts of high quality agricultural soil, despite urban planning efforts to promote densification and minimize fragmentation. To maintain or improve current levels of food production and food security, the remaining agricultural areas in the regional corridor – much of it in the more arid Nord-Est, must become more productive. Irrigation in these arid zones, as well as improved drainage in some water-clogged areas, will be critical for climate resilience, economic development and food security.

Figure 24 Map of Regional Drought Risk



Source: author, based on NATHAT 2011 data

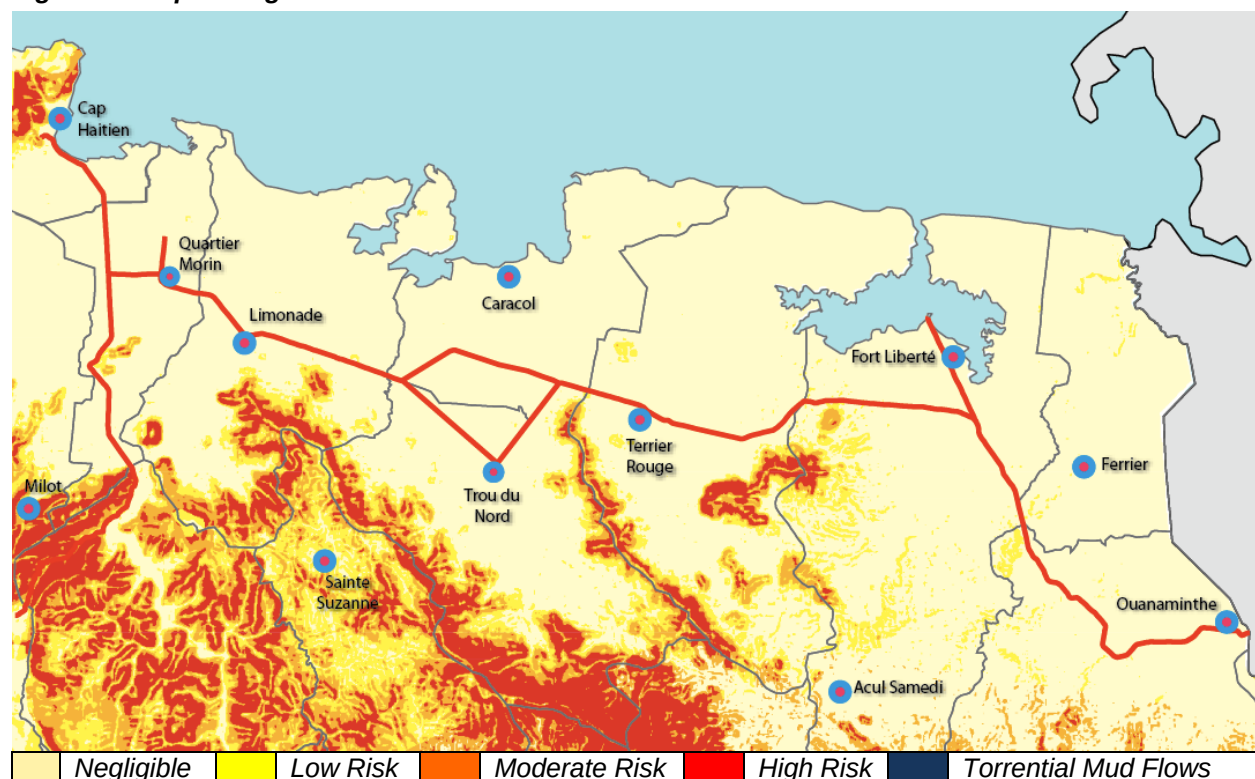
10 Organisation Panaméricaine de la Santé/Organisation Mondiale de la Santé, Comité National Interministeriel, Analyse du Secteur Eau Potable et Assainissement, Agenda 21, 1996.

4.1.4 Landslides, Mud Flows and Erosion Risks

The combination of steep slopes and high rainfall make land and mudslides an important risk in the region. Within the study area, the highest risk communities are Sainte Suzanne, which is located on a small plain within the mountains, and the slopes above Cap-Haïtien, where many people have constructed shanties with no slope support infrastructure.

Continued erosion is also a major concern within the watersheds. In keeping with Haiti's *Décret du 6 janvier 1982*, the zoning codes adopted for the region should limit construction in areas with slope greater than 50%. Again, coastal development will increase demand for charcoal, wood, sand and soil for construction, and food and fruit products that come from the mountains. Although this increased pressure could present a risk of greater pressure on existing trees, it could also lead to mountainous communities planting more stands of productive trees that reduce erosion, so long as they have access to credit and nurseries.

Figure 25 Map of Region's Landslide and Mudflow Risks



Source: author, based on NATHAT 2011 data

4.1.5 Projected Climate Change Impacts

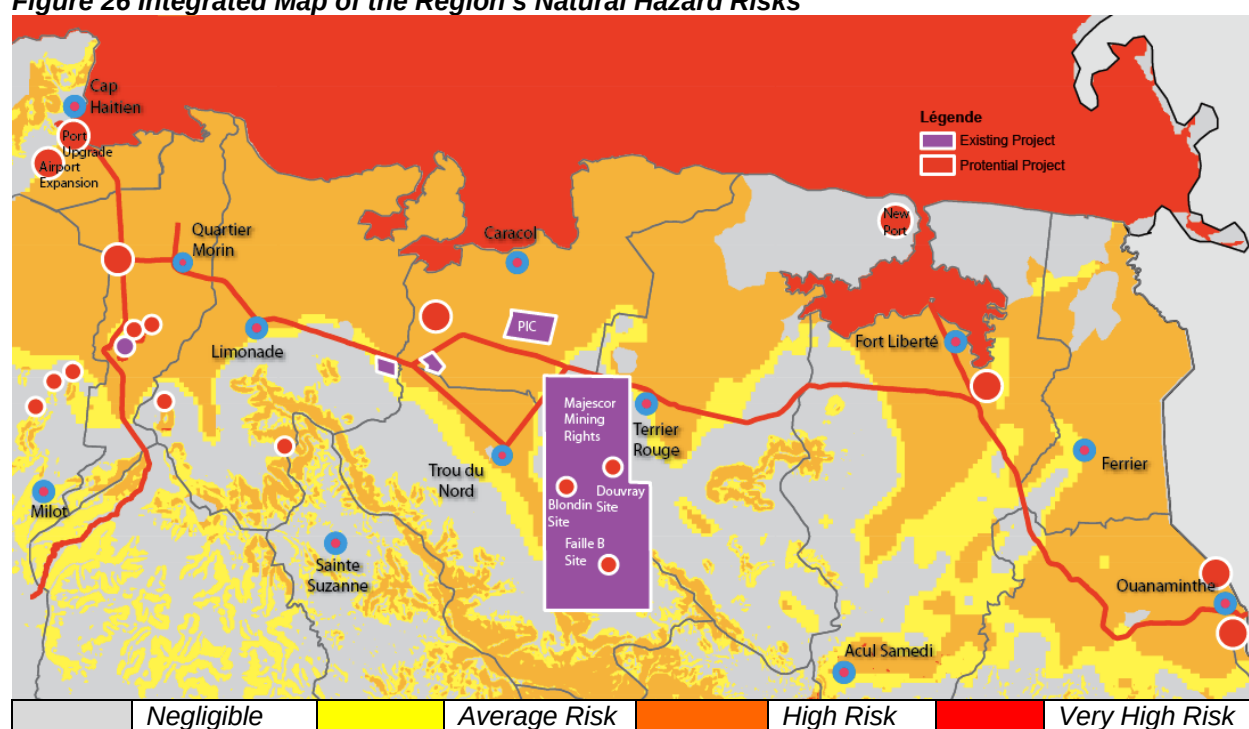
The 2011 Report “Modelling the Transformational Impacts and Costs of Sea Level Rise in the Caribbean” provides the most comprehensive analysis of climate change projections for the region to date. By the close of the century, the 14 models tested in the study show that temperatures will equivocally be warmly, likely by 2-2.5°C, that downscaled rainfall projections are uncertain, and that the sea level is very likely to rise by 1 meter (up to 2 meters) in the Caribbean. The rise 1 meter in sea level would impact 1% or less of Haiti's land area, population, urban areas, crops and plantations, and road networks; it would impact 2-3% of wetland areas and agricultural land. Disproportionately, it would impact 44% of sea turtle nests, 46% of major tourism resorts, 50% of airports and 100% of its ports. In addition to the coastal protection zone established by the Parc de Trois Baies, no construction or public investment should be made at least within 2 meters of sea level.

4.1.6 Integrated Map of Natural Hazard Risks

The NATHAT study superimposed flood hazards, ground motion, liquefaction of soft soils, seismicity, storm and tsunami surges to develop a picture of Haiti's risks to multiple hazards. For ease of comparison, each of the layers was given relatively equal weight. Although the NATHAT mapping exercise is preliminary, the results are largely consistent with field observations and with information available (Mora et al., 2010). As seen in Figure 26, all cities in the region are at some degree of risk, with risks increase closer to the coastline. Nearly all of the major investments being made in the region also lie within areas of high risk.

The NATHAT conclusions can be compared with an Plan/Oxfam/EU 2008 study of exposure to risk for towns in Le Nord-Est (Table 15). The two studies have major differences in findings, although in the absence of more information about the Plan/Oxfam/EU study, methodology and rankings, it is difficult to judge the accuracy of the results. Clearly more detailed analyses would be helpful, although in the meanwhile, all towns would reduce their risks through precautionary measures.

Figure 26 Integrated Map of the Region's Natural Hazard Risks



Map integrates landslide, liquefaction, flood, seismic, storm surge and mudflow risks.

Source: author, based on NATHAT 2011 data

Table 15 Nord-Est Towns' Degree of Risk to Five Major Natural Hazards

Risques	Degré d'exposition	Caracol	Trou du Nord	Ste Suzanne	Terrier Rouge	Fort Liberté	Ferrier	Ouanaminthe
Risque 1: Tremblement de terre et tsunami	Fortement							
	Modérément	x	x	x	x	x	x	
	Faiblement							
Risque 2: Inondations	Fortement	x	x				x	x

	Modérément							
	Faiblement							
Risque 3: Cyclones	Fortement	x	x	x	x	x	x	x
	Modérément							
	Faiblement							
Risque 4: Sécheresses	Fortement				x	x		
	Modérément	x	x					x
	Faiblement							
Risque 5: Glissements de terrain	Fortement			x				
	Modérément							
	Faiblement							

Source: Plan/Oxfam/EU Study, 2008

4.1.7 Map of Land Development Suitability

On the basis of available data, some towns such as Limonade, Trou du Nord, Terrier Rouge and Ferrier are located close to areas of lower risk where future development should be prioritized. In the case of Cap-Haitien, Quartier Morin, Caracol, Fort Liberté and Ouanaminthe as well as regional investments, particular efforts should be made to reduce vulnerability to floods and landslides.

The superimposition of the maps shown above helps to shed light on the future orientation of growth in the region. Figure 27 shows the areas of the best agricultural soils and the Parc de Trois Baies, which comprise the main areas to be avoided for construction. Notably, the state owns significant tracts of the best agricultural land in the region, although much of the land in Terrier Rouge requires irrigation. The Parc de Trois Baies would also extend legal protection over some of the best agricultural soils. Public ownership of these areas provides one means of enforcing and protecting these areas.

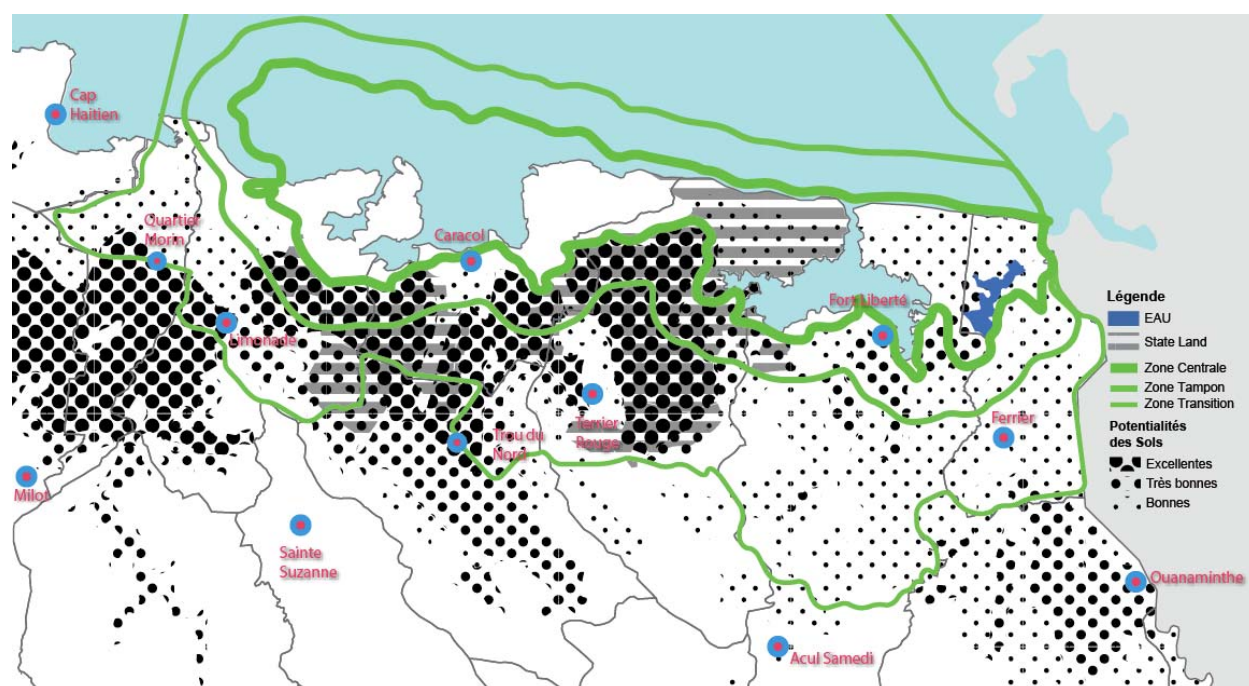
Figure 28 overlays the best agricultural soils with the areas of risk. The best agricultural soils often overlap with the areas of highest natural hazard risk. These areas should be avoided to the extent feasible in future urban expansion, economic investments and infrastructure development, unless they are to increase agricultural productivity and mitigate risks. The old RN6 highway (following the curve down to Trou du Nord) corresponds in places to the demarcation between high and low risk areas; often, development would be at lower risk if placed to the south of the highway. These spatial analyses, which must be confirmed through stakeholder outreach and ground-truthing, suggest the following:

Table 16 Direction of Growth by Town

Town	Direction of Future Growth	Key Risks (per NATHAT)
Quartier Morin	North, Northeast	Liquefaction, flooding, drought
Limonade	South, Southeast	Liquefaction, flooding, drought
Caracol	South	Liquefaction, tsunami, flooding, drought
Trou du Nord	South, Southwest	Liquefaction, flooding, drought
Terrier Rouge	West, Southwest	Liquefaction, flooding, drought
Sainte Suzanne		Seismicity, landslides
Fort Liberte	South, Southeast	Liquefaction, flooding, drought
Ferrier	Southwest	Liquefaction, flooding

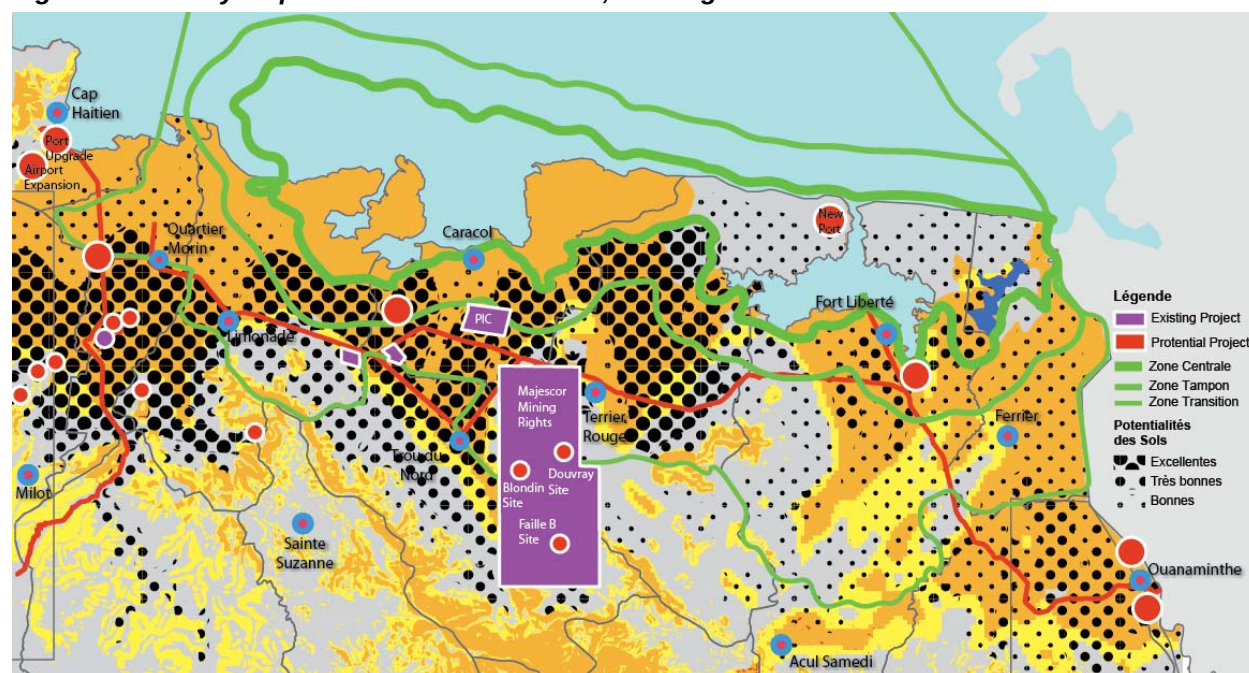
Figure 29 combines the risk, protection and agricultural maps together with aforementioned restrictions on constructing on steep slopes and riparian zones to show areas by their relative suitability to construction.

Figure 27 Overlay Map of Best Agricultural Soils and the Parc de 3 Baies



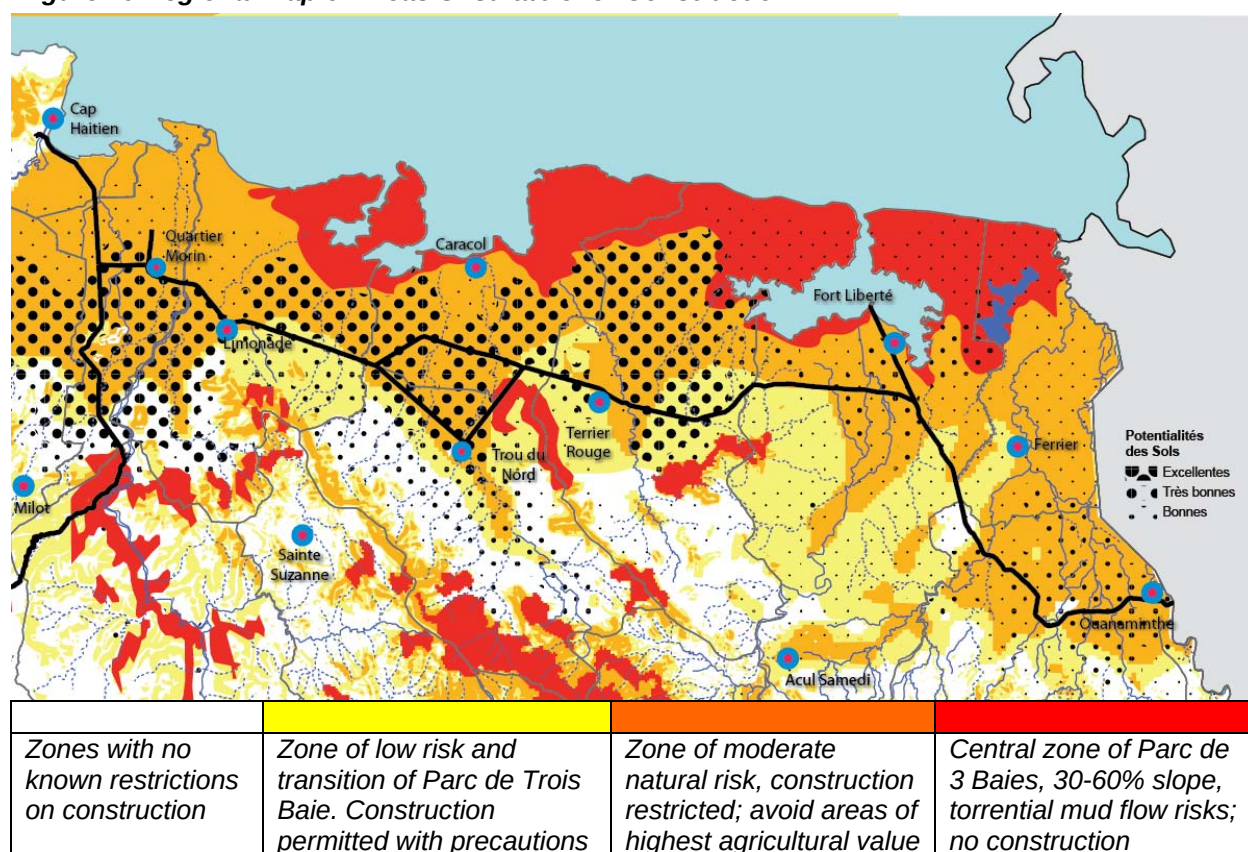
Source: author, based on CNIGS soil potential and Parc de Trois Baies; state land based on AGRER 1989 maps

Figure 28 Overlay Map of Natural Hazard Risks, Best Agricultural Soils and the Parc de 3 Baies



Source: same as Figure 28, also NATHAT 2011

Figure 29 Regional Map of Areas Unsuitable for Construction



4.2 Land Consumption Requirements

To estimate future land requirements, the CIA estimated the land that is currently built up for each town and then estimated their densities. Around 2,090 ha of land is currently urbanized along the corridor in the cities studied; 790 ha of this is outside of Cap-Haïtien/Petite Anse. Existing densities throughout the corridor range from 110 to 310 per hectare; for comparison, the density for the city of Port-au-Prince is roughly 250 per hectare. By bracketing the current densities, four future scenarios were created:

- Baseline population growth at lower than current densities,
- Baseline population growth at higher than current densities,
- High growth population at lower than current densities,
- High growth population at higher than current densities.

These calculations (see Tables 17-19) suggest that under baseline population growth, future urban land consumption will range from 750 to 1,200 hectares; 180 to 290 ha would be needed around the smaller towns outside of Cap-Haïtien/Petite Anse/Ouanaminthe. Under the high growth scenario, an estimated 1,600 to 2,660 ha would be needed, depending on growth densities. Of this, 600 to 900 ha would be needed around the smaller towns. These estimates indicate a significant loss of agricultural land and underscore the importance of constructing higher density (earthquake proof) housing and clustering development to avoid agricultural fragmentation.

Technically, each town has a legal boundary defined by IHSI (see Table 19), although this definition can be random and does not always overlap with local electoral limits. CIAT also has boundaries for *centrevilles* that does not always correspond with urbanized areas. The clarification of these boundaries is a high priority for supporting future plan implementation and urban management. Under the high growth scenario, most towns would require more land than is currently within their legal boundaries; in other

scenarios, each town has adequate land with the exception of Caracol and Fort Liberté (for which the data on legal boundaries may be outdated). It should be noted that local plans should compare current city boundaries with risk maps; much of the current land that lies within bounds may not be buildable.

Au plan foncier, la principale caractéristique de la région est le fait, lié à l'histoire récente de la région, que la plus grande partie de la superficie de la vaste plaine littorale fait partie du domaine privé de l'Etat. Au début du 19^e siècle d'abord, le royaume du Nord avait favorisé le maintien des grandes plantations dans toute la partie septentrionale d'Haïti, limitant l'investissement des terres par les petites exploitations paysannes. Dans un second temps, durant la période s'étalant de 1926 à 1972, des surfaces très importantes pour le pays (de l'ordre de 20.000 ha de terres de plaines), supposées inoccupées et sous-exploitées, furent concédées par l'Etat à des compagnies étrangères. Celles-ci après avoir dépossédés les paysans qui, de fait, étaient installés là, lancèrent une vaste exploitation agro-industrielle du sisal, sur la zone de Madrasse, à l'Ouest du Trou du Nord, d'une part, et d'autre part, en direction de l'est, où la plantation Dauphin s'installa sur la plaine littorale, de Jacquezy à la frontière dominicaine, sur une profondeur de 10-15km, entre la côte atlantique et l'ancienne route menant de Limonade à Ouanaminthe.

En 1972, au départ de la dernière compagnie américaine ayant bénéficié de ces concessions et baux à long terme ainsi que de terres rachetées aux paysans, l'ensemble des terres qu'elle détenait est entré dans le domaine privé de l'Etat haïtien, créant une situation exceptionnelle de disponibilité en terres d'Etat dans le pays. Depuis 1986 cependant, ces terres ont été largement réinvesties par des agriculteurs et éleveurs de la région, ainsi que par des charbonniers, pour les plus incultes d'entre elles. Par endroits, il semble également que certaines personnes aient obtenu de la DGI de Fort-Liberté ou à Port-au-Prince, des baux sur de grandes parcelles. Les DGI communales semblent souvent ne pas même être informées de ces transactions.

Leur statut domanial de la majorité des terres de la plaine littorale n'est globalement pas remis en cause, et cette situation est vécue par les élus locaux comme permettant une certaine marge de manœuvre pour la mise en place de projets. Il faut cependant ne pas sous-estimer le risque que le changement de destination de ces terres domaniales pour l'installation de logement et d'infrastructures collectives, ne se fasse au détriment des exploitants actuels, et donc des revenus agricoles et de la production alimentaire dans la région (le nombre des paysans installés sur ces terres et le volume de leur production, notamment animale, sont souvent sous-estimés du fait de l'absence de validation par la DGI de leur présence sur le terrain). Ce risque est d'autant plus important que ces exploitants ne sont pas partie prenantes des décisions et que les interlocuteurs des projets ont eux-mêmes d'autres objectifs (comme l'augmentation des ressources financières communales par la taxe sur le bâti, par exemple, qui revient directement aux communes, alors que l'encaissement de fermages sur des petites parcelles n'intéresse pas la DGI qui préfère garder en principe la main sur ces vastes étendues). Aux abords des centres urbains, notamment à Fort-Liberté, mais aussi à Ferrier, Terrier Rouge et très probablement Trou du Nord, des lotissements ont été réalisés sur des terres dont le statut foncier n'est pas clair ou qui sont connues pour être domaniales. D'une façon générale, la sécurisation des occupants déjà installés sur ces terres serait souhaitable, par l'établissement de baux en bonne et due forme avec la DGI, voire par la cession de ces terres à ceux qui les mettent en valeur ou y ont bâti leur maison, car l'insécurité dans laquelle ils sont maintenus constitue un frein aux investissements alors même que la région aurait besoin que sa production augmente et que le statut foncier des « cités » apparues en grand nombre depuis une à deux décennies, soit clarifié.

Although the CIA focuses on environmental issues, it is important to make note of a prevalent sentiment expressed by current residents in the community consultation workshops for this planning exercise. Many appeared unwilling to share scarce resources and opportunities with outsiders, having waited so long for these things themselves. Their proposed locations for urban expansion tended to be "over there" and "away". The distribution of subsidized or gifted housing (either for migrant workers or earthquake refugees) will foster segregation between existing residents and newcomers, and lack of social cohesion could seed future conflict over scarce resources. The spread of clusters of housing on public land far from existing settlements will further isolate new communities, deepening their poverty, through increased transport costs and weak social networks. To the extent possible these investments should be shifted towards existing urban areas to consolidate communities and costs of infrastructure improvements.

Table 17 Land Requirements in 2030 under Baseline Scenario

Baseline Scenario	Population in 2009	Population in 2030	Additional People (2009-2030)	Less dense urban expansion		Denser urban expansion	
				Average Density of Expansion (people/ha)	Land Area Needed (ha)	Average Density of Expansion (people/ha)	Land Area Needed (ha)
Ville de Cap Haitien	155,505	240,315	84,810	175	762	300	445
Quartier de Petite Anse	89,155	137,779	48,624				
Ville de Quartier Morin	3,500	5,409	1,909	100	19	250	8
Ville de Limonade	14,886	23,005	8,119	150	54	300	27
Ville de Caracol	2,690	4,157	1,467	100	15	150	10
Ville de Trou du Nord	21,805	33,697	11,892	150	79	250	48
Ville de Terrier Rouge	12,226	18,894	6,668	200	33	300	22
Ville de Sainte Suzanne	1,488	2,300	812	150	5	250	3
Ville de Fort-Liberte	18,417	28,461	10,044	125	80	250	40
Ville de Derac	2,046	3,162	1,116	100	11	150	7
Ville de Ferrier	7,371	11,391	4,020	150	27	250	16
Ville de Ouanaminthe	58,250	90,018	31,768	200	159	250	127
Total	387,339	598,587	211,248		1,211		753

Table 18 Land Requirements in 2030 under High Growth Scenarios

High Growth Scenario	Population in 2009	Population in 2030	Additional People (2009-2030)	Less dense urban expansion		Denser urban expansion	
				Average Density of Expansion (people/ha)	Land Area Needed (ha)	Average Density of Expansion (people/ha)	Land Area Needed (ha)
Ville de Cap Haitien	155,505	317,061	161,556	175	1,452	300	848
Quartier de Petite Anse	89,155	181,779	92,624				
Ville de Quartier Morin	3,500	7,136	3,636	100	36	250	15
Ville de Limonade	14,886	39,279	24,393	150	163	300	81
Ville de Caracol	2,690	7,098	4,408	100	44	150	29
Ville de Trou du Nord	21,805	57,535	35,730	150	238	250	143
Ville de Terrier Rouge	12,226	32,260	20,034	200	100	300	67

Ville de Sainte Suzanne	1,488	3,034	1,546	150	10	250	6
Ville de Fort-Liberte	18,417	48,596	30,179	125	241	250	121
Ville de Derac	2,046	4,172	2,126	100	21	150	14
Ville de Ferrier	7,371	15,029	7,658	150	51	250	31
Ville de Ouanaminthe	58,250	118,767	60,517	200	303	250	242
Total	387,339	831,745	444,406		2,661		1,596

Table 19 Comparison of Current and Future Land Availability by City

	Population in 2009	Density in 2009 (people/ha)	Built-up area in 2009 (ha)	Legal Boundary (ha)	Remaining Land in Boundary (Deficit) for Each Scenario			
					Baseline, Low Density	Baseline, High Density	High Growth, Low Density	High Growth, High Density
Ville de Cap Haitien	155,505	188	1,300					
Quartier de Petite Anse	89,155							
Ville de Quartier Morin	3,500	111	32	102	51	63	34	56
Ville de Limonade	14,886	192	77	167	35	63	(73)	8
Ville de Caracol	2,690	123	22	20	(17)	(12)	(46)	(31)
Ville de Trou du Nord	21,805	201	108	288	100	132	(59)	37
Ville de Terrier Rouge	12,226	311*	39	152	79	91	13	46
Ville de Sainte Suzanne	1,488	191	8	16	3	5	(2)	2
Ville de Fort-Liberte	18,417	139	132	55*	(157)	(117)	(318)	(198)
Ville de Derac	2,046	123	17					
Ville de Ferrier	7,371	180	41	115	47	58	23	43
Ville de Ouanaminthe	58,250	185	315					
Total	387,339		2,090				(429)	(37)

* Numbers are suspect and should be cross-referenced. Note: City built up areas are estimated through Google Earth based on the immediate boundaries of the developed core. The densities in 2009 are estimated assuming the 2009 population figures represent a similar area. Any discrepancies would likely make current densities lower.

PART 5. SECTORAL RESOURCE DEMANDS AND IMPACTS

The northern region, like the rest of Haiti, is severely under serviced in all areas of infrastructure, a reality that is both caused by and contributes to poverty and continued environmental degradation. Even absent the planned economic investments in the region, natural population growth and existing migration flows will exacerbate existing infrastructure shortages and worsen pollutant loading in urban areas along the corridor. The proposed economic investments accelerate these tendencies by increasing 2030 population by as much as 40% from the baseline scenario, and influence the location of service demands.

It is an important policy goal of international funding agencies that their investments – at least – do not exacerbate existing conditions, and – at best – improve them. In reality, efforts to actually improve local quality of life will have to address not only the needs of the additional people attracted by new economic opportunities, but also existing and future deficits of infrastructure.

The following sections attempt to capture the scale of magnitude of environmental impacts, and implicitly, the amount of infrastructure required to serve the region and offset local and regional impacts.

5.1 TRANSPORTATION INFRASTRUCTURE

These bottlenecks in local infrastructure not only impact quality of life and natural ecosystems, but also reduce economic competitiveness. Nowhere is this more evident than the region's transport infrastructure.

Port. Le seul port dans la région qui peut être utilisé pour évacuer ou recevoir des marchandises conteneurisées est celui du Cap-Haïtien. The traffic of the Port at Cap-Haïtien was around 170,000 tonnes in 2005, with a capacity of 1,000 containers per month, and uses 10 articulated trucks per day on average. It lacks adequate lifting and towing equipment needed for conventional materials. The IDB estimates that it would cost \$700,000 to renovate the port. Le problème du port doit être pris en compte à court et moyen termes. Dans le court terme, il est important de relever les défis d'utilisation à pleine capacité du port actuel. Ceci ne peut être matérialisé sans régler le problème de circulation qu'engendra ce nouveau développement au niveau de la ville. La solution de créer une bretelle entre la rue 5 et la RN3, pour palier ces difficultés, reste à être concrétisée. Toutefois, avec le trafic de conteneurs que généreront les effets induits des grands projets déclencheurs, la construction d'un nouveau port en dehors de la ville du Cap est envisagée à moyen terme.

To meet its port shipment needs, the PIC is considering three options: a) constructing a bridge to bypass Cap-Haïtien traffic, b) using the closest Dominican port, or c) building a new port on the Baie de Fort Liberte either on the external or internal sections of the "arm" in Terrier Rouge. The first option has the benefit of strengthening an existing transport facility, largely utilizes existing road networks and requires significantly less dredging and coastline modification. It places the port in a coastal flood zone and is more vulnerable to storms, floods and disruptions in Cap-Haïtien. The second option is the least politically desirable option, but presents the lowest environmental impacts. Traffic congestion in Ouanaminthe poses the main challenge.

The third option has by far the most significant environmental implications in terms of dredging and coastline reconfiguration, given the shallow depth of the bay and the presence of a coastal barrier reef. A port in the sheltered quay would require dredging 3 million m³ of sediment in the access channel, while an external quay requires a long breakwater and has bad earthwork balance. Both are vulnerable to seismicity due to the presence of a fault near the harbor and suffer sediment transit disturbance (Terminal Link, 2010). For these reasons, it was not considered an ideal site for a container transshipment hub in Haiti. The construction of a port, container traffic and possible oil leakages would all degrade this coastal environment. Access to the port would also require paving and expanding road access through the area between the PIC and the port.

Figure 30 Bathymetry of the Baie de Fort Liberté

**BAIE DE FORT-LIBERTÉ
ET SES BORDURES**



Source: Atlas Cotier du Nord-Est d'Haïti

Quai Flottant. Un contrat pour la construction d'un quai flottant sur la baie de l'Acul est déjà signé entre l'état haïtien et une firme étrangère. Cette facilité permettra aux croisiéristes de Labadie de se rendre au PNH; la dynamique au niveau du couloir sera certes influencée par un accroissement des activités au PNH.

Aéroport. The Cap Haitien airport, the second largest in the country, hosts local flights as well as flights to the Dominican Republic, Miami, and other Caribbean destinations. Aircraft capacity is normally 30-40 people. It is served by one national companies and a dozen companies in the Caribbean area offer regular flights. By the most conservative projections, this airport would serve half a million passengers per year by 2015 (MTPTC, Unknown date). The runway is 1,500 meters, only part of which is paved, and the airport has a minimum of signage, markings and navigation aids. The local emergency department and firehouse were destroyed or vandalized in the riots of 2004. The grounds are not fenced and the property line is not enforced. La réhabilitation de l'aéroport qui devrait prendre 18 mois, est estimée à 8.4 millions de US\$. Les travaux sont en cours mais sont paralysés à cause du mécanisme trop lourd de décaissement. La région a grandement besoin de l'aménagement de cet aéroport pour mieux gérer le trafic avec le reste du monde. Il faudra revisiter les procédures dans la mesure du possible pour permettre une plus grande fluidité dans le processus de décaissement ; si contraint par les termes du contrat, le gouvernement devrait nommer un facilitateur en charge de ce projet.

An additional airport is reportedly under consideration, to be located near Madras in Caracol Commune. This would increase impervious areas and introduce new traffic to an area that will likely become highly congested. Both the rehabilitation of the existing airport into a jetport and the addition of a secondary airport would introduce increased levels of air pollution.

Road Transport. The MTPTC Transport Plan of 2009 cites the need for a National Transport Infrastructure Master Plans with a time horizon of 20 years. A detailed transportation demand survey and

plan is also needed for the northern region, particularly given rising transport costs and the foreseeable commuting to the PIC.

Walking and bicycling are very important at urban and even regional levels. Purchasing power, as well as the precarious conditions of public transportation, makes the choice clear. Access to private vehicles, whether car or motorcycle, is scarce, and individual mobility is very limited.

Motorized transport is mainly provided by two informal modes. The tap-tap's capacity ranges between 10 and 15 persons/vehicle and the moto-taxi's capacity ranges between two and three people. On market days, vehicles are used to transport goods and are remarkably overcrowded. A limited number of bus organizations and enterprises offer transport. It is not possible to offer precise information on the total supply of public transport (number and size of vehicles) in the region. In Haiti, there is an estimated 1 car per every 100 persons (MTPTC / UGSE / BME / EDH, 2011). Assuming this statistic, there may be around 4,000 cars at present in cities along the corridor, in addition to transport and cargo vehicles.

Traffic counts undertaken by the project team in Le Nord-Est show that about two thirds of vehicles traveling along the interurban roads are motorcycles, nearly 20% are tap-taps, and only 10% private cars. Less than 10% are trucks and buses. The average occupancy for the tap-tap is 10 passengers during peak periods, while buses average 14. The number of such vehicles in the total traffic volume is less than 15%, although capacity counts for nearly 40% of trips. Regional flow analysis confirms a preponderance of motorcycles in traffic stream, sometimes up to 2/3 of the total volume, but their carrying capacity is much lower regarding the number of passenger/trips. This analysis confirms the presence of a regional system in which a large number of people work outside their hometown, requiring inter-urban transportation.

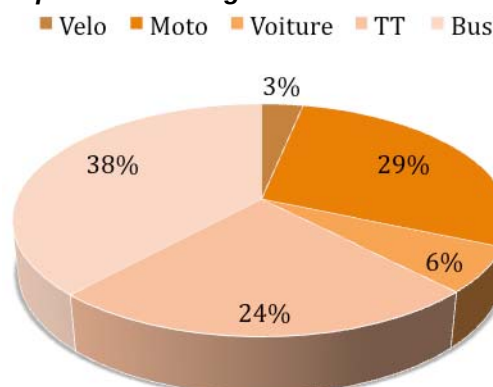
The price difference between the two common modes of transportation is considerable. For a tap-tap, a local trip costs about 5 gourdes, while traveling an intermediate distance costs 10 gourdes. The same trip costs 50 gourdes in mototaxi. A ticket from Cap to Ouanaminthe or Fort Liberté could cost 75-200 Gds, compared with 5-20 Gds in 2000 (NORD UE Cosinus Conseil).

Agricultural and other household goods mainly from the Dominican Republic come to major markets in each commune. Cargo transport takes place under difficult conditions with regards to safety and security. Based on the traffic counts conducted by the team at the Ouanaminthe market, 44% of vehicles that are used on market days are pick-ups, 25% small trucks, large trucks 25% and 6% articulated trucks. The hourly flow of merchandise is important on market days, with almost three vehicles per minute during the peak hours. The impact on the road maintenance is therefore considerable.

By 2030, the number of passengers using public transit will be close to 6,000 passengers per hour each way. This demand will be best served if measures in priority corridors, at least in the peak hours, are put in place. At this moment the most important traffic takes place on market days. However, this traffic is low, only 476 vehicles per direction. Assuming a capacity of 1,800 vehicles/hour per lane, the level of service at this time would be "A". In 2030, with a growth of close to 5% per year, traffic would increase to 1,238 vehicles/day. Traffic may still circulate effectively with the current capacity of the RN6. The main challenge will be to develop a good road management and maintenance system, improve road signage, and possibly implement control systems in some intersections and nearby municipalities. For specific recommendations, see Annex 3.

Outside of Cap-Haïtien and Ouanaminthe, the industrial park represents the largest point of congestion. Based on SAE's investment plan, the textile factory will generate about 65,000 kg per day of final product

Figure 31 - Distribution Modale des Déplacements Régionaux



Source: Propre, à partir de comptages réalisés la semaine du 6 au 10 Août 2012

during years 2 to 7 (SAE-A, 2010). This will equate with on average no more than a few trailer trucks per day, although their movement may be concentrated at certain times of the month, with additional vehicles to deliver input materials.

Much more significant will be the number of vehicles to transport the workers to the industrial park. This assessment makes a rough estimate of the number of vehicles required. At 20,000 workers in year 7, assuming two shifts daily would be 10,000 people per shift – not including additional movements of people for *manje kwit* and other services around the park. Sole use of tap taps, which fit 25 people, would equal 400 vehicles per shift, or 800 vehicle trips daily at each of the entrances, or 1,600 vehicles stopping on this section of the RN6. Use of larger buses and mode splits with bicycling and walking could reduce the number of vehicles somewhat. The circulation and bus stops around the park should be designed to allow vehicles to exit the RN6 and avoid tight turning radiuses and bottlenecks, and to permit safe pedestrian road crossings. Streets should be designed and housing located in ways that promote safe walking and cycling.

Given older engines and vehicular idling, concentrated non-point source air pollution is anticipated to be severe around the park. This would lead to high levels of vehicular exhaust and harmful emissions. Such emissions should be accounted for in future assessments of air quality impacts of the PIC.

Road Development. Given infrastructure shortages, development often takes a linear form along the sides of paved roads. Land along the RN6, particularly near the industrial park and surrounding towns, will quickly change hands and become developed through legal or illegal means. This type of development cannot be completely avoided, but should be contained due to the impacts it has on other forms of service delivery, the identity of communities and the visual affect it has on a corridor for which tourism will be an important sector.

An important strategy to counter roadside development will be to plan for and set aside land for additional roads around existing towns in advance of the proliferation of informal settlements. Active road creation, when done at sufficient scales, can help reduce land prices and speculation, as well as help direct development away from at risk areas. The typical rule of thumb is one arterial every one kilometer, and blocks and local road widths such that no house is out of reach of a fire truck's hose.

Road Maintenance. Le report des interventions pour l'entretien des routes, pour ne citer que ce type d'infrastructures, résulte en des coûts directs et indirects très élevés. Un report des réparations de trois ans se traduit en des coûts six fois plus importants et un délai de 5 ans, en des coûts d'entretien 18 fois plus élevés que les coûts initiaux (Burningham and Stankevich, 2005). En regard des conditions actuelles de fonctionnement des ménages, les niveaux de revenu ne constituent pas une base taxable adéquate permettant aux gouvernements locaux de faire face à ces nouveaux défis (IHSI, 2010b). La transformation économique anticipée se trouve donc tributaire d'un climat facilitant les investissements et de mesures de politique de renforcement du secteur privé local.

La RN6 est certes dans un état acceptable pour l'instant. Toutefois, l'intensité du trafic qui se confirme maintenant, soulève la question de la capacité de l'actuelle construction à supporter ces charges. Certaines routes agricoles sont à considérer pour faciliter l'écoulement des produits. Voir la section sur l'agriculture, et la Table 3.

Transport Safety. According to the WHO Global Status Report on Road Safety (2009), low-income countries have on average 30 fatalities per 100,000 people per year (the range is 12.1 to 48.4). In the study corridor, that translates to 115 deaths per year in 2009 among urban residents, and around 180 to 250 deaths per year among urban residents in 2030. Externalities in terms of noise and air quality, as well as the contribution to congestion, especially in the city of Cap-Haitien, are important.

Annex 3 presents the proposed transportation plan in response to identified needs and challenges. Annex 4 presents cross-sections of road designs that minimize stormwater runoff and promote non-motorized transport.

5.2 WATER SUPPLY

Current Water Access: According to the EMMUS IV, 59% of all households and 80% of all urban households in Le Nord and Nord-Est have improved access to potable water. Access ranges from 39% in rural areas, to 95% of towns, to 64% in small cities in Le Nord, and 48% in rural areas and 86% of towns in Le Nord-Est. Notably, towns have better access rates than small cities, namely Petite Anse and Cap-Haïtien. The percentage of access to improved water is roughly the same for potable and non-potable uses, with the exception of small cities in Le Nord, where 64% of potable water comes from improved sources and 76% of non-potable uses come from improved sources. The difference is due mainly to an increased reliance on water vendors, which are not categorized by the WHO-UNICEF Joint Monitoring Programme as a safe source.

Current Demand for Water: Although Haiti's per capita use of water is frequently cited as one of the lowest in the world, limited information is available about per capita consumption and use by sector. The EMMUS IV unfortunately did not survey this issue. On the lower end of estimates, the LGL 2007 reports find that households in Caracol and Trou du Nord that relied on kiosks use 15 to 20 liters per person per day (l/pp/day) and those that relied on household connections used 45 l/pp/day. That report noted that many people still continue to use traditional sources such as individual wells and the river for non-potable uses. The 2009 Human Settlements Centre estimated that Cap-Haïtien uses 16,500 m³ of water a day for 254,495 residents, or roughly 65 l/pp/day.

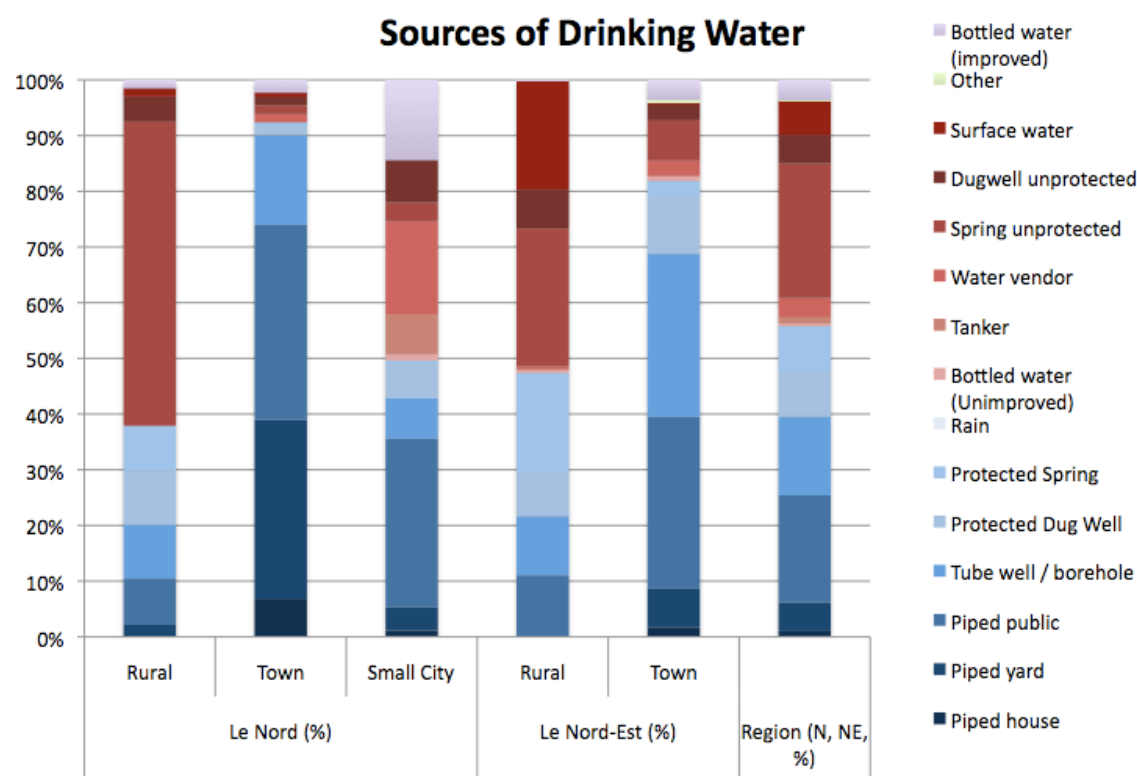
The FAO AQUASTAT database estimated that municipal water use in Haiti was 69 l/pp/day in 2000, a figure that rose to 74 l/pp/day of water by 2005, or roughly an increase of 1 liter per capita per day each year. This estimate of domestic water use per capita is "usually computed as the total water withdrawn by the public distribution network. It can include that part of the industries, which is connected to the municipal network. The ratio between the net consumption and the water withdrawn can vary from 5 to 15% in urban areas and from 10 to 50% in rural areas" (FAO Aquastat). This is divided by countries' total population. Given that it is significantly higher than the LGL's reports from data during the same period, this report assumes that the FAO's per capita use figures account for commercial, institutional and small industries that would be connected to a public system, as well as a conservative estimate of physical water loss.

Future Water Access: The WHO-UNICEF Joint Monitoring Network for Water and Sanitation calculated that access to improved water in urban areas of Haiti rose by 0.5% per year. Given that urban access rates in Le Nord and Le Nord-Est had reached 80% in 2005, this CIA posits that they may reach 90% by 2015, 95% by 2020 and 100% by 2025. This is an optimistic scenario, particularly under the high-growth scenario, given that water access ratios can sometimes fall in rapidly urbanizing areas.

Household piped access reached 16% in 2005. Under the baseline population growth scenario, it is estimated that this may reach 40% by 2025, on par with LGL projections from 2007. Optimistically, piped water increases to reach 95% of the population by 2025, and only 5% continues to rely on wells and springs. Under high-growth, demographic pressures could overwhelm service provision capacity, leading to lower proportions of household and public piped connections, and a greater reliance on communal wells.

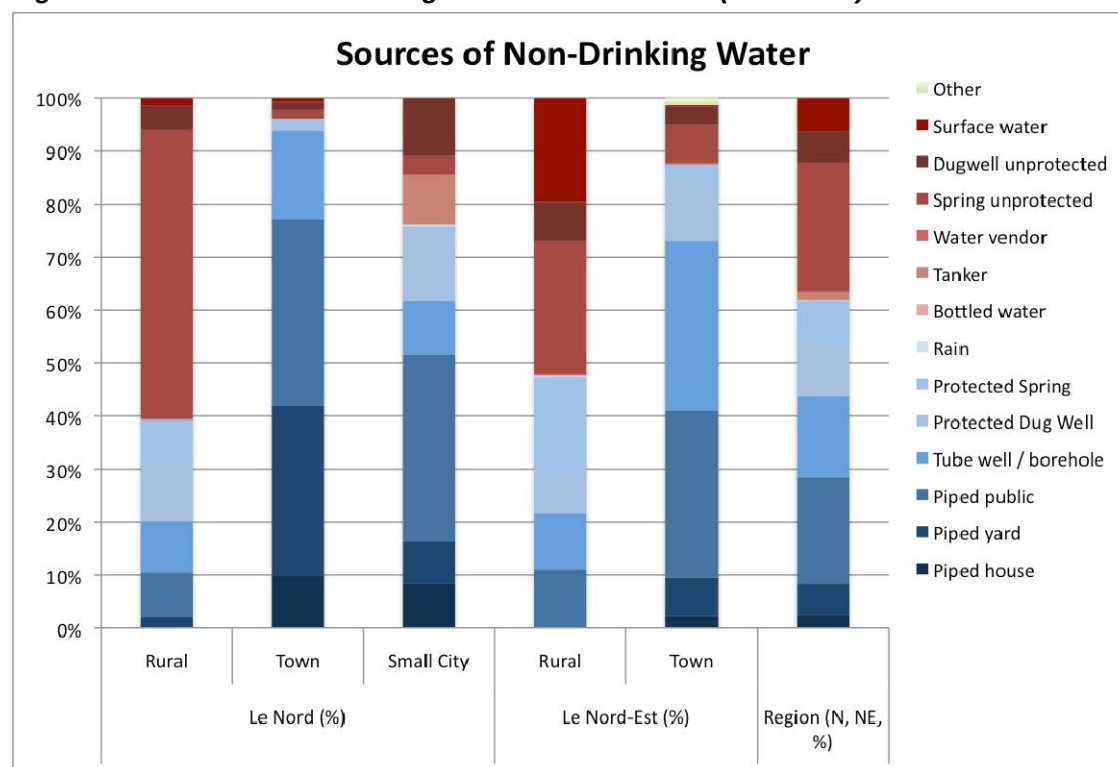
Future Demand for Water: Table 20 uses these assumptions to project urban water demand in the Cap-Haïtien-Ouanaminthe corridor under the baseline and high-growth scenarios. The projections account for a modest increase in per capita consumption. Under the baseline scenario, the corridor would require 19 million m³ of water per year for domestic use (including household, commercial, institutional and small and medium enterprises). Under the high-growth scenario, it would require 24 million m³ of water. As a comparison, the Centre for Human Settlements had estimated in 2009 that metropolitan Cap-Haïtien would grow to 411,100 people by 2025 and consume 7.5 Mm³/day at 50 l/pp/day. This estimate roughly corresponds to the high-growth scenario's population projection, but seems excessively conservative in its water demand. Beyond these estimates, the PIC will need an estimated 1.3 Mm³ of water per year by the end of Phase 1 (around 2020) and 4.2 Mm³ per year by the end of Phase 2. According to available information, the industrial park plans to withdraw all of this water from the Plaine du Nord aquifer.

Figure 32 Access to Drinking Water in Corridor (2005-2006)



Source: EMMUS IV 2005-06

Figure 33 Access to Non-Drinking Water in the Corridor (2005-2006)



Source: EMMUS IV 2005-06

Table 20 Projected Future Access to and Demand for Municipal Water

Baseline Scenario	Urban Population along Corridor	Per Capita Water Demand (l/pp/day)	Estimated Water Demand (Mm3/yr)	Overall Access to Improved Water (%)	House/ yard connection	Kiosk / standpipe	Tube, bore, dug well or spring
In 5 years (2015)	449,194	83	14	90%	30%	45%	25%
In 10 years (2020)	505,743	87	16	95%	35%	50%	15%
In 15 years (2025)	555,644	92	19	100%	40%	55%	5%
High-Growth Scenario	Urban Population along Corridor	Per Capita Water Demand (l/pp/day)	Estimated Water Demand (Mm3/yr)	Overall Access to Improved Water (%)	House/ yard connection	Kiosk / standpipe	Tube, bore, dug well or spring
In 5 years (2015)	461,825	83	14	90%	20%	45%	35%
In 10 years (2020)	572,191	87	18	95%	25%	50%	25%
In 15 years (2025)	709,954	92	24	100%	30%	50%	20%

For recent and planned water projects in the region, see Table 3. Key among these is an ongoing study for DINEPA by the firm WASSER with funding from the Spanish government. To be completed by 2013, the study will provide 65 cities in the north and central plains with strategic master plans for water and sanitation. Three cities, including Fort Liberté, will receive construction bid-ready master plans. In addition investments in rehabilitating Cap-Haïtien's water distribution and supply network, DINEPA has a goal of rehabilitating water systems in 12 cities of 20-50,000 people, and 20 cities with 10-25,000 people. The EU has been working in Quartier Morin, Limonade, Trou du Nord, Terrier Rouge and Ouanaminthe to rehabilitate and build water distribution and supply networks. Through US CDC and USAID, DINEPA has also trained 280 technicians (or two per commune) to provide water education, outreach and monitoring services. Implicit in Table 20 is the need for significant additional funding to achieve the levels of access and consumption targeted by 2030.

Water Supply and Quality. Urban settlements in the corridor rely on a mix of sources of water. Of the 80% of urban households with access to improved potable water, most rely on groundwater taken from standpipes and kiosks (40%) and tube, bore and protected dug wells (33%). In addition, 2% obtained water from protected springs and 9% from bottled water that is considered safe. Only 3% had an in-house piped connection and 13% had an in-yard piped connection.

In Cap-Haïtien, for example, the municipal system supplies 17% of the demand, and relies on 3 gravity-fed systems from reservoirs and 1 pumped well. Other more established communities such as Limonade, Trou du Nord, and Fort Liberté also have piped water from intake points in the mountains; these, however, have various operation problems, difficulty collecting payment, and are in need of renovation, repair and expansion. On occasion, montane communities have been known to sabotage these systems in protest of what they see as the theft of their resource with no benefit to their communities, which often also lack water and sanitation services. More rural villages such as Caracol and Ferrier rely entirely on groundwater and nearby rivers, and are most at risk of the contamination of groundwater.

Several considerations may temper past assessments on water availability for Le Nord/Nord-Est, which typically suggest that agriculture, industrial and urban uses of water tap a very small proportion of available water (see, e.g., MPCE, 1997a). First the Transboundary Plaine du Nord/Massacre Aquifer shared with the Dominican Republic is essentially a delta aquifer fed by (and directly linked to) the five rivers that feed the aquifer (Marchand, 2012). Although detailed data is limited, the "delta" nature of this coastal aquifer implies that all aspects of groundwater, stream flow, flooding and coastal water health are

directly and intrinsically connected. Significant changes to any one component of the water cycle – through the over-extraction of groundwater, the alteration of upstream flows and delta flooding conditions, and the surface discharge of partially treated wastewaters to streams – could have considerable and potentially serious impacts to the overall water resource. These threats are only heightened by the anticipated impacts of global warming and sea level change. As a coastal aquifer, the system is also connected to the coastal waters and at risk of saline intrusion if the aquifer is not sustained.

Second, despite some measurements undertaken for the PIC industrial park, the total volume pumped from the aquifer for irrigation, urban and industrial needs in the region is unknown. Little research has been done on the broader aquifer system, its depth, flow rates and behavior, contiguity and water quality. How the aquifer will react to continued pumping of large volumes of water throughout the year is unclear.

Third, the overall least expensive option for water supply would be mountainous reservoirs and water intake points that are then piped via gravity to urban households. These systems require blocks of public investment to renovate, expand and maintenance. Given the foreseeable lag in large public investments, many entrepreneurs, households and communities will continue to develop private tube and bore wells. Although these may meet international classifications for improved sources, the shallowness of the aquifer, ranging in places to less than one meter below ground, suggests that aquifer water may increasingly become contaminated. As household access to water improves, more and more people will begin to rely on water-flushed sanitation systems, many of which sit in the water table and leak pathogens into the aquifers. At present, only 28% of people in the region report doing something to treat their water (IHSI, 2006). Studies by the Division of Public Hygiene in Cap-Haïtien show that a large number of shallow wells are heavily polluted by fecal bacteria (MPCE, 1997a). In 2005-2006, 29% of children in Le Nord and 18% in Le Nord-Est had had diarrhea in the two weeks prior to the survey (IHSI, 2006).

Finally, although the annual water availability volumes are high, they vary in their distribution throughout the year and from east to west. An expansion of the lacs collinaires, already used in upland communities, complemented by larger reservoirs and dams, would provide much needed infrastructure that can help farming and livestock communities improve year-round productivity, improve water pressure in distribution networks and potentially mitigate flood risks (see Annex 2).

Institutions providing water services and governance. The water and sanitation sector recently witnessed a major reform in 2009, when the government disbanded the state-owned Service National d'Eau Potable (SNEP) and the Centrale Autonome Metropolitaine d'Eau Potable (CAMEP). In their place, the government established the national DINEPA authority, which will coordinate policies, funding, data observatory. The regions are organized by OREPAs (e.g., OREPA-Nord covers the three northern departments) and URDs for rural areas. They address the regional management of water resources and monitor utility performance. At the local levels, the Centre Technique d'Exploitation (CTEs) operate in cities greater than 10,000 people, and Comités d'Eau Potable et d'Assainissement (CAEPAs or CPEs) operate in areas with fewer than 10,000 people. Mayors and communal leaders can work closely with these entities to prioritize expansions in urban distribution networks in key locations.

Annex 4 details stormwater and flooding mitigation measures, and Annex 5 establishes recommendations for rainwater harvesting and household water quality management.

5.3 SANITATION, WASTEWATER AND STORMWATER

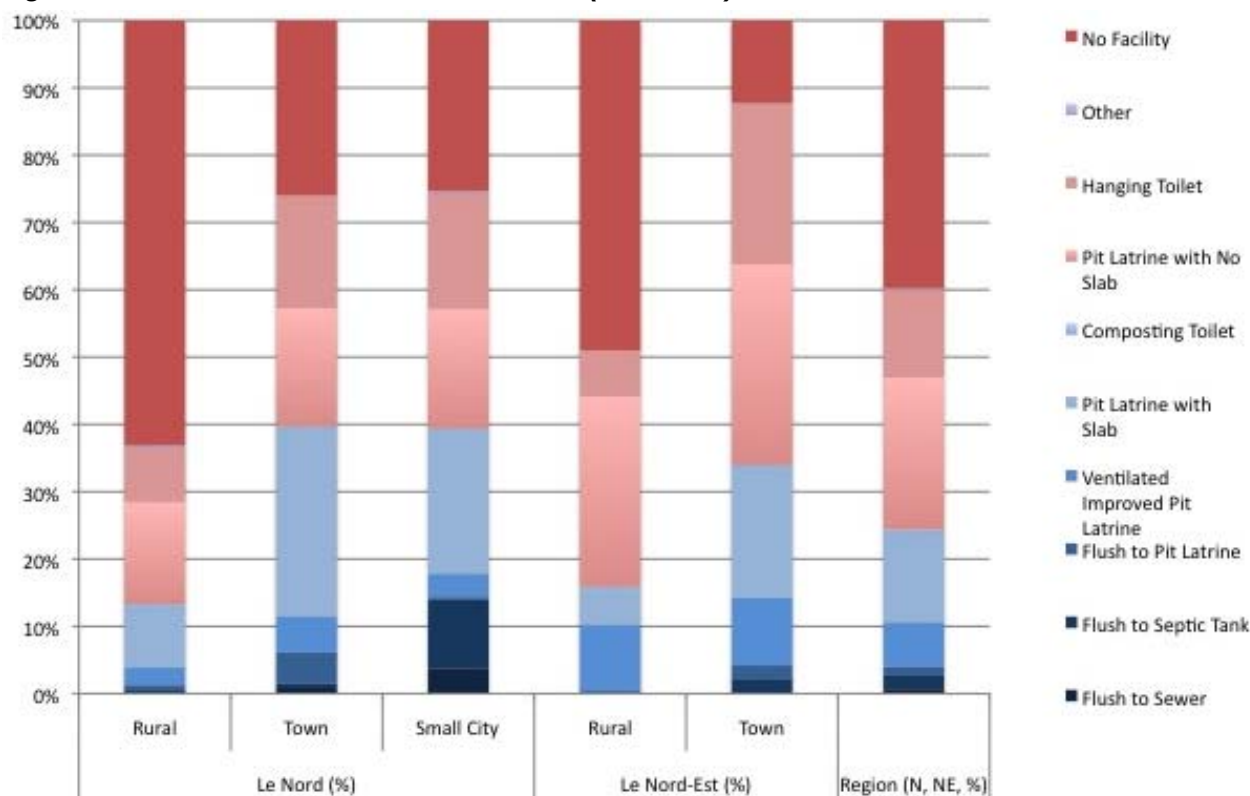
Current Access to Sanitation. In DINEPA's 2009-2010 annual report, it admitted that sanitation has never been a public priority and that there is no public sewerage system in the country, although the Spanish government recently funded the country's first wastewater treatment plant in Titanyen outside of PAP. The national government, having delegated responsibility for sanitation and wastewater management to local government, did not develop, until 2010, any national frameworks or policies on this issue. These historic priorities are reflected in the limited access to sanitation services across the country. At the national level, as cities grew over the last 20 years, the coverage of improved sanitation in cities fell from 88% in 1990 to 48% in 2010. Over the same period, open defecation decreased by only 3%, while the percentage of people using unimproved facilities rose to 43% from 0%.

In Le Nord and Nord-Est, 24% of people have improved sanitation, 36% have unimproved facilities and 40% have no facilities. The access to improved sanitation is lower in rural areas (13-16%) and higher in urbanized areas (34-40%). Even in a major city like Cap-Haïtien, only 14% of people use water-flushed sanitation; in other urban areas in the region, less than 4% of households use such systems. Overall, 8% of urban residents in the two departments use water-flushed systems (IHSI, 2006). It is important to note that, although international organizations count systems like septic tanks with direct discharge (no leaching fields) as improved forms of sanitation, many systems actually lack qualifying features. For instance, they may not be water tight or have dual chambers, and may not include safe disposal.

Current Waste Collection and Treatment. A pervasive challenge in Limonade, Caracol and Trou du Nord is the use of manual excavation workers to empty septic tanks and latrines (LGL, 2007b,c,d). In larger cities, private companies operate vacuum tankers that empty these systems, though their fees are prohibitive to most. There are at present no wastewater and sludge treatment or disposal facilities in the region. As a result, both manual workers and private companies typically dispose of the waste in nearby waterways, open dumps, drains or vacant land. In villages like Ferrier and Caracol, and in periurban areas, households also tend to bury and close latrines when they become full. These will eventually self-digest and compost, but may continue to contaminate groundwater systems until they are fully digested.

With no wastewater collection or treatment systems, effectively all greywater, blackwater, and sludge make their way into the soil and water ecosystems. Table 22 below estimates the volume of waste generated in the region's urban areas in 2005. This clearly has a tremendous impact on the natural environment, with rivers and coastal environments being the most affected. According to the Louis Berger 2011 water quality test of the Riviere Trou du Nord and the well at Fleury, barium and fecal coliform all exceeded national standards for drinking water. The river and well's fecal coliform count was 2,400 and 2,000 NMP/100mL respectively, compared with the national standard of 0 for drinking water.

Figure 34 Access to Sanitation in the Corridor (2005-2006)



Source: EMMUS 2005-2006

Table 21 Access to Sanitation in the Corridor

	Le Nord (%)			Le Nord-Est (%)		Region (%)
	Rural	Town	Small City	Rural	Town	
Improved Sanitation	13%	40%	39%	16%	34%	24%
Flush to Sewer	0%	1%	4%	0%	0%	1%
Flush to Septic Tank	0%	1%	10%	0%	2%	2%
Flush to Pit Latrine	1%	5%	0%	0%	2%	1%
Ventilated Improved Pit Latrine	3%	5%	3%	10%	10%	7%
Pit Latrine with Slab	9%	28%	22%	5%	20%	14%
Composting Toilet	0%	0%	0%	0%	0%	0%
Unimproved Sanitation	87%	60%	61%	84%	66%	76%
Pit Latrine with No Slab	15%	18%	18%	28%	30%	23%
Hanging Toilet	8%	17%	17%	7%	24%	13%
Other	0%	0%	0%	0%	0%	0%
No Facility	63%	26%	25%	49%	12%	40%

Source: EMMUS 2005-2006

Proposed Projects. Under the reform of the water and wastewater sector, DINEPA is also in charge of Haiti's sanitation and wastewater policy and recently developed the country's first sanitation strategic plan. According to DINEPA's 2009-2010 annual report, its first priority remains in the water sector and it will be unable to provide adequate funding for piped sanitation systems. Therefore, its strategy for sanitation focuses on reinforcing improved practices of private sanitation – for instance by updating construction standards for latrines and septic tanks and providing incentives to build septic tanks, latrines, and sanitation blocks for schools and markets, the last two of which will be prioritized. In the future, the water operators would be responsible for ensuring the proper construction of sanitation systems, in partnership with the city and the local branches of the Ministry of Health. Article 9 of the *Decret-Loi Cadres sur l'Eau* requires water tariffs to include the cost of wastewater infrastructure and treatment. DINEPA proposes to support these investments with public education and hygiene campaigns.

DINEPA is providing a total of US\$35 million to five pilot cities to develop wastewater collection and treatment systems, including one in Ouanaminthe. In particular, these systems will pilot the strategy of collective sanitation, such as condominium sewerage. The ongoing water and sanitation master plans mentioned in section 5.2 above will be completed by the summer of 2013.

In addition, several other major projects in the region have associated domestic sanitation and wastewater treatment components. The EKAM housing project, according to the sanitary engineer, will use septic tanks shared by several households. Information on how the project will treat greywater generated by the community, or how households will manage the accumulation of sludge inside the systems was not available. Other recent donor-funded housing projects, such as Food for the Poor and the Digicel-funded demonstration village, also rely on water-flushed septic tanks.

The PIC will generate a significant volume of industrial wastewater. By the end of Phase 1, the park is expected to generate 4,500 m³ of wastewater per day and 500-1,000 m³ of dried sludge per year. At build out, the park could generate three times as much wastewater and sludge. It is envisioned to house textile factories that include dye operations, a potential furniture company and a paint company, among others, resulting in a complex mixture of industrial-strength chemicals. The IDB has issued TORs seeking proposals for wastewater treatment designs that will treat the domestic and industrial effluent onsite. Domestic wastewater from staff bathrooms will be treated using septic tanks.

Despite a commitment to high levels of effluent treatment, the close proximity of the ecological protected area two kilometers downstream leaves little room for accidental or persistent malfunctions in the system. Physical redundancies in the treatment infrastructure and external monitoring, including by community

groups, will be important to ensuring that the Industrial Park lives up to its promise of not polluting the coastal environment.

Projected Access to Sanitation and Sludge and Greywater Generation. Whether under baseline or high-growth scenarios, urban populations will increase significantly in settlements along the corridor. The trend in the past twenty years has been for the coverage of improved sanitation to decrease under these conditions, and a significant and concerted effort will be necessary to reverse this trend. Given the national and international commitment to improving infrastructure in the region, however, the CIA proposes an optimistic outlook and predicts relatively significant gains to access to improved sanitation under the baseline scenario. Gains are still projected under the high-growth scenario, but are more modest given higher demographic pressures.

The widespread acceptance of dry sanitation suggests an opportunity to upgrade households to improved dry sanitation systems, an important strategy given the shallowness of the water table and the lack of experience and capacity at the local level for implementing sewerage systems. However, as piped water access increases, coupled with the potential increase in household incomes brought by the major investments in the region, more and more households will be able to afford and desire water-flushed sanitation. The projections account for private investments in water-flushed septic tanks and latrines, as well as significant public sector investments in shared community sanitation blocks. Priority should be given to reducing open defecation and raising household sanitary conditions to the level of a latrine.

Table 22 provides a rough estimate of the volume of sludge and greywater that will be generated in the corridor. Greywater and any sewerage collection systems will need to be designed for each community. Sludge treatment facilities could be located at these points, or at solid waste treatment facilities. Caracol, Limonade, Trou du Nord, and Terrier Rouge collectively represent a major population node on the corridor that could share a waste treatment facility, or even share facilities with the PIC's proposed systems.

Table 22 Projected Sanitation Access and Wastewater Generation

	Urban Pop. along Corridor	Access to Improved sanitation	Water Flushed Sanitation	Dry improved sanitation	Un-improved sanitation	No Facility	Per Capita Water Demand (l/pp/d)	Total sludge volume* (m ³ /yr)	Grey Water Volume** (Mm ³ /year)
2005 Data									
2005	351,000	24%	8%	16%	36%	40%	74	28,698	9.0
Baseline Scenario									
2015	449,194	35%	10%	25%	40%	25%	83	45,908	12.9
2020	505,743	45%	15%	30%	40%	15%	87	67,378	15.3
2025	555,644	55%	20%	35%	35%	10%	92	89,236	17.7
High-Growth Scenario									
2015	461,825	30%	10%	20%	40%	30%	83	45,513	13.3
2020	572,191	35%	12%	23%	40%	25%	87	63,908	17.3
2025	709,954	40%	15%	25%	40%	20%	92	91,992	22.6

*Estimated at 1.5 l/pp/day flushed, 0.2 l/pp/day dry; **95% water consumption

Agricultural Impact on Water Quality. Although difficult to measure, agriculture typically contributes significant levels of nutrients and waste into groundwater and surface water. In the study corridor, due to low incomes and lack of financing for small-hold farmers, the use of agricultural inputs such as fertilizers and pesticides are minimal. The implementation of two major agricultural projects – the Global Agriculture and Food Security Program and the Feed the Future Program, which aim to remove barriers to investment and financing, could lead to increased use of agricultural inputs that, absent other land management techniques, could elevate agriculture's contributions to nonpoint source pollution.

Animal husbandry is also widely practiced along the corridor, particularly in Le Nord-Est. Due to the completely free range of livestock and limited size of riparian buffers, animal manure easily enters surface waterways. Animal droppings, as well as animal carcasses, likely impact water quality. Communities commonly cited “elevage libre” as a problem because animals are often killed crossing the road and cause accidents. Efforts to create bounded pastures should also consider strategies to reduce animal contamination of surface water.

Stormwater. Due to the lack of detailed information on precipitation and absent a detailed engineering study, it is difficult to estimate the amount and quality of stormwater in the region. Deforested hillsides suffer from severe erosion and landslides, as evident in Sainte Suzanne. These contribute to the sediment loading in surface water, reducing the water quality for downstream human and natural uses.

Although the extent of paved roads is limited in the corridor, roads tend to be compacted and act as impervious areas. The small size of most of the towns along the urban corridor, however, suggests that the increased imperviousness is not yet a major factor in aquifer replenishment. Instead, the main challenge of urban imperviousness lies in the lack of drainage systems, the sizing of existing systems that are no longer adequate for current storms, and problems with drain blockage or grading, such that even small storms can lead to localized flooding. Design of stormwater infiltration systems to mitigate flooding will also have the benefit of recharging the aquifer in urban areas.

Certain land uses – such as informal dumps, industrial sites, fuel storage sites, mechanics shops, gas stations, slaughterhouses and markets – tend to have higher stormwater loading. These facilities rarely apply additional stormwater management strategies. Although a lower priority given the overwhelming impacts of domestic pollution at this point in Haiti’s development, major industrial projects such as PIC and donor-funded improvements should address stormwater issues.

Annex 6 presents strategies for wastewater treatment at household and community levels.

5.4 SOLID WASTE GENERATION

Institutions providing services and governance. Haiti lacks a law dedicated to solid waste management that provides a clear framework on managing construction and demolition, medical, hazardous, electronic and municipal waste. The lack of policy development in the solid waste sector reflects national priorities, which have historically not allocated adequate resources to local and commune governments to establish sanitary facilities or collection networks. As a result, solid waste has become one of Haiti’s most visually apparent environmental challenges.

At the national level, it is unclear which agency is responsible for coordinating and detailing standards within the sector, which entity is responsible for implementation, and what are the standards for public or micro-enterprises providing the services (Emmanuel, 2008). Historically, communes were responsible for solid waste management, but the lack of human and financial resources at this level has caused solid waste management to fall back on the Ministries of Interior and Planning.¹¹ The national public company, Le Service Métropolitain de Collecte des Résidus Solides (SMCRS), has a division for Le Nord and serves Cap-Haïtien. It has a monthly operational budget of 500,000 Gds (US\$12,200) for a service population of 500,000 people.

Today, following the reform of the water and sanitation sectors, there is debate as to how to reform the solid waste sector, given the clear relationship between the water, sanitation, drainage and solid waste. Two possibilities under consideration include creating a DINEPA equivalent for solid waste, or placing national solid waste management under the DINEPA.

11 The Law of 1942 states that there should be a surcharge of 2 Gds for solid waste, although this has not been updated or exercised (MTPTC, 2006).

Characteristics of Solid Waste Generation. The following analysis is based mainly on data from Cap-Haïtien and Port-au-Prince's solid waste characteristics from 5 to 15 years ago. A 2001 study of municipal solid waste in Cap-Haïtien, Milot, Limonade, Acul Nord and Plaine du Nord found that waste generation tended to average 0.45kg per capita per day in each city (Bécoulet, 2004). Average waste generation was estimated at 0.6kg per capita per day in Cap-Haïtien in 2008 (Emmanuel, 2008).¹² Should both these figures be reliable, that would mean a 5% annual increase in waste generation per capita. This study takes as its base the 0.6kg figure for 2008, and uses a conservative 3% increase per year in waste generation.

As is typical of developing economies, the municipal waste stream is primarily organic. Estimates of the waste stream composition range from 53-77% organic for cities in the region, with 14-34% of materials made of inorganic and largely recyclable materials. These figures undoubtedly vary depending on the primary economic sectors of each city. Nevertheless, they suggest significant opportunities for composting and recycling.

Table 23 Composition of Municipal Waste in the Region

	Study of Madeline dump in Cap-Haïtien (CHF 1996)	Cap-Haïtien (2004)	Limonade (2004)	Study of Port-au-Prince (GRET Study, MTPTC 2006)
Organic Material	77%	65%	53%	73%
Inorganic Materials	14%	18%	34%	27%
Paper, cardboard	5%	7%	9%	10%
Cloth	3%			
Metal	3%	1%	8%	3%
Plastic	2%	7%	7%	6%
Glass	1%			
Other		3%	10%	8% (partially degradable)
Inert Materials (e.g. gravel, sand, ashes)	9%	17%	13%	

Source: CHF/BM en 1996 a la decharge de Madeline, MTPTC PAP 2006; Bécoulet, 2004

In addition to municipal waste, other sectors also contribute important volumes of solid waste. Emmanuel (2008) estimated that 85% of Cap-Haïtien's waste stream came from households, and 15% from markets. Figures from Port-au-Prince indicate that the city generates 912,500 tons per year of household waste and 2.75 million tons per year of demolition, green, industrial, commercial and medical (MTPTC, 2006a). These figures suggest that household waste contributes 25% of total waste, with other sectors contributing 75%. Given the rapid rate of urbanization, the number of proposed development projects that include major industries and hospitals, non-domestic sources of waste will likely increase as a proportion of total waste. In the absence of a completed study on the industrial park's solid waste generation, this study assumes that this 25:75 domestic to non-domestic waste ratio holds for the Cap-Haïtien-Ouanaminthe corridor.

Current Collection and Disposal Situation. At present, there are no sanitary landfills in operation in the region of study. A 2004 study of solid waste management in Cap-Haïtien noted that 11% of solid waste in the city is collected and deposited in an uncontrolled landfill by the sea (possible the Madeleine or the GATAP site in Petite Anse). An area in Ti Charite was reserved for an open dump in the 1990s, but has not been used for 10 years and now much of it has been built over today (Emmanuel, 2008). One study estimated that another 15% of waste is used to backfill the wetlands for construction, for instance in Fort St. Michel, Petite Anse, Shada and Cite Chauvel (IPES 2004). A survey of residents in Cap-Haïtien, Milot, Limonade, Acul Nord and Plaine du Nord found that 58% of people throw waste anywhere, 30% burn their waste, and 10% dispose of waste in dedicated bin. A more recent study of Cap-Haïtien found that 76% of households have no waste disposal collection, with 25% of households disposing of waste in the sea, 24% on vacant land, 17% in ravines, 7% in streets and 2% in drains (EauCap/CHS, 2009).

12 For comparison, studies of Port-au-Prince from 2006 estimate a per capita municipal waste generation rate of nearly 1kg per day (MTPTC, 2006).

Table 24 Solid Waste Disposal Strategies in Cap-Haïtien and Surrounding Areas

	Anywhere						Burn	Dedicated Bin
	Total	Sea	Vacant Land	Ravine	Street	Sewer		
2004 Study	58%						30%	10%
2009 Study	76%	25%	24%	17%	7%	2%	7+%	17%

Sources: Bécoulet, 2004; EauCap / CHS, 2009

From high-resolution satellite images of the cities in the region, it is often possible to locate existing open dumps due to the reflectivity and appearance of solid waste (Figure 35). This analysis shows that open dumps tend to be sited on the fringes of settlements and along waterways or near markets, with few homes located more than 500 to 1,000 meters away from a dump site. Given the lack of a formal collection or disposal system, most sites tend to be on the back of the community and are usually inaccessible to vehicles. Future collection systems should focus on creating upgraded collections facilities with similar frequencies, but ensure greater vehicular access to allow waste to be transferred to improved or sanitary landfills.

One estimate indicates that 17% of households in Cap-Haïtien avail of waste collection services (14% from the city and 3% from private companies) (EauCap / CHS, 2009). Another estimates that the Mairie of Cap-Haïtien and MTPTC collect on average 13% of the waste produced, and that private enterprises collect another 2% (Emmanuel, 2008). The city of Cap-Haïtien has five vehicles, and focuses on the historic *centreville* and periodically in some *quartiers* of Zone II (Emmanuel, 2008). Those that use city or micro collection services are charged Gds 75-250 per month, a price that is too expensive for most. Others pay for a *brouettier*, or wheelbarrow worker, Gds 20 a month to dispose of waste.

Composting is formally and informally practiced. Starting in 1992, L'Unité de Compostage des Ordures Menagere du Cap-Haïtien (UCOMEC) aimed to compost 20% of the waste collected by the municipality. However, it closed in 1995. In Ferrier, the rice husks from the rice mill are used for compost to improve rice fields, and in many other rural and peri-urban households compost in their gardens. Two grassroots composting efforts operate out of Sainte Raphael, 80km south of Cap-Haïtien, where there is an important market for compost. In cities and smaller towns, free roaming goats, cows and pigs commonly pick out organic waste in urban areas. In the region, the main existing example of recycling is Citadelle Plastic, which has been making plastic bags for supermarkets since 2004 (EauCap / CHS, 2008).

Current and Future Wastes Streams. The IDB is funding an ongoing regional solid waste study that will shed considerable light on the levels of waste generation, systems of collection, and methods and locations of disposal. That study will result in detailed master plan proposal for waste management in the region. In advance of that detailed analysis, this study undertakes a rough estimate of future waste generation in the corridor based on available information of historic and recent waste streams. Two scenarios (baseline and high population growth) are presented, based on a 3% increase in per capita waste generation each year, and that domestic waste comprises 25% of total waste streams.

As Tables 25-28 on current and projected solid waste generation volumes indicate, total municipal waste generation could grow from 244 tonnes per day in 2009 to 688 tonnes per day in 2030 under the baseline scenario. While the population in the main cities along the corridor will double, the domestic waste stream nearly quadruples (386%) due to the 3% annual increase in per capita waste generation. Under the high growth scenario, municipal waste generation grows from around 240 tons per day in 2009 to 940 tonnes per day in 2030, such that with a tripling of the population, the solid waste volumes will increase more than five-fold (545%). By 2030, there could be a potential need to compost 500 to 1,000 tons of organic waste per day. Given an inorganic, recyclable content of 14-34%, there is a potential to recycle 130 to 450 tons of materials per day.

Non-domestic waste could potentially increase from around 700 tonnes per day in 2009 to 2,800 (baseline scenario) to 4,000 (high-growth scenario). Textile industries, local manufacturers and mechanic shops, agro-industrial waste, including animal carcasses, will be the main contributors to local non-domestic waste. To these streams of waste should be added about 100 tons per day of fecal sludge as well as the sludge generated by the water treatment facility at the industrial park.

Figure 35 Likely Open Dumps as Identified in Aerial Photos

Limonade



Trou du Nord



Terrier Rouge



Fort Liberté



Table 25 Current and Future Municipal Waste Generation (Baseline Scenario)

	2009		2015		2020		2025		2030	
	Pop	Waste (t/day)	Pop	Waste (t/day)	Pop	Waste (t/day)	Pop	Waste (t/day)	Pop	Waste (t/day)
Tonnes of Municipal waste per day per cap		0.00062		0.00074		0.00086		0.00099		0.0012
Le Nord	248,160	153	287,790	212	324,019	277	355,990	353	383,502	441
Ville de Cap Haïtien	155,505	96	180,338	133	203,041	174	223,074	221	240,315	276
Quartier de Petite Anse	89,155	55	103,392	76	116,408	100	127,894	127	137,779	158
Ville de Quartier Morin	3,500	2	4,059	3	4,570	4	5,021	5	5,409	6
Le Nord-Est	139,179	86	161,405	119	181,724	155	199,655	198	215,085	247
Ville de Limonade	14,886	9	17,263	13	19,436	17	21,354	21	23,005	26
Ville de Caracol	2,690	2	3,120	2	3,512	3	3,859	4	4,157	5
Ville de Trou du Nord	21,805	13	25,287	19	28,470	24	31,280	31	33,697	39
Ville de Terrier Rouge	12,226	8	14,178	10	15,963	14	17,538	17	18,894	22
PIC Node Subtotal	82,922	51	59,848	44	67,381	58	74,031	73	79,753	92
Ville de Ste Suzanne	1,488	1	1,726	1	1,943	2	2,135	2	2,300	3
Ville de Fort-Liberte	18,417	11	21,358	16	24,047	21	26,419	26	28,461	33
Ville de Derac	2,046	1	2,373	2	2,671	2	2,935	3	3,162	4
Ville de Ferrier	7,371	5	8,548	6	9,624	8	10,574	10	11,391	13
Ville de Ouanaminthe	58,250	36	67,552	50	76,056	65	83,561	83	90,018	104
Total Population & Municipal Waste	387,339	239	449,194	332	505,743	432	555,644	551	598,587	688

Table 26 Current and Future Total Waste Generation (Baseline Scenario)

	2009		2015		2020		2025		2030	
	t/day	t/year	t/day	t/year	t/day	t/year	t/day	t/year	t/day	t/year
Domestic Waste	239	87,372	332	121,000	432	157,830	551	201,188	688	251,257
Other Waste	718	262,116	995	362,999	1,297	473,489	1,654	603,563	2,065	753,770
Total Waste Stream	958	349,488	1,326	483,998	1,730	631,319	2,205	804,751	2,753	1,005,027

Table 27 Current and Future Municipal Waste Generation (High Growth Scenario)

	2009		2015		2020		2025		2030	
	Pop	Waste (t/day)	Pop	Waste (t/day)	Pop	Waste (t/day)	Pop	Waste (t/day)	Pop	Waste (t/day)
Tonnes of Municipal Waste per day per capita		0.00062		0.00074		0.00086		0.00099		0.0012
Le Nord	248,160	153	294,857	218	358,738	307	436,460	433	505,977	582
Ville de Cap Haïtien	155,505	96	184,767	136	224,797	192	273,500	271	317,061	365
Quartier de Petite Anse	89,155	55	105,931	78	128,882	110	156,804	156	181,779	209
Ville de Quartier Morin	3,500	2	4,159	3	5,060	4	6,156	6	7,136	8
Le Nord-Est	139,179	86	166,969	123	213,452	183	273,494	271	325,768	375
Ville de Limonade	14,886	9	18,027	13	24,125	21	32,284	32	39,279	45
Ville de Caracol	2,690	2	3,258	2	4,359	4	5,834	6	7,098	8
Ville de Trou du Nord	21,805	13	26,406	19	35,338	30	47,290	47	57,535	66
Ville de Terrier Rouge	12,226	8	14,806	11	19,814	17	26,515	26	32,260	37
PIC Node Subtotal	51,607	32	62,497	45	83,636	72	111,923	111	136,172	156
Ville de Sainte Suzanne	1,488	1	1,768	1	2,151	2	2,617	3	3,034	3
Ville de Fort-Liberte	18,417	11	22,303	16	29,847	26	39,942	40	48,596	56
Ville Industrielle de Derac	2,046	1	2,431	2	2,958	3	3,598	4	4,172	5
Ville de Ferrier	7,371	5	8,758	6	10,655	9	12,964	13	15,029	17
Ville de Ouanaminthe	58,250	36	69,211	51	84,206	72	102,449	102	118,767	137
Total Population & Municipal Waste per day	387,339	244	461,825	341	572,191	489	709,954	704	831,745	957

Table 28 Current and Future Total Waste Generation (High Growth Scenario)

	2009		2015		2020		2025		2030	
	t/day	t/year	t/day	t/year	t/day	t/year	t/day	t/year	t/day	t/year
Domestic Waste	239	87,372	341	124,402	489	178,566	704	257,060	957	349,125
Other Waste	718	262,116	1,022	373,206	1,468	535,699	2,113	771,180	2,870	1,047,375
Total Waste Stream	958	349,488	1,363	497,608	1,957	714,266	2,817	1,028,240	3,826	1,396,500

Projected Air Pollution from Open Burning. Of these amounts of waste, an estimated 7 to 30% of waste will likely be burned in the corridor. As shown in Table 29, which uses emissions factors from the U.S. EPA's tests of open burning in barrels, waste burning could lead to 40-54,000 pounds of air pollution daily. These pollutants directly contribute to acute and chronic respiratory diseases, especially among children and the elderly.

Table 29 Estimated Air Pollution Generated by Open Burning

	Emissions (lb/ton)	2030 Baseline	2030 High Growth
Total Municipal Waste Generation (tons / day)		688	936
Percent waste burned		30%	30%
Total burned waste (tons / day)		206.4	280.8
Carbon Monoxide	85	17,544.00	23,868.00
PM10	38	7,843.20	10,670.40
PM2.5	34.8	7,182.72	9,771.84
Methane	13	2,683.20	3,650.40
VOCs	8.556	1,765.96	2,402.52
Nitrogen Oxide	6.0	1,238.40	1,684.80
Benzene	2.48	511.87	696.38
Acetone	1.88	388.03	527.90
Styrene	1.48	305.47	415.58
Sulfur Oxides	1.0	206.40	280.80
Hydrogen cyanide	0.936	193.19	262.83
Hydrogen Chloride	0.568	117.24	159.49
Phenol	0.28	57.79	78.62
Total Polycyclic Aromatic Hydrocarbons (PAHs)	0.132	27.24	37.07
Naphthalene	0.036	7.43	10.11
Acenaphthylene	0.022	4.54	6.18
Phenanthrene	0.0146	3.01	4.10
Total Polychlorinated biphenyls (PCBs)	0.00572	1.18	1.61
Chlorobenzenes	0.0008484	0.18	0.24
Hexachlorobenzenes	0.00044	0.09	0.12
Dichlorobenzenes	0.00032	0.07	0.09
Trichlorobenzenes	0.00022	0.05	0.06
Tetrachlorobenzenes	0.000148	0.03	0.04
Pentachlorobenzenes	0.000106	0.02	0.03
Total Polychlorinated dibenzo-p-dioxins (PCDD)	0.000076	0.02	0.02
Total Polychlorinated dibenzo furans (PCDF)	0.0000122	0.00	0.00
Total Air Pollution (tons / day)		40,081	54,529

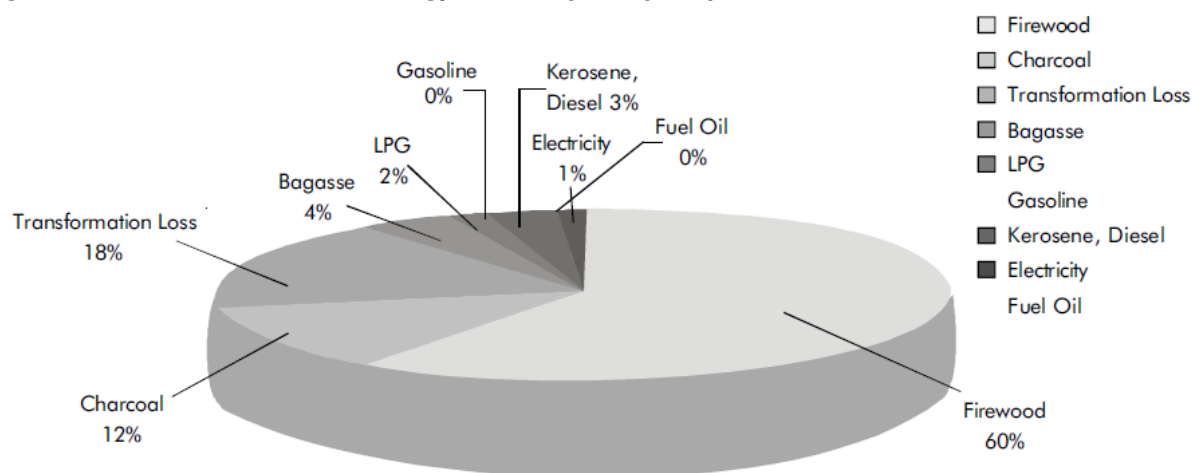
Source: Emissions factors from U.S. EPA, 2001

Annex 7 establishes a strategy for solid waste management through the development of policies, public education, financing, and physical infrastructure.

5.5 ENERGY CONSUMPTION

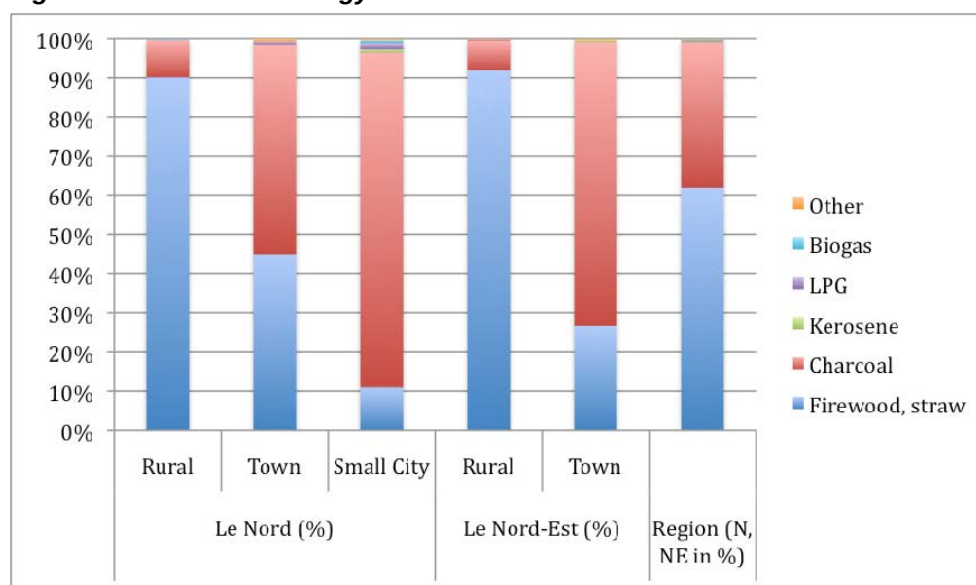
Biomass. The domestic sector, which comprises 65-70% of total energy use, relies predominantly on biomass energy, with rural households using firewood, and urban households using charcoal (MTPTC / BME / EDH, 2007; World Bank, 2007). Around 74% of urban households in Le Nord and Nord-Est rely on charcoal, 24% use firewood, and less than 1% use LPG, kerosene, biogas and other materials each (EMMUS-IV, 2005-06). The more urban the area, the more households shift towards charcoal. According to a 2005 Ministry of Environment Survey of Port-au-Prince, per capita consumption of charcoal is generally increasing, reaching on average 0.4kg per person per day. In the urban towns of the study corridor, this would translate to 114,200 kg of charcoal used per day, or around 42 kilotonnes of charcoal per year.

Figure 36 National Household Energy Consumption (2003)



Source: World Bank, ESMAP 2007

Figure 37 Household Energy Sources for Le Nord and Nord-Est



Source: EMMUS IV 2005-06

A number of international and national initiatives are promoting alternative energy resources, such as more efficient cook stoves, LPG, kerosene, ethanol, jatropha oil, waste paper briquettes, biomass pellets,

biochar, and solar cookers. In the near term, these initiatives will likely have limited impacts on local energy use due to the immaturity of the market for some of the alternatives and the high cost of more efficient cook stoves and fossil fuels. As of 2003, Haiti's estimated household energy consumption is: 79% biomass, 17.6% oil, 2.6% electricity and 0.6% LPG (World Bank, 2007). Major power plants under consideration in the region will improve access to electrical appliances but will also likely have little impact on charcoal consumption, which is used primarily for cooking. In the medium to long-term, charcoal use may decline as households opt for cleaner stoves and fuels due to financial capacity and health concerns.

Given urbanization trends in the northern corridor, the CIA conducted a rough estimate of future charcoal consumption based on assumptions about future reliance on different energy sources and per capita charcoal use. The estimates posit an overall reduction of biomass reliance from 98% in 2009 to 80% in 2030, an optimistic reduction given cultural preferences, economic realities and governance capacity to launch overarching sector reforms. The estimates include a small increase in per capita charcoal use of 5% every five years.

Table 30 Projected Household Energy Sources

	2009	2015	2020	2025	2030
Fuelwood	24.4%	22%	20%	18%	15%
Charcoal	73.7%	72%	70%	67%	65%
Kerosene	0.5%	2%	3%	5%	6%
LPG	0.7%	2%	4%	6%	9%
Biogas	0.3%	2%	3%	4%	5%
Other	0.4%	0%	0%	0%	0%

These estimates suggest that given the population forecasts, charcoal consumption could rise from 42 kilotonnes per year in 2009 to 69 to 96 kilotonnes per year in 2030 (see Table 31).

Charcoal conversion efficiency in Haiti is around 20% (meaning 1kg of charcoal is produced for every 5kg of wood) (MTPTC / BME / EDH, 2007). These are confirmed by international studies that suggest that households using charcoal require roughly 4-6 times as much wood as those using woodfuel (van der Plas, 1995; Kammen and Lew, 2005). At present, charcoal production in the region appears to be sustainably harvested, although illegal imports of charcoal from the Dominican Republic may augment local production (Gronewold, 2009). As charcoal demand increases, currently sustainable production patterns based primarily on re-coppicing trees and shrubs such as *Prosopis juliflora* may begin to overexploit resources. Mangroves, whose wood has high calorific value and is resistant to rot, will be at risk of exploitation for charcoal and housing construction. The proximity of the mangrove stands to foreseeable urbanization makes this resource highly vulnerable.

Electricity. Approximately 38.5% of Haitians have access to electricity (World Bank Development Indicators 2009), although electricity consumption represents just 4% of total energy use (PNDE 2005). The industrial sector consumes 43% of all electricity produced (MTPTC / BME / EDH, 2007). In the North, access rates are much lower – in Le Nord-Est, only 3% of households have electricity. The main cities in the region have electrical generators that produce only 6 hours of electricity daily, and EDH grids are very limited. Solar, wind and ethanol/jatropha energy resources continue to be explored, particularly by donors and donor-funded entrepreneurs, but remain cost-prohibitive to most households.

Haiti's Plan de Développement du Secteur de l'Energie aims to electrify the north by 2013-2015. For a list of planned or proposed public energy infrastructure improvements, see Table 3. The national electrical company EDH is constructing a 6.9 MW electrical power plant in Fort Liberté, which would serve the city of Fort Liberté and potentially the proposed Port and additional USG-financed settlements in Fort Liberté. The Industrial Park has also proposed to install by 2012 three 1.6MW Hyundai Innovative Marine and Stationary generators that would provide the 4MW needed during the first phase of the project (AECOM, 2011). This would be expanded to 10MW by 2014, with an eventual capacity of 25-35 MW. This plant would serve the industrial park, 3,300 residential customers in USG-financed housing near the industrial park, and 27,150 residential clients in Caracol, Trou du Nord, Terrier Rouge and Limonade.

Table 31 Projected Household Charcoal Consumption

	2009		2015		2020		2025		2030	
	Pop. Using Charc.	Charcoal Use (kg/day)	Pop. Using Charc.	Charcoal Use (kg/day)	Pop. Using Charc.	Charcoal Use (kg/day)	Pop. Using Charc.	Charcoal Use (kg/day)	Pop Using Charcoal	Charcoal Use (kg/day)
Kg of Charcoal /day/cap		0.40		0.42		0.44		0.46		0.49
Projected Household Charcoal Consumption (Baseline Scenario)										
Le Nord	182,894	73,158	207,208	87,028	226,813	100,025	238,513	110,443	249,276	121,199
Ville de Cap-Haïtien	114,607	45,843	129,843	54,534	142,129	62,679	149,460	69,207	156,204	75,947
Quartier de Petite Anse	65,707	26,283	74,443	31,266	81,486	35,935	85,689	39,678	89,556	43,542
Ville de Quartier Morin	2,580	1,032	2,922	1,227	3,199	1,411	3,364	1,558	3,516	1,709
Le Nord-Est	102,575	41,030	116,212	48,809	127,207	56,098	133,769	61,942	139,805	67,974
Ville de Limonade	10,971	4,388	12,430	5,220	13,606	6,000	14,307	6,625	14,953	7,270
Ville de Caracol	1,983	793	2,246	943	2,459	1,084	2,585	1,197	2,702	1,314
Ville de Trou du Nord	16,070	6,428	18,207	7,647	19,929	8,789	20,957	9,704	21,903	10,649
Ville de Terrier Rouge	9,011	3,604	10,208	4,288	11,174	4,928	11,751	5,441	12,281	5,971
PIC Node Subtotal	38,035	15,213	43,091	18,098	47,168	20,801	49,600	22,967	51,839	25,204
Ville de Sainte Suzanne	1,097	439	1,242	522	1,360	600	1,430	662	1,495	727
Ville de Fort-Liberte	13,573	5,429	15,378	6,459	16,833	7,423	17,701	8,196	18,500	8,995
Ville de Derac	1,508	603	1,708	718	1,870	825	1,966	911	2,055	999
Ville de Ferrier	5,432	2,173	6,155	2,585	6,737	2,971	7,084	3,280	7,404	3,600
Ville de Ouanaminthe	42,930	17,172	48,638	20,428	53,239	23,479	55,986	25,924	58,512	28,449
Total	285,469	114,188	323,420	135,836	354,020	156,123	372,282	172,385	389,081	189,172
Projected Household Charcoal Consumption (High-Growth Scenario)										
Le Nord	182,894	73,158	212,297	89,165	251,117	110,743	292,428	135,409	328,885	159,905
Ville de Cap-Haïtien	114,607	45,843	133,032	55,873	157,358	69,395	183,245	84,852	206,090	100,201
Quartier de Petite Anse	65,707	26,283	76,271	32,034	90,217	39,786	105,059	48,648	118,157	57,448
Ville de Quartier Morin	2,580	1,032	2,994	1,258	3,542	1,562	4,124	1,910	4,639	2,255
Le Nord-Est	102,575	41,030	120,217	50,491	149,417	65,893	183,241	84,850	211,749	102,953
Ville de Limonade	10,971	4,388	12,980	5,451	16,887	7,447	21,630	10,016	25,531	12,413
Ville de Caracol	1,983	793	2,346	985	3,052	1,346	3,909	1,810	4,614	2,243
Ville de Trou du Nord	16,070	6,428	19,013	7,985	24,736	10,909	31,684	14,671	37,398	18,183
Ville de Sainte Suzanne	1,097	439	1,273	535	1,506	664	1,753	812	1,972	959
Ville de Terrier Rouge	9,011	3,604	10,660	4,477	13,870	6,116	17,765	8,226	20,969	10,195
Ville de Fort Liberté	13,573	5,429	16,058	6,745	20,893	9,214	26,761	12,392	31,587	15,358
Ville de Derac	1,508	603	1,750	735	2,070	913	2,411	1,116	2,712	1,318
Ville de Ferrier	5,432	2,173	6,306	2,648	7,459	3,289	8,686	4,022	9,769	4,750
Ville de Ouanaminthe	42,930	17,172	49,832	20,929	58,944	25,994	68,641	31,784	77,198	37,534
Total	285,469	114,188	332,514	139,656	400,533	176,635	475,669	220,259	540,634	262,858

According to the USAID Environmental Impact Assessment for the industrial park power plant, the generators would likely meet U.S. EPA standards for air pollution in the initial phase of 4MW. Similar emissions may be expected by the 6.9MW EDH facility in Fort Liberté. However, at full build out, the power plant at the PIC “would exert 5.2 times more emissions, which would likely violate WHO air quality standards, thereby creating strong negative impacts on air quality and human health” (AECOM, 2011). As the EIA notes, however, it is hard to evaluate results without an air dispersion model, and further study is needed to confirm impacts. These emissions should be considered in context of motor vehicle emissions, which will be concentrated at the proposed port and industrial park.

Motor Fuels. See above section on Transportation. The increased use of motor vehicles will lead to increasing air pollution, concentrated in Cap-Haïtien, Ouanaminthe, Fort Liberté and around the industrial park.

Petroleum Infrastructure. As demand for petroleum products serving the industrial and transport sectors in the north increase, the region would likely need a petroleum terminal. This may be co-located at the proposed port serving the industrial park. Storage and transport of petroleum products at the port and at the industrial park pose potential leakage and air quality impacts and would need to be addressed through onsite drainage and treatment controls, as well as the development of an oil spill contingency plan. Likewise, the corridor will need to expand gas stations and vehicle servicing centers to support increased traffic. Gas stations will require particular attention to groundwater and air pollution impacts.

Noise Pollution. The increase in traffic, energy production facilities, construction and economic activities will all escalate the level of noise pollution in the urban corridor. Due concern for noise pollution mitigation in the choice of equipment and the design of sound barriers should be demonstrated for major commercial and industrial investments.

Annex 8 presents recommendations to extend access to energy and electricity.

PART 6: CUMULATIVE IMPACT ASSESSMENT

The following section summarizes the cumulative environmental impacts for each of the valued environmental systems. Table 33 presents a visual matrix summarizing the impacts, and proposed indicators are presented in Table 34. It should be noted that, while the assessment and strategies are categorized by valued environmental system (VES) for the purposes of the CIA, in reality implementation would inevitably take place along sectoral boundaries. An important task for the AIA local urban plans will be to identify and integrate community priorities across sectors. Integration and systems-oriented approaches will ultimately rely on municipal coordination and cross-sectoral dialogue. These should be discussed at the September meeting on management structures and strategies.

6.1 VES 1: Estuarine, Coastal and Marine Systems

Coastal, estuarine and marine systems are already at risk due primarily to the following practices: the destruction of mangroves for charcoal and construction materials; overfishing; surface water contamination through untreated human, livestock and industrial liquid waste; and marine litter that washes down from the coastal rivers. During the rainy season, impromptu landfills in waterways are flushed into the ocean, where they float into coastal estuaries, coral systems and to other countries and ecosystems. This litter impairs not only the aesthetics of marine environments throughout the Caribbean, but can also destroy habitat, particularly coral reefs and sea grass beds, and endanger aquatic wildlife that accidentally eat or are enmeshed in fishing nets and gear (UNEP, 2008). The volume and pace of resource demand and waste production will typically double or triple by 2030, up from 2005 levels, thereby exacerbating existing system degradation. These impacts will occur more slowly or quickly in line with investments in employment generators, regardless of international and national decisions.

The proposed investments in the corridor, however, would result in two major changes. First, in addition to affecting Cap-Haïtien and Ouanaminthe, which was the past trend, the Caracol-Trou du Nord-Limonade-Terrier Rouge region will become a new node on the corridor. In the past, the Baie de Caracol was relatively isolated due to the small size of upstream and nearby communities and the poor quality of roads. This isolation, which afforded the ecosystem some measure of protection, will soon be lifted. Even if the industrial park avoids *bidonvilliation*, the impacts of larger populations around in Trou du Nord, Caracol, Terrier Rouge and the RHC will eventually drain into the Baie de Caracol. The role that the Caracol estuary and its connected rivers play as a refuge for the entire northern coastline becomes endangered. There is significant fear among local people that this pollution will impact the coastal salt basins, which produce salt for regional and international consumption, as well as coastal fisheries, both of which are economic mainstays of coastal communities such as Caracol. The proximity of the mangroves to the investment and employment centers make them particularly vulnerable to increasing demand for construction materials, lime and charcoal.

Second, the siting of major new investments all along the coast begins to ring the corridor's greatest marine resources with industrial and traffic heavy land uses. The industrial park, in case of accidental releases of untreated wastewater, would directly pollute the protected marine coastal park and salt production in the region. Increased stormwater runoff pollutants from the park and surrounding roads will add to the pollutant load. The port, should it be built in the Baie de Fort Liberté, would require significant dredging, coral reef cuts, and shoreline reconfiguration and introduce heavy traffic of large cargo ships – with their attendant bow thrusters and oil leaks – into a sensitive ecosystem. The Baie de Cap-Haïtien is already highly altered and impacted through industrial and port uses, airport, and dense urban settlements. This would leave the Baie de Limonade as the last less urbanized and impacted coastal marine system, although its proximity to Cap-Haïtien suggests increasing development pressures there as well. Taken together, these developments will have a large cumulative impact on the coastal environment, leaving few areas unaffected.

These investments have spatial impacts as well. The industrial park with a major entrance on the roads to Caracol and Jacquezy will effectively consume the capacity and identity of these roads. Should an airport also be constructed on the former sisal plantation land in Madras, that road will quickly also become utilized to serve the airport and the industrial and commercial uses that tend to cluster around the airport.

These industrial uses and road congestion will use all roads leading to the Baie de Caracol Marine Protected Area, seriously affecting the marketing and visual appeal of this area from the land side.

Finally, the concentration of new urban communities in the coastal zone, in closer proximity to flooding and the Septentrional Fault places increasing numbers of people at risk. In the absence of significant public efforts to provide land and services in lower risk areas, new migrants will have a tendency to settle on less desirable land – in ravines, along coastlines, in flood-prone areas and steep slopes. As Haitians know well, disasters deplete individual and community assets, leading to persistent poverty that in turn leads to an inability to fund infrastructure and services that reduce both human and environmental risks.

6.2 VES 2: Surface and Ground Water Resources

Freshwater supplies are one of the scarcest resources for island ecologies and must be managed carefully and holistically. The cities along the RN6 corridor currently use around 12 million cubic meters of water each year. With modest increases in per capita water demand, increasing access to piped water, and increasing populations, domestic water demand could rise to 19-24 Mm³/year by 2025. The PIC, by the end of Phase 1 (2020) would need 1.3 Mm³/year, and by the end of Phase 2 (year unknown), as much as 4.2 Mm³/year. Future corridor wide consumption – in cities – will be at a minimum 20-28 Mm³/year, not including water consumption in rural areas and other small towns, and for agriculture and industries – all of which will increase under planned development programs. Although these figures are low in comparison to the estimates of the 250,000,000 m³ aquifer and the 1,000 Mm³/year water balance in Le Nord/Nord-Est, it is unclear how the withdrawals of this much water so close to the coast would affect saline intrusion patterns, land subsidence and the water table.

The water sector in the region is affected both by too much information and too little. A number of studies have been done on surface and groundwater flow rates and quality for PIC, for agricultural projects, and to develop master plans per city. These have a tendency to examine water availability on a project-by-project basis, without an overall understanding of the water balance in the main and sub-watersheds. At the same time, detailed information on local precipitation, flood maps, and the behavior of the transboundary Plaine du Nord aquifer is unknown. Under such circumstances, it is difficult to do detailed urban drainage plans or estimate how much water consumption can be sustained in the northern corridor.

A watershed-level planning study is much needed and will require long-term baseline data based on in-stream river flow rate monitors, precipitation gauges in cities and along the mountains-to-coast transect. Support for DINEPA to augment their limited monitoring system is a high priority. Localized time series data collected will support better understanding of changing weather patterns, broader planning initiatives about seasonal water management, dam and reservoir construction, inter-sub-watershed transfers for irrigation and flood management, flood water channelization to arid regions of the Nord-Est's coastal plain, payment schemes for environmental services that help finance reforestation / productive forests. These policy and planning initiatives will have critical implications for the northern urban corridor's long-term rate of urbanization, sustainable water supply, and vulnerability to flooding and food security.

In the interim, there are several acute water-related concerns.

Flooding is the first priority concern with regards to urbanization along the corridor. Il convient de mentionner que le bassin versant de la Grande Rivière du Nord est en termes de surface un des plus importants du pays (700 km²). Ce cours d'eau constituait même à l'époque coloniale, lorsque le couvert boisé était plus important, une menace suffisamment grave pour que des fonds publics soient considérés pour son endiguement. Historic developments tend to be located in higher areas, but new developments, in part due to poverty and demographic pressures, are increasingly located in flood-prone areas in each of the towns along the corridor. The PIC, EKAM and URHC sites were selected prior to risk and environmental assessments and as has been demonstrated by the past rainy season, are all susceptible to inundations. These employment centers will have a tendency to attract new settlements to locate around them and along either side of the RN6. These communities will also be equally vulnerable to inland flooding that will likely become more intense and, increasingly, to coastal sea-level rise and storm surges. If unaddressed, increasing demand for charcoal and wood-based construction materials could

lead to higher harvesting rates in the mountains that could also worsen flooding downstream. Impermeability, insufficient drainage, poor grading, and drain clogging – all realities in Haitian towns – will further exacerbate localized flooding even during minor rain events. Flooding is most likely to affect the poor that are located in ravines and lower lying areas, and that are least able to afford elevated construction.

Secondly, increased water access in the absence of significant support for sustainable sanitation will lead to overall increases in household water consumption and water-flushed sanitation in particular. The greatest risk of groundwater contamination exists when the depth of the ground surface to the water table is less than 3 meters, groundwater recharge is greater than 25 cm/year, the topographic gradient is less than 2%, the aquifers consist of irregular limestone or fractured basalt, and the hydraulic conductivity is greater than 80 m³/day/m² – conditions that characterize much of the northern coastline (UNEP, 2005). Only in Ouanaminthe is a pilot wastewater treatment system planned, and latrines and septic tanks will increasingly sit within the water table and directly seep waste into the groundwater.

This gap in infrastructure provision will result in rising volumes of sewage, septage, sludge and greywater entering drainage networks and the soil, ultimately leading to the contamination of surface and groundwater supplies. The main environmental impact of inadequate wastewater management will be on water bodies and their ecosystems. Effectively this is a concentrated transfer of land-based nutrients and overloading water systems. This is first and foremost a danger to public health for women and children, particularly given the recent cholera epidemics, who do their washing in the river, to the poor whose only water source is surface water, and to communities who depend on informal wells that are likely to be shallower and unmonitored. The increase in traffic, industrial uses, cargo ships and gas stations will all increase the pollutant loading of stormwater. In addition, worsening water quality affects the fish and riparian species living in rivers and estuaries.

Third, PIC's water use represents the single most concentrated site of water pumping out of the system, and that will be returned as surface water to the river and from there to the estuary. There is significant fear among local people that this pollution will impact the coastal salt basins, which produce salt for regional and international consumption, as well as coastal fisheries, both of which are the economic mainstays of coastal communities such as Caracol. Although the IDB is committed to treating industrial wastewater to secondary levels, the experience of other countries suggests that wastewater treatment facilities often do not perform at the level at which they are designed. Significant investment in continued monitoring, staff training, and facility maintenance, as well as redundancy in the design of the wastewater treatment system is needed for industrial wastewater to not affect the ecology of the bay.

Mining, though still at an exploratory phase, poses a major potential threat to local hydrology, erosion and water quality. Exposure of mineral ores to open air can release sulfuric acid, arsenic and mercury that wash into waterways. Processing gold and copper also requires cyanide wash. The resultant tailings ponds can contain heavy metals such as arsenic, antimony, residual cyanide and mercury, and must be properly managed and maintained (sometimes for decades and centuries) to avoid contact with wildlife and runoff.

The placement of major industrial and institutional investments along the coast will attract new migrants to town located along rivers that flow from the mountains to the coast. Severe water pollution discharged from these cities will affect downstream fishing and coastal communities, and reduce the ability of species that travel from marine waters upstream all along the coast. The overall effect will be a general degradation of the coastal environment.

6.3 VES 3: Highland Watershed and Riparian Habitat

It is important to consider planning for this corridor in a broader regional context, both ecologically and economically. The coastal plain is closely linked to the ecology of the larger watershed, with forest cover, silvicultural practices, and charcoal and wood production having a significant impact on erosion and flooding, water quality, and energy and food costs downstream.

Le Nord and Le Nord-Est are 45% urbanized, with cities growing at 3-5% per year, while rural areas, mostly montane, grow at less than 1% per year. Without substantial investments in montane communities, the region will continue to face a rural exodus towards the coastal corridor, which will place increasing stress on these cities' ability to provide adequate physical infrastructure and social services. The reduced demographic pressure in the mountainous areas themselves do not necessarily equate with reduced pressure on mountainous products; for instance, some studies estimate that every 1% increase in urbanization leads to a 13% increase in demand for charcoal, a largely urban consumer good that uses 5 times as much wood as rural dweller's wood fuel.

The dry regions of Le Nord-Est in particular, as well as farmers and fishing communities throughout Haiti, are in need of support for irrigation works, agricultural equipment, storage facilities, and better access to markets (notably through better roads). Inadequate investment in rural areas will lead to high urban commodities prices and greater imports. The following irrigation needs were identified by the IDB in 2010.

Table 32 Irrigation Needs

Location	Irrigation Need
Cmn. Quartier Morin	La Tannerie (2000 has)
Cmn. Limonade	Bois de Lance (50 has)
Cmn. Trou du Nord	Roche Plate (40 has)
Cmn. Fort Liberté	Bayaha (40 has)
	Farinen (100 has)
	Dumas (350 has)
Cmn. Ferrier	Bas Maribaroux (2000 has) [bedou, depe, dulair, lamatrie]
Cmn. Ouanaminthe	Haut Maribaroux (8000 has)
	Duro (120 has)
	Boujeau (1000 has)
	Savane Longue (25 has)
Dept. Nord et NE	Mise en place de 50 à 100 glacis de séchage pour améliorer la présentation des produits agricoles

Source: Sylvain, Hervey, IDB infrastructure survey, March 2010

While this CIA and the PAR's broader economic development strategy focuses on the east-west coastal corridor, it is important to note the importance of broader integrated development planning and dialogue that begins to bridge the proposals from this regional planning initiative with existing and future agricultural and rural development plans.

Increased removal of construction materials such as sand, rocks and wood from rivers and estuaries will damage the regions hydrology and exacerbate flooding. With 127,000 to 177,000 new urban households in the corridor by 2030, the region will have a high demand for construction materials. This will lead to growing pressures for streambed excavations, mining for materials in ravines and coastal beaches, all of which will damage in-stream habitat and damage the watersheds' hydrological function. Major mining exploration efforts are also underway in the urban corridor, which could also lead to the loss of topsoil and increased erosion. The Majescor property is of particular concern given its upstream location from the Baie de Carcaol. The development of these mines could also result in greater human settlement on steep slopes, resulting further aggravating erosion, although with adequate investments, workers could be accommodated at the nearby urban centers of Trou du Nord and Terrier Rouge.

An estimated 65-130% increase in charcoal consumption by 2030 would exert significant additional pressure on existing wood resources. Households using charcoal consume five times the wood as those using wood fuel, so the migration of rural households to urban settings will elevate the amount of wood needed to energize the region. Wood products for construction will place additional demands on trees. Although charcoal and wood production in the region is currently not resulting in deforestation, increasing

per capita resource demands and growing urban populations will challenge the region's current levels of wood harvesting. Mangrove forests, which are easily accessible to areas of urbanization and produce valuable charcoal and construction materials, are at risk. In mountainous areas, excessive wood harvesting would worsen erosion and contribute to downstream flooding.

The disposal of solid waste in ravines and rivers would more than increase 3.8-5.4 fold by 2030 in current trends continue. Solid waste clogs these ecosystems, depletes oxygen levels, introduces toxins into the water, and imperils the habitability for fish and other species. Both waterways by urban and the downstream portions would become degraded. In addition, the tendency for poorer households to construct houses in steep slopes and ravines will likely contribute to the loss of riparian habitats and vegetation on hillsides. The banks along the river by the URHC, Trou du Nord River, and the hills around Cap-Haitien are the most at risk.

6.4 VES 4: Air Quality

The two main sources of air pollution in the region derive from burning trash and vehicular emissions. An estimated 7+ to 30% of waste is burned in the corridor. Based on emissions factors from the U.S. EPA's tests of open burning in barrels, this will lead to 40-54,000 pounds of air pollution daily. Decomposing waste contributes high levels of methane and other greenhouse gases, which present lost opportunities for reuse, as well as potential hazards for fires particularly for scavengers living on or near the site.

The new and planned investments in the northern region's various modes of transportation (airport, port, roads) will facilitate the region's economic role as a transport hub. With Cap-Haitien serving as the north-south/east-west junction on one end of the corridor, Ouanaminthe serving as a key border crossing with access to the Dominican ports on the other end, and the industrial park requiring movement of 20,000 workers a day and 75,000 kg of textiles each month, vehicular trips by trailer trucks, buses, passenger vehicles will all quickly increase. Congestion will occur at each of these points, which will also be where most trash is burned. Aging fleets will elevate vehicular emissions. These pollutants directly contribute to acute and chronic respiratory diseases, especially among children and the elderly. Noise pollution will rise in relation to urban levels of transport, congestion, construction and power production.

Charcoal fires add an important source of air pollutants, that disproportionately affect women both those at home, and those working in bakeries and laundry shops, the two types of businesses that use the most charcoal. Point sources of pollution include generators as well as power plants, which will contribute fewer emissions overall due to stricter standards and newer machinery. Reducing trash burning will offer the most effective way to reduce greenhouse gas emissions.

6.5 VES 5: Soils and Agricultural Valuable Areas

The primary impact to the region's urbanization will be the loss of some 750 to 2,600 hectares of prime agricultural land to urban uses in the next 20 years. In a baseline population case, the corridor will consume 750-1,200 ha of additional land; in the high growth scenario, this would rise to 1,600 to 2,600 ha of additional land. Cette situation est particulièrement critique dans les communes de Caracol, Limonade et Trou du Nord qui constituent des zones potentielles d'extension du bâti résultant de la création du Parc industriel et de l'Université ainsi que dans celle de Quartier-Morin, voisine de l'aire métropolitaine du Cap-Haïtien. Though the amount and location of the land conversion can be moderated somewhat, the overall trend is less farmed land. Despite compensation, the process of displacing rural farmers and ranchers could deepen rural poverty and worsen the country's overall food security. Il est probable que des intensités de précipitations accrues associées aux changements climatiques accentuent par ailleurs ce problème de sécurité alimentaire dans le futur et conduisent à des pertes de production sérieuses, particulièrement sur les berges des cours d'eau et dans les aires de sols argileux mal drainés des communes de Quartier Morin, Limonade, Trou du Nord et Ferrier.

The second major impact on the region's soils will be through increased pollution loading from human and industrial solid and liquid waste. A doubling or tripling of the region's urban population, and the attendant increase in per capita solid waste generation that comes with economic growth, will lead to a 3.8- to 5.4-

fold increase in total waste generation by 2030, or 1 to 1.4 million tons per year. In addition, there will be some 90-95,000 m³/year of combined domestic and industrial sludge. Around 13-19% of this is compostable municipal waste, another unknown portion is green waste, and the rest is inorganic, construction, industrial and medical waste.

On average in the region, around 50-58% of waste ends up in nature (sea, ravines, streets and sewers), a quarter on vacant land in informal dumps, and the remainder is burned or landfilled. This poses a significant challenge to drainage systems, natural ecosystems, marine habitats throughout the Caribbean, and soil contamination. Increased stormwater pollutant loading could also affect soil quality.

Finally, the de-concentration of rural montane communities in favor of coastal cities could reduce pressures for highland agriculture, deforestation and land conversion; however, this may well be offset by heightened pressures for wood-based construction materials and charcoal.

6.6 VES 6: Culturally Valuable Areas

Despite periodic interest in and efforts to conserve the region's cultural heritage, the sites have by and large been neglected and, in some cases, disappeared from public consciousness. Larger, better known monuments and buildings are likely to continue to slowly deteriorate under the elements, while historic urban fabric and period houses could become demolished or damaged in the face of new development. The anarchy that characterizes the spatial expansion of the city along with the abandonment of several old houses in town, now dilapidated and subdivided, are the victims of neglect and ignorance of their intrinsic value. Many migrants to the city are unfamiliar with the urban context and introduce new models that are out of scale and misaligned in shape, volume and materials. This remains a major concern for the preservation of the historic centers of Trou du Nord, Fort Liberté, Quartier Morin and Limonade.

The development of a new port on the Baie de Fort Liberté, one of the sites under consideration, would likewise introduce a new industrial use to the corridor's other major heritage and tourism center. Although the port would be situated on the "arm" of the bay and have direct land access through the former Dauphin plantations, it is likely that many of the workers and those indirectly employed by the port would live in the city of Fort Liberté. Ferry traffic would increase in the Baie de Fort Liberté, and the town itself would experience significant growth pressures that could endanger its cultural heritage if not managed.

With the roads leading from the RN6 to coastal areas increasingly committed to industrial and inter-modal traffic, and with the tendency for development to spread along either side of the RN6, the aesthetic landscape of the region will also deteriorate. These public investments will likely foster a pattern of roadside development that will be continued by private and informal developers. The fragmentation of the region's landscapes could dampen the region's potential for tourism, which commonly serves as a strong economic rationale for enforcing ecosystem and cultural protection. Open dumps and scattered solid waste deter both economic investments and the tourism appeal of a region.

6.7 Matrix of Impacts and Table of Monitoring Indicators

Table 33 below broadly categorizes the major impacts of each of the proposed projects and future trends under the high growth scenario without considering mitigating actions as a major negative impact, moderate negative impact, neutral or net zero impact, moderate positive impact, or major positive impact. It is not an exact ranking, nor do all colored boxes carry the same weight of impact. Due to this factor, and because the matrix includes all three options for the proposed port, the matrix is not additive.

Nevertheless, as a visual tool, this matrix makes clear that surface water quality, air quality and valuable agricultural land will be the environmental systems that are most acutely and gradually impacted by new and proposed projects. Coastal estuaries, mangroves, and marine life will also be acutely affected, and large populations and economic infrastructure are likely to be vulnerability to flooding. The visual beauty of the region's landscape will gradually and consistently become degraded. Growing populations and urban demands for resources, the PIC, and mining activities (if fully exploited), and a port at Fort Liberté would impose some of the most intense and wide-ranging impacts.

It will be critical to monitor local ecosystem health in order to gauge the level of impact and to adjust management practices and priorities accordingly. Table 34 proposes indicators for consideration based on international best practice, although the final list will need greater discussion and finalization together agencies that are already conducting monitoring and evaluations in the region and those ultimately charged with compiling the data. It is anticipated that CIAT/OPM will design and implement the monitoring and evaluation (M&E) system as a critical feature of the regional planning office. CIAT will establish a close working partnership with the *délégations*, MICT and MPCE to ensure effective monitoring and evaluation of municipal and regional plans over time. The monitoring and evaluation approach will include provisions for eventual transfer of primary responsibilities for M&E to the *délégations* with close partnership and technical support from the MICT and MPCE.

Table 33 Matrix of Cumulative Impacts on the Environment (High Growth Scenario without Mitigation)

Legend		Population Growth	Industrial Park	Mining Activities	Port (at Ft. Liberté Bay)	RHC University	Port (Cap Access Upgrade)	New Airport	5,000 units of Housing	Electricity Stations	Port (use DR facility)	Road/Drain Upgrades	Tourism Promotion/Facilities	Proposed Regional Hospitals	Agricultural Programs	Proposed Parc de 3 Baies
Major Negative Impact	Moderate Positive Impact															
Moderate Negative Impact	Major Positive Impact															
Negligible / Neutral / Net 0 Impact																
System	Sub-system															
VES 2a	SW Quality															
VES 4	Air Quality															
VES 5	Alluvial Soils															
VES 3	Landscape															
VES 2b	GW Quantity															
VES 3	Slope Erosion															
VES 2b	GW Quality															
NATHAZ	Flooding															
NATHAZ	Tsunami/SLR/storm surge															
VES 1	Marine life															
VES 1	Coastal Landscape															
VES 3	Vegetation															
VES 2a	SW Quantity															
NATHAZ	Earthquakes															
VES 1	Estuary/mangrove															
VES 3	Fauna															
NATHAZ	Landslides															
VES 1	Coast/beach															
VES 5	Rangelands															
VES 6	Int'l/ Nat'l Patrimony															
VES 6	Sub-Nat'l Patrimony															
NATHAZ	Drought															

VES 1: Estuarine, Coastal and Marine Systems; VES 2: Highland Watersheds and Riparian Systems; VES 3a: Surface Water; VES 3b: Groundwater; VES 4: Air Quality; VES 5: Soils, Minerals and Agriculturally Valuable Areas; VES 6: Culturally Valuable Areas; NATHAZ: Natural Hazards

Table 34 List of Proposed Key Monitoring and Evaluations Indicators

Indicator Category	Resource (Input) Indicators	Output Indicators	Outcome / Impact indicators
Demo-graphic	Population living within each zone of the Parc de 3 Baies designation	% of population living in slums - Population growth rates and densities overall, by city and in each Parc de 3 Baies zone - Rate of urbanization in communes along RN6	- Life expectancy - DALYs
Economic	- International and national project investments in community, environmental and infrastructure in each of the 3 coastal zones - Number of banks	- GDP per capita and growth rates % of local economy attributable to coastal resources (including salt, fishing, tourism) - Number of staff trained in various sectors - Volume of private investments % of people with bank accounts - Number of small-medium enterprises - Number of farmers with access to financing - Numbers of tourists/ length of stay % and number of jobs dependent on coastal and ocean resources	- Number and percentage of people living above the urban and rural poverty lines - Dependency on aid and external funding % of local revenue from own sources
Land and Ecosystems	- Meters of shoreline reconfigured - Hectares of serviced land or number of plots provided - Volume of charcoal and woodfuel consumed - Area of productive plants for charcoal - Fertilizer and pesticide consumption in coastal plains - Number and density of livestock in coastal lands	- Land area formally protected - Land cover change rate and area by type - Hectares of mangroves remaining - Hectares of tree cover % of households reliant on charcoal - Impermeable surface area and rate of change in each zone - Land area made toxic due to hazardous spills and informal dumps - Housing and land prices - Number of land conflicts	- Levels of food security - Affordability of housing and land - Number and status of endangered species

Indicator Category	Resource (Input) Indicators	Output Indicators	Outcome / Impact indicators
Water	• % and number of population with access to water and sanitation • Volume of domestic, industrial wastewater • Annual withdrawals of ground and surface water • Domestic consumption per capita of water • Industrial and agricultural water use	• % and number of people with access to wastewater and solid waste collection/ treatment • % and volume of domestic and industrial wastewater treated • Volume of sediment dredged and coral reef destroyed or affected • Number and volume of oil spills • Specific measures of water quality in water sources and downstream points (N, P, BOD, COD, pH, fecal coliform, Pb, Cd, Hg, pesticides) • Quality and contamination of salt	• Overall condition of coastal and surface waters (water quality index, sediment quality index, benthic index, fish tissue contaminants) • Fish stock levels • Number and status of endangered species • Number of cases of waterborne diseases each year • % of children under 5 who die or are affected by waterborne disease
Air	• % of public institutions and households with access to electricity • Number of passenger vehicles, tap-taps, buses and trailers registered in the communes along the RN6 and per 1000 inhabitants • Vehicle trips made on the RN6 • Number of cargo and other major ship trips • Number of flights arriving and departing airports • Volume of solid waste burned	• Point-source emissions of CO₂, SO₂, and NO_x • Ambient concentrations of CO, SO₂, NO_x, O₃, and PM₁₀	• Number of cases of acute and chronic respiratory disease each year • % of children under 5 who die or are affected by acute respiratory disease
Community Health and Well-being	• Number of housing units constructed • Average number persons per dwelling, per room • Quality of housing units • Frequency of natural disasters • Numbers of public institutions equipped for disaster response • % of children attending and completing schools at each level • Availability of updated building (earthquake resistant) and infrastructure codes	• Cases of violent conflict and crime • % of population located in at risk land areas • % of homes and buildings built to seismic code	• Number of homes affected by or deaths caused by disasters (flooding, drought and earthquakes) • Cost of community relocation or reconstruction

Indicator Category	Resource (Input) Indicators	Output Indicators	Outcome / Impact indicators
Governance and Planning	- Number of municipal and regional plans (<i>arrêtés municipaux</i>) issued by municipalities - Regional planning office established and funded under OPM/CIAT auspices - Amount of GOH funding for implementation of municipal and regional plans in the N/N-E corridor - MICT announces policy support and creates dedicated administrative unit or working group to actively facilitate the implementation of municipal and regional plans in the northern corridor. - MICT ensures the timely flow of FGDCT funds for <i>commune</i> operations and plan implementation. - Total and Per-capita size of municipal budgets in the northern corridor - Number of overall and technical municipal staff (total and per capita) - Number of authorities at all levels making public declarations favoring plan implementation and enforcement	- Monitoring and evaluation program for municipal and regional plans in place and functioning. <i>Communes</i> and <i>délégations</i> organize public/private <i>comités de suivi</i> and make use of existing <i>tables de concertation</i>, including those organized by the departmental MPCE, to support plan implementation and its M&E. <i>Communes</i> strengthen or create their own dedicated <i>services d'urbanisme</i>, especially corridor <i>communes</i> subject to rapid increase in urbanization. - Donors and the government of Haiti collaborate closely around implementation of regional and municipal plans, e.g., policies, coordination, meetings, statements issued, flow of funds. - Number of municipal publicity campaigns including media messages and public meetings to support implementation of municipal and regional plans. <i>Communes</i> take concrete measures to guide urban growth in zones targeted for extension using a sites and services approach, e.g., laying out streets, assigning addresses, ensuring access to water and electricity; updating housing census for improved planning and tax collection (CFPB); increased tax collection especially CFPB, <i>patentes</i> and <i>permis de construire</i>. - Verifiable increase in (i) the number of requests and (ii) the processing of requests for construction permits and housing developments (<i>lotissements</i>) by <i>communes</i> and the TPTC. - Reduction in the number and scale of uncontrolled land invasions focused on new urban housing.	<i>Délégation</i> strengthened in terms of financial and human resources; trained to assume leadership to coordinate and monitor the implementation of regional and municipal plans. - Mapped evidence of controlled growth in keeping with municipal and regional plans. - Verifiable enforcement of zoning requirements and building code, e.g., site inspections, rule based rejection of requests for construction permits, willingness to impose sanctions or conditionality to enforce building code and zoning requirements, pursuit of violators in a court of law, collaboration by law enforcement officials to ensure enforcement and sanction violators. <i>Délégation</i> plays active role in coordination, monitoring and implementation of regional and municipal plans; in-service training, meetings with STD directors organized around plan implementation, STD reports collected demonstrating compliance with regional and local plans.

Based on AIA team recommendations and supported by indicator lists from NOAA's Coastal Zone Management Act [Performance Measurement System](#); UNSD's [List of Environmental and Related Socio-Economic Indicators](#), 1995; and Bowen and Riley's "[Socio-economic Indicators and Integrated Coastal Management](#)", *Ocean and Coastal Management* 46 (2003): 299-312.

PART 7: PROPOSED MANAGEMENT STRUCTURES AND STRATEGIES

Effective regional planning touches upon a broad range of stakeholders in both public and private sectors. For an assessment of governance concerns, see Annex 1. Accordingly, the following strategy builds from the bottom up, rooted in municipal governance, while maintaining an overarching regional vision by creating a regional planning office to promote regional planning and monitor plan implementation. Table 35 summarizes the impacts, management strategies, monitoring indicators and suggests entities that could be tasked with key actions. Specific sector-based management recommendations are provided in Annexes 2-9.

There have been a large number of past studies and assessments on a variety of sectors and environmental systems in Haiti and in this region. These studies and reports set forth detailed management strategies and recommendations. The following list of management strategies summarizes and highlights priority actions particularly as they relate to AIA's regional and local plans. It is by no means comprehensive, nor should it be seen as a replacement for existing management documents and initiatives. By organizing strategies around valued environmental systems, the following also aims to show overlaps in strategies across line ministries and international programs, and the need to coordinate ongoing sector initiatives.

Renewed efforts to coordinate investment efforts, channel donor and national resources through local authorities, and build local public revenue are much needed to strengthen management of the region's natural and urban systems. For the approach outlined below to move forward, it is essential for the Government of Haiti to determine whether or not CIAT or some other organ of government will take the lead in establishing a Regional Planning Office that would lead these coordinating and monitoring activities. It is also essential for the Ministry of Interior to commit itself as an active partner for implementation of regional and urban plans in target *communes*, including ministry staff assigned to build capacity with the *communes* and two departmental *délégations*.

The approaches and structures proposed here are by no means final or prescriptive. They will be discussed in a September workshop that includes mayors, chambers of commerce, providers of *services techniques déconcentrés*, departmental *délégations*, the Université de Roi Henri Christophe, ministry representatives, in particular those from the MICT and its *Agences Techniques Départementales*, MPCE, MOF and CIAT, and donor organizations. A dialogue among these diverse stakeholders will help shape a strong and feasible strategy for strengthening local governance and protecting the region's natural resources for future generations.

In an effort to call attention to gaps in knowledge and coordination that need to be addressed in the short-term, the following lists activities that require additional immediate funding and attention.

Studies Needed

- Watershed Management Plan for Trou du Nord sub-watershed, emphasizing watershed-wide water resource demands and strategies for harnessing, retaining and slowing floodwaters.
- Detailed aquifer behavior analysis that sheds light on the transboundary aquifer and the impact of the PIC.
- Detailed (preferably 5-meter) topographical maps and flood zone maps for major urban centers along the corridor.
- Cadastral survey for each of the towns, clarification of commune and centreville boundaries, and inventory/mapping of private lands and private domains of the state, particularly in peri-urban and roadside properties in the region.
- Updated and disseminated building codes and trained builders reflecting earthquake and flood mitigation standards; develop standards for public facilities and large projects that would allow them to serve as centers of refuge.
- Updated, disseminated safe latrine and septic tank design standards and trained plumbers/

masons to minimize groundwater pollution and promote cleaning access.

Infrastructure and Investments Needed

- Elevating remaining PIC facilities and/or other actions to reduce PIC's flood vulnerability.
- Designating land to be set aside for future rights of way and public facilities such as schools, clinics and administrative offices, as determined by the AIA local master plans.
- Augmenting DINEPA's capacity to monitor basic and longitudinal water and sanitation related data.
- Developing a financial hub that provides entrepreneurs with project funding, allows for satellite payments and absorbs risks.

Coordination Activities

- Establishment of a Regional Planning Office to coordinate investment activities, provide technical assistance to local authorities and implement the regional and local master plans.
- Coordination with agricultural program promoters (GAFSP, FTFCN, PMDN, PPII) to identify rural projects that can support or mitigate urban resource demands and promote water quality and flood management.
- Coordination between ongoing teams studying water, sanitation and solid waste for towns and the PIC in the region to identify opportunities for shared facilities and management systems.

7.1 Proposed Management Structures

1. Communes and regional planning. In the governance context of northern Haiti, the municipality is the front line for regional as well as local urban planning. Despite critical weaknesses and deep dependency on the central government, the *commune* is the most feasible as well as the most strategic point of entry for on-the-ground implementation of regional and local plans. Implementation of the regional plan thus builds from the bottom up, rooting its institutional framework in the network of *communes* that make up the region including the two urban centers that define the region's outer limits, Ouanaminthe and Cap-Haïtien.

This strategy has the virtue of building on an existing legal framework rather than trying to create a new legal structure for plan implementation and enforcement. *Communes* already have the capacity to establish inter-communal agreements and issue *arrêtés* endowing local and regional plans with the force of law. This strategy also generates leverage for additional services from central ministries and departmental services (STD) on behalf of local and regional plans, especially through the Ministry of Interior and Ministry of Public Works, but also the ministries of Finance including the tax office (DGI), also Planning, Agriculture, Health, Education and Environment.

A *commune*-based approach is entirely consistent with the creation of a regional planning office to provide leadership, monitoring and evaluation and database management, and consultation with regional and local stakeholders. This strategy thus links top and bottom ends of the planning pyramid. It directly engages all public sector partners in plan implementation including municipal administrations, two departmental *délégations*, departmental directors of deconcentrated services (STD) of central government ministries, and the specialized urban and land management planning units of the central government (CIAT, MPCE, MTPTC).

2. Ministry of Interior and FGDCT financing for regional planning. The Ministry of Interior is a critical partner in this strategy including its funding and oversight of municipalities and *délégués*, and its management of the FGDCT fund for local government. As a fund financed by dedicated taxes rather than

the national budget, the FGDCT can provide a sustainable source of long term financing to support implementation of urban and regional plans.

Implementation of regional and municipal plans requires strong, focused support from the Ministry of Interior. Plan implementation will require increased budgetary support to underwrite local publicity campaigns that actively promote the plans, increase municipal personnel required for active enforcement of zoning and building codes, and update property tax rolls to increase the local tax base, especially in *communes* marked by significant population growth.

Ministry support is also needed to appoint well qualified departmental engineers and to prioritize enforcement of regional and municipal plans via the construction permitting process for housing developments (*lotissement*), and the *permis de construire* and *droit d'alignement*. Aside from municipal engineers, human resources assigned to the Agence Technique Départementale should include a broader mix of training and skills such as urban and environmental planning.

3. Enhanced local financing for plan implementation. The expansion of the local tax base holds the promise of sustainable increase in local revenues to support urban plans and respond to heightened demand for public services. The Ministry of Interior and donor assistance should invest in updated property census and tax collection, especially in communes with sizeable urban centers and expanding urban populations. This will require investment in more and better trained human resources and institutional development in *commune* administration and financial management.

4. A Regional Planning Office. Despite the authority of communes to promulgate and implement plans, implementation of a regional plan and related urban plans requires political clout and an overarching regional vision. In the absence of a governing jurisdiction that coincides with the targeted region, one option is to create a regional planning office under the auspices of CIAT. The basic purpose of such an office is twofold:

- (i) Actively promote, animate and technically accompany the implementation of regional and municipal plans, and
- (ii) Design and implement a monitoring and evaluation program.

The Regional Planning Office will actively set the stage for a sustainable, coordinated approach to long term regional planning under the leadership of departmental *délégations* and MPCE directors. This will include public and private representation via an advisory committee composed of critical stakeholders in regional development and planning. This committee will include representation from the private sector and civil society, the chambers of commerce for the two departments, higher education including the new university, municipal governments, STD directors and the two departmental *délégations*.

Activities of the regional office will include the following:

- Publicity and animation for implementation of local and regional plans;
- Monitoring and evaluation, database management;
- Non-formal training and diffusion of information regarding regional plans, zoning, construction norms and standards;
- Operation of a small grants and technical assistance program to facilitate implementation of municipal and regional plans;
- Operation of a donor coordination unit;
- Creation of a public/private advisory committee composed of stakeholders in local and regional planning.

The regional office will work in close partnership with the Ministry of Interior to strengthen *commune* administrations and *délégations*, and generate increased capacity to implement and coordinate regional

and municipal plans. Capacity building will include in-service training of local elected officials and staff of *communes*, *délégations*, law enforcement institutions and all deconcentrated services (STD). It should be a high priority to train upcoming newly elected mayors and their staff in the content of municipal and regional plans, and practical strategies for implementing them.

5. Monitoring and evaluation. Monitoring and evaluation are essential tools to ensure implementation of a regional plan. CIAT is the best-placed governmental unit to take responsibility for monitoring and evaluating the regional plan, particularly in light of the current role of CIAT in developing plans for the targeted region. Therefore, CIAT should design and implement a monitoring and evaluation plan for regional and municipal plans in the northern corridor.

This activity would be directly linked to establishment of a regional planning office under the auspices of CIAT/OPM in close partnership with the two regional *délégations*. The *délégations*, supported by MICT and MPCE, should eventually take primary responsibility for monitoring and evaluation, using it as a tool for departmental STD coordination as well as regional planning. This transition should be anticipated from the very beginning through a close working partnership between the *délégations* and the new Regional Planning Office.

In sum, CIAT/OPM will design and implement the monitoring and evaluation (M&E) system as a critical feature of the regional planning office. CIAT will establish a close working partnership with the *délégations*, MICT and MPCE to ensure effective monitoring and evaluation of municipal and regional plans over time. The M&E approach will include provisions for eventual transfer of primary responsibility for M&E to the *délégations* with close partnership and technical support from the MICT and MPCE.

6. Small grants and technical assistance program. This activity would be operated by the Regional Planning Office or supervised by that office under a subcontract. Its purpose is to facilitate the implementation of regional and municipal plans and to accelerate and provide additional incentive for doing so. Pre-qualification requirements might include some or all of the following elements: (1) the proposed local effort is consistent with and furthers the regional or municipal plan, (2) includes cooperation with multiple partners (other *communes*, local non-governmental organizations, private sector partners), (3) emerges from dialogue with the community that prioritizes needs and proposes a practical response, (4) includes matching resources or contributions from the *commune* or community, (5) generates support across political affiliations or factions, (6) promotes local capacity building, (7) includes measures to ensure sustainability.

7. Donor coordination unit. As noted above, the Regional Planning Office would also set up a donor coordination unit. This would allow for greater efficiency and cost effectiveness of donor investments in the region, in keeping with the comprehensive regional plan. The Regional Planning Office could generate a pool of potential priority projects and investments for consideration by donors. These investment priorities would be established in a participatory manner in consultation with mayors and the public/private advisory and monitoring committee.

8. Sites and services approach. Given the anticipated difficulties in ensuring compliance with a regional plan, regional and municipal plans will target sites and services to facilitate compliance based on inherent incentives rather than relying solely on coercive measures. For example, urban planning and the mapping of new roadways will anticipate urbanizing pressures in areas of town extension including self-governing urban districts such as Cité Dessalines (Quartier Morin). Municipalities and STDs can then target services to sites that match zoning criteria for new constructions thereby guiding developments and diminishing the tendency for uncontrolled growth and land invasions. For example, municipalities can take initiative to physically lay out roads in zones targeted for new urban extension. According to law, *commune* governments (*la voirie*) already have full legal competency for doing so.¹³

9. Support for a municipal civil service (*fonction publique territoriale*). The strategy outlined above requires significantly improved human resources in both quantitative and qualitative terms. The most

13 Décret du février 2006 sur le cadre de la Décentralisation.

accessible near term solution is to increase the corps of career municipal engineers and planners assigned to *départements* for the benefit of departmental *communes* (Agence Technique Départementale).

The MICT is committed to this approach and has donor support for doing so; however, as a long-term strategy, the MICT and municipalities should advocate with parliamentarians and the executive to implement municipal civil service and insulate municipal administrations from the personnel discontinuity that invariably accompanies the electoral cycle.¹⁴

10. Strengthen municipal planning and city engineering services. Aside from the overall goal of establishing a municipal civil service, it is a high priority to create or strengthen municipal planning and city engineer services (*Service d'urbanisme*) within city administrations of targeted *communes*. The Ministry of Interior and its Agence Technique Départementale (ATD) can help meet the gap in human resources in the near term; however, as noted earlier, in the long term, urbanizing *communes* need their own local dedicated city services for planning and urbanization.

11. A plan-focused approach for the MICT Agence Technique Départementale. The MICT should ensure that this corps gives highest priority to implementation of regional and municipal plans in the targeted region. The MICT should expand the mix of skills of this small departmental corps to including planning and animation in addition to municipal engineering.

12. Délégation. The coordination and oversight role of departmental *délégation* should be strengthened as an essential tool for implementing regional and municipal plans. These efforts should explicitly separate the technical aspect of coordination and monitoring from the political role of the *délégation*, although the political role of the *délégué* may also be invoked to support regional and municipal plans.

The MICT is the primary channel for efforts to strengthen the coordination capacity of the *délégation*. Donors should take this into account in their support for the MICT and implementation of regional and municipal plans. Strengthening the coordination role of the *délégation* should build on departmental STD meetings (*Conseils Techniques Départementaux*) organized by the *délégation*. The *délégation* in partnership with a regional planning office should actively use the Conseil Technique Départemental as a tool for implementing and monitoring regional and municipal plans.

13. Departmental office of the Ministry of Planning. In addition to its close partnership with the *délégations*, the new regional planning office should also establish a close working relationship with the departmental office of the MPCE whose duties include registration and oversight of non-governmental organizations. Its various *tables de concertation* should actively promote implementation and monitoring of regional and municipal plans.

14. Services Techniques Déconcentrés (STD): The implementation of a regional development plan creates opportunity to promote devolution of authority for STD services. Annual budgets proposed by the office of Prime Minister and approved by parliament should explicitly link STD funding to implementation of regional and municipal plans.

Parliamentarians, local elected officials from the region, central government entities such as the MICT, and donors providing assistance on behalf of regional and municipal plans should advocate for enhanced delegation of authority to departmental STD directors. STD planning should explicitly adapt, target and orient services in accord with regional and municipal plans, thereby anticipating the needs of new and expanding urban centers in the corridor.

15. Plan advocacy and coordination committees. Mayoral administrations should establish local private/public monitoring committees to support implementation of municipal urban plans. A similar committee should be established at the regional level. A *comité de suivi* has been established to good effect in Ouanaminthe to accompany and advance the municipal development plan.

14 *Op. cit.*, Décrêt du 1er février 2006 sur la fonction publique territoriale.

The public/private advisory and monitoring committees can play an important role supporting publicity campaigns on behalf of urban and regional plans. Such committees can also serve as an advocacy tool on behalf of urban planning including advocacy with parliamentarians and the central government for (1) tangible deconcentration of central government services, including devolution of authority, (ii) implementation of decentralized governance as provided by the Constitution, and (iii) establishment of a municipal civil service.

16. Campaigns to support urban and regional plans. In field interviews, mayors strongly advocated for media campaigns to diffuse information and promote municipal and regional plans issued by municipal *arrêté*. Publicity campaigns should also include media spots and radio interviews. Such campaigns should organize public meetings with the local population and also particular sectors or stakeholders including business, commerce and members of the building trades. Mayors should rally support for the regional plan and share plan-related concerns within the regional mayoral associations, specifically AMUNE (Association des Maires Unis du Nord-Est) and AMNORD (Association des Maires du Nord).

Mayors within the corridor also recommended high profile efforts to “strengthen the authority of the state” in order to facilitate implementation of zoning restrictions and building codes. This should include public declarations by the Office of Prime-Minister, the Ministry of Interior and the *délégations*.

Constitutional provisions for municipal police could also be implemented to assist with enforcement of zoning and construction requirements. As noted earlier, publicity campaigns should include informational sessions with the courts and law enforcement personnel, and recruit their support for plan enforcement including the imposition of sanctions on violators as needed.

17. Inventory and mapping of private land and private domain of the state. In target communes with significant proportions of private domain of the state, the central government together with local communes, perhaps with donor support, should undertake an inventory and mapping of state domain as well as private lands to facilitate planning and development. This initiative should be addressed in very practical terms at the commune level in response to local stakeholder demand rather than relying primarily on a top down national strategy. Such an inventory will require close collaboration by municipal governments, the Ministry of Interior, Ministry of Finance and Direction Générale des Impôts.

18. Découpage territoriale. Commune borders need to be clarified, updated and marked in order to facilitate urban and regional planning and zoning, and to avoid current or potential conflict over tax collection by municipal jurisdictions. Field interviews identified this as a felt need of corridor mayors due to conflict over the collection of CFPB taxes, competition for agricultural zoning versus urban development¹⁵ and the aspiration of *quartiers* to attain the status of *commune*.¹⁶

19. National building code. The Ministry of Public Works has recently taken measures to update and implement building codes. It is essential that the Ministry formally adopt a new building code adapted to Haiti’s needs and consistent with building codes such as the International Building Code (IBC) or the standards and codes of the International Code Council (ICC).

20. Donors and donor coordination. It is imperative that donors coordinate their support for local and regional plans and collaborate closely with Haitian government counterparts around plan implementation. It is equally imperative that the Haitian government (especially the OPM and MPCE) play its role in coordinating donor investments.

Donors should ensure that their investments in the corridor including housing are compatible with regional plans and targeted zones of urban extension. Donors should actively join together to support genuine deconcentration of services including regional input into priorities and budgets, and full implementation of the laws on decentralized governance and a career-based municipal civil service.

15 E.g., Quarter Morin versus Cap-Haïtien.

16 E.g., Dupity (Sainte-Suzanne), Grand Bassin (Terrier Rouge), Acul Samedi (Ft. Liberté).

21. University Roi Henri Christophe. The university should serve as a source of technical assistance and skills training to support the implementation of regional and municipal plans. As a newly established institution whose curriculum is not yet well defined, the University has an unprecedented opportunity to devise a curriculum and institutional strategy based on practical needs of the region including job training, community outreach and extension services.

This should include university training to increase the pool of human resources with specialized skills required by the region's economic growth sectors. This includes the industrial park, the coastal littoral including fishing, salt production, and port and maritime services, also tourism, agriculture, forestry and tree crops, hydrology and watershed management, grazing, dairy and animal husbandry, environmentally appropriate mining operations and other economic sectors that characterize the region. Human resources from the University could also support data collection and management for monitoring and evaluation of regional and municipal plans. In short, the University should seize the present opportunity to develop practical extension services to benefit neighboring *communes* and the regional economy.

7.2 Management Strategies for VES 1: Estuarine, Coastal and Marine Systems

Efforts to protect the region's coastal resources will require a balance of the following:

- 1) Establishing policies and enforcement mechanisms for the protection of coastal environments.
 - o The MDE is calling for the immediate designation of protected status for the Parc de 3 Baies, which is pending approval. Clarification is required for what is permitted and not permitted in each of the three zones of the park, which effectively serve as the region's coastal zone management lines.
 - o Studies on Caracol Bay are being considered through a UNDP/GEF/IDB/GoH initiative; this will include determination of mitigation measures, management arrangements and the preparation and implementation of a protected area plan.
 - o In addition, the MDE has sought co-financing of a Marine Protected Area Programme from the IDB as compensation for residual impacts on the order of US\$4.1 million.
 - o As part of CIAT/OPM/MICT/MPCE monitoring activities, they can support existing local groups that championing, monitoring and acting as the local enforcers of protected areas.
 - o Identify and define appropriate setbacks from waterline, enforce strict zoning of floodplains and mangroves to mitigate human vulnerability and effects of pollution, salinization, and beach erosion.
- 2) Providing serviced land, together with infrastructure and alternative energy supplies:
 - o The local master plans for the region should identify adequate growth and densification areas located outside of protected and environmentally sensitive areas and in less risk-prone areas. The proposed densities should be as high as can be permitted given seismic risks and typical construction practices.
 - o The implementation of these plans should consider:
 - o Setting aside land through community agreements or outright public purchases for major future roads and rights of way. Though they may not all be immediately paved, they should be designed with adequate drainage systems given future storm intensities and incorporate low-impact design strategies of stormwater filtration. See Annex 4: Stormwater Management and Proposed Road Designs.
 - o Prioritizing major sanitation and wastewater improvements. DINEPA is funding an ongoing study to develop water and sanitation master plans for

most of the towns along the corridor, with priority for Fort Liberté. DINEPA has proposed targeting sanitation facilities for markets and schools; these should be fast-tracked for the towns along the corridor. See Annex 6: Sanitation and Wastewater Management Recommendations.

- o Promoting solid waste management. The GOH/IDB is funding solid waste master planning studies for the region, with proposed facilities for Limonade/Cap-Haïtien/Quartier Morin and Ouanaminthe, and the IDB is developing a study of a long-term landfill for the industrial park that would also serve surrounding regions. These are critical new investments that will need to be complemented by local collection and transfer systems. Strategies that emphasize profitable resource recovery, such as composting for green waste and septage/sludge, recycling, and energy generation, are more likely to find local support. These are detailed in Annex 7: Solid Waste Recommendations.
- o Investing in highland production of charcoal and efficient charcoal production ovens that reduce the economic incentives to harvest slow-growing mangroves.

3) Redundant safeguards for wastewater treatment systems at PIC:

- o The IDB is currently soliciting proposals for wastewater treatment for PIC. To safeguard the Baie de Caracol, and the livelihoods of communities that depend upon it, the selected system should incorporate the redundant safeguards and the operational budget of the park should account for annual maintenance costs, qualified staff, and periodic water quality testing.

4) Promoting coastal tourism assets that form part of a circuit of natural, historic and religious heritage:

- o Identify scenic routes and trails – including through water-side access – as part of the local and regional plans;
- o Promote community-based eco-tourism options;
- o Identify appropriate groups, such as sawyers, producer groups and mangrove fishers to adapt co-management plans to local natural forest and mangrove areas.
- o Concentrate industrial access routes, and/or permit trailer truck traffic during off-peak hours to facilitate free-flowing traffic; use the road to Caracol as the main entrance to any future airport at Madras, preserving the road to Madras for eco-tourism access.

7.3 Management Strategies for VES 2: Surface and Ground Water Resources

To ensure the long-term sustainability of the North/Northeast region, it will be necessary to develop the water resources in a way that limits the negative impacts of development, while also restoring the resource and creating a resilient system that can respond to both population increase and climate change. The various sectors of water infrastructure – potable water, wastewater, and stormwater – are inextricably linked and, therefore, should be thought of as one resource. In order to manage the water resources of the region, it is imperative that the water balance be maintained and a local (decentralized) approach be implemented by:

1) Initiating long-term watershed management, involving:

- o Better water monitoring for in-river flow rates, surface and groundwater withdrawals, and water quality; DINEPA, as the new national authority charged with serving as a data observatory, is in a position to direct this.
- o Conducting a watershed management study to understand the dynamics of the Plaine du Nord aquifer, the hydrologic relationship between the Dominican Republic and Haiti, and the impacts of combined industrial, urban and irrigation demands on the aquifer.

- o Expand the Programme de Mitigation des Desastres Naturels, which is currently developing a management plan for the Grand Riviere du Nord watershed to the other two watersheds in the region.
 - o Training community groups to rapid watershed assessment techniques focusing on sources catchment areas susceptible to sedimentation, floods and drought.
- 2) In the near term, cities in the region can take a multi-pronged approach towards reducing flood risk. First, cities must direct their expansion towards areas of reduced flood risk, with every effort to establish and protect riparian corridors. The creation of new roads that open up addition areas for growth in more elevated areas will be the strongest tool to allow poorer households to access safe land for growth. Second, in both new and existing areas, street and housing design should incorporate principles of low-impact development that allows for greater in-situ rainwater absorption and capture, as well as adequate traditional drainage infrastructure. There are strong traditions and demand for shared open spaces and gardens that can reinforce the ecological soft-scape infrastructure. Third, unavoidable urban expansion in areas of high flood risk should be built off the ground to allow floodwaters to pass through the city without incurring high economic damages. (See also Annex 2: Actions Prioritaires pour un Intensification de la Production Agricole et pour la Conservation des Sols et des Eaux and Annex 4: Flood and Stormwater Management Recommendations). Specific priority actions include:
- Conduct local drainage and topography studies to establish elevation maps at the 5-meter level of detail. Use these to generate flood maps for each of the urban centers in the corridor and establish restrictions and standards for construction in each zone. For coastal cities, such evaluations should also consider tsunami and storm surge risks.
 - Elevate the remaining construction for the industrial park above the 50-year flood line;
 - Review drainage sizing calculations and ensuring that they are adequately sized for current and future storms;
 - Provide land and infrastructure for urban expansions outside of the 50-year flood line, and providing household financing for construction to be elevated above the 50-flood line.
- In the medium-term, a regional flood, drainage, irrigation, storage and aquaculture system that diverts, slows and/or absorbs floodwater, wastewater and stormwater away from cities and sensitive habitats needs to be developed. All new investments should incorporate stormwater absorption and management at the source. Master plans should identify areas where flooding will be targeted to allow for aquifer recharge and to reduce downstream flooding.
- 3) Promote local access to safe water supplies based on the premise of a de-centralized approach that is responsive to local needs, less energy dependent, and restorative to the resource even with the challenges of population growth and climate change. Although this sector will be elaborated through the ongoing master plans for local water and sanitation, the AIA team provides the following recommendations for water supply (Annex 5: Water Supply Recommendations for details) and sanitation (see Annex 6: Sanitation and Wastewater Management):
- o Implement local Rainwater Harvesting Systems, especially for non-potable water needs.
 - o Update plumbing and building codes to reflect rainwater harvesting systems, standardized latrines and septic tanks, and train masons and plumbers to build these.
 - o Promoting household-level and community-based water treatment systems and education.
 - o Implement programs to maintain local wells and monitor their water quality.

- o Recharge the groundwater aquifer through both treated wastewater and stormwater / floodwaters.
- o Priority should be the development of alternative water supply for coastal communities who would likely be the first to be affected by saline intrusion.
- o Reuse of Treated Wastewater for Irrigation Needs.
- o Land application of Treated Wastewater (and avoidance of stream discharges).
- o Protection of floodplains and defined areas of intentional flooding for aquifer recharge.
- o Treatment and infiltration of separated stormwater flows in urban areas.

7.4 Management Strategies for VES 3: Highland Watersheds and Riparian Systems

A number of international and national agencies are planning major investments in the region's agricultural and watershed management through the GAFSP, FTF and PMDN programs. One of the tasks of the identified regional planning office should be to engage with these programs and develop both a watershed management plan for the Trou du Nord sub-watershed, as well as projects that will meet and mitigate urban demand for natural and agricultural resources. Specific projects these programs can support include:

- o Promoting sustainable tree and woody plant harvesting regimes, and working with communities to preparation their own management plans and controls. The goal is to establish self-governing mechanisms to avoid resource conflicts and over harvesting (see Annex 2).
- o Stabilizing river and stream banks – particularly those leading to the Baie de Caracol, and maintaining drainage channels.
- o Building infiltration trenches, natural soakways and buffer zones (such as field borders, wind breaks, riparian forest buffers) to help recharge groundwater, filter sediments, limit animal waste entering the waterways, and reduce gully formation (see Annex 4).

The MDE, in coordination with local communes leaders and the regional planning office, should also closely regulate and monitor the removal and mining of building material (sand, rocks, poles) in ravines and coastal beaches, including mangroves, to avoid further deterioration of the hydrological function of river channels and estuaries. Local mayors should be empowered to enforce restrictions on construction within 16 meters of waterways and on slopes exceeding 50%.

7.5 Management Strategies for VES 4: Air Quality

Reducing air pollution will require a multi-sectoral strategy:

1. Implement a comprehensive solid waste management strategy that not only builds landfills, but also establishes a sustainable collection system. See Annex 7 for Solid Waste Recommendations.
2. Develop a regional transportation plan that promotes multi-modal and cost-effective transport. See Annex 3 for a proposed transportation plan.
3. Site future investments within biking/walking distance of existing urban centers to limit travel distances. Urban and regional plans should design roads to be safe for pedestrians and bicyclists. See Annex 4 for proposed road designs.
4. Expand the efficient cook stove programs, currently piloted in Port-au-Prince, throughout the northern corridor. See Annex 8 for strategies to extend access to energy and electricity.

7.6 Management Strategies for VES 5: Soils and Agriculturally Valuable Areas

It is important to consider planning for this corridor in a broader regional context and to integrate the proposals from this regional planning initiative with existing and future agricultural and rural development plans. The priority actions for intensifying agricultural productivity are presented in Annex 2. In short, these suggest:

1. Extending irrigation coverage primarily through groundwater exploitation. Preference is given to groundwater over surface water due to costs of maintaining canals, which are frequently damaged by floods.
2. Mechanization of plowing, which will also help retain rainwater onsite through better-tilled soils.
3. Creating a system of gullies in the mountains that brake and store floodwaters, while also creating micro-environments conducive for value-added crops.
4. Leverage the proposed GAFSP, FTF and PMDN agricultural projects to develop the above proposals. Funding and credit should also emphasize crops / trees that will meet urban demands for wood and charcoal.

In addition, the following steps can be considered:

5. The MDE will need to closely evaluate future environmental impact assessments for future copper, copper-gold and gold mining for their cumulative impact on the region's water resources and natural habitat. Infrastructure serving mining activities should reinforce existing population centers and needs to the extent feasible.
6. The regional planning office, together with local authorities, the Ministry of Finance and international donors, should focus on concentrating urbanization, infrastructure and economic projects in and around existing urban centers (under the PAEs), and establish zones that protect agriculture in the regional plan (PAR). To ensure that planned housing projects by USAID/IDB, Food for the Poor and other donors do not place their residents in at risk areas, far from social networks, jobs and existing infrastructure, or worsen the region's overall food security and social cohesion, these projects should consider (re)locating in existing towns in the future. A variety housing typologies will permit greater density and reduce agricultural fragmentation. Given limited enforcement capacity by the small municipalities along the RN6, these zoning designations will effectively be most implemented through the provision or withholding of basic infrastructure.
7. Converting urban waste (sludge, compost, construction and green waste, wastewater) to agricultural inputs. Dried biosolids can also be applied for land application to mitigate flood risks. The spatial implications include:
 - a. Allocating space for solid waste, compost and recycling collection facilities near markets and at peri-urban points that are accessible by truck;
 - b. Ensuring space to accommodate Broder Schutt's plastic recycling program, which is working with USAID to establish compaction facilities for plastics in each city along the corridor, then sending to a central facility in Cap-Haïtien;
 - c. Sizing proposed landfills for Cap-Haïtien, Ouanaminthe and the industrial park to serve as regional waste centers with facilities for composting and septage treatment facilities, recycling for construction and municipal waste, and medical, industrial and hazardous waste. Medical waste from major hospitals in Cap, Trou du Nord, Ouanaminthe and those proposed facilities; industrial waste, including sludge from the industrial park; and waste from tires and automotive industries require particular attention given the relative higher levels of chemicals predominance.

8. Integrating rural development projects with urban centers by improving rural roads, and providing targeted centers of refrigeration for fishing, fruit growing and butchering communities.

7.7 Management Strategies for VES 6: Culturally Valuable Areas

Efforts to preserve and develop the cultural and natural heritage of the region should emphasize the following strategies:

1. Complete the inventory and historic resource identification work and existing condition surveys being carried out by entities such as ISPAN (Institute for the Conservation of National Heritage), World Monuments Fund and UNESCO (United Nations Educational, Scientific and Cultural Organization) need to be implemented and should serve as models for the towns of the northeast corridor.
2. Apply the minimal measures of protection established in 1997 by CMC / UNDP / UNESCO / CNRS to areas that are to be protected in the region of Fort-Liberté, which includes:
 - Baie de Fort Liberté (periphery and bottleneck) and the French colonial fortifications;
 - The Lagon-aux-Boeufs;
 - The Mamelles zone (Coastal Four a Chaux) and the colonial fortifications;
 - The coast from the mouth of the River Massacre Bay to the Bay of Caracol.
3. Protect the historic and visual integrity, while respecting the local religious value, of the natural landscape and cultural sites of the North-east and north within the study area by designating the following areas as protected zones:
 - The coast line from the Bay of Limonade to Caracol Bay;
 - The area between the Seashore of Limonade, En Bas Saline and Puerto Real (site of the sixteenth century Spanish city);
 - The Foulon River in Sainte Suzanne for its Taino petroglyphs and unique landscape.
 - The historic centers of towns and cities in the region, defined by their urban form, architecture, building scale, building façade alignments, public spaces and squares, important symbolic buildings such as churches and cemetery gates, sites that are notable for their use acquired over time, districts defined by the social and symbolic appropriation by the people and the physical relationship with natural environment, built and landscape.
 - Highly symbolic and mystical places identified by local communities including:
 - o La Fosse Capois (Monument Capois LaMort)
 - o Lakou Deréal
 - o Lakou Clérisse
 - o Springboard Basin
 - o Basin Mambo (Limonade)
 - o Lovana (Quartier-Morin)
 - o Chabert (Caracol)
4. Preserve and rehabilitate vernacular settlements, such as “garden-towns” (Acul Samedi), the “Kay-gardens” (along roads and paths) and the architectural integrity of urban centers (Ste Suzanne, Fort Liberté, Quartier Morin).
5. Consolidate and restore:
 - The French colonial coastal defense system and Haitian fortifications, such as Fort Capois;

- Sugar plantation homes of Desglairaux, Bongars, Duplaa Larue and Veron;
 - Important coffee production sites (Chop, Moka nine, etc.) that are historic predecessors of today's coffee industry around Terrier Rouge, production infrastructure (bridges, aqueducts, baths, sinks) and monuments Henri Christophe ("palace" or "castles" of Belle-le-Roi and Chastenoye)
6. Safeguard the intangible cultural heritage that contributes to the spirit of a place:
 - The fiestas and patron saint celebrations
 - Legends surrounding the projects of King Christophe
 - The names of places (neighborhoods, streets, houses)
 - Gastronomical traditions in the region
 - Mardi Gras "raras" and carnival disguises in Ferrier, Mapu, Meillac, Fort Liberté
 7. Preserve the landscapes that shape the region's overall identity and the view sheds that provide a glimpse of the region's cultural heritage. These include but are not limited to:
 - Sweeping views from the sea to the plains and mountains
 - Panoramic views of the mountains to the plains and the coast (Derac)
 - Unique silhouette of the vegetation
 - The confluence of water ways
 8. Improve drainage and flood management to prevent stormwater damage to sites of significant cultural and historical importance, which may once have relied on water control systems upstream that are no longer functioning. Many notable sites are subject to natural forces that create gullies, sedimentation and changes in the topography. These are all artificially accelerated by current rural farming practices and deforestation.
 9. Prevent illegal sprawl and growth around monuments and sites that need to be protected. Adopt protected sites zoning that includes a no-build buffer zone for each significant site.
 10. Account for the social, historical and cultural fabric of the region's urban space in local master plans.
 11. Advocate for and adopt a housing policy that addresses both the renovation of historic areas, the homes of the poor, transportation and waste management. In-fill building of historic zones, such as *Fort Liberté*, should be promoted and encouraged through tax or other incentive programs to revitalize and repopulate the historic urban whole, rather than opting for new territorial expansions. The UNESCO document "Historic Urban Landscapes" should serve as a reference guide on principals to use in the focus of urban development within this corridor.
 12. Educate and build awareness among the population about their cultural heritage and its manifestation in the build environment. Adopt an integrated approach to culture. Education extends to the development of trade schools and traditional building crafts' centers, not only to create jobs, but as an essential link in the revitalization and continued maintenance of the historic town centers, in-fills and compatible new constructions. Particularly through the new university (UHRC), research programs and research-based funding should be promoted to generate data on the archaeological and historical potential of the region.
 13. Promote quality tourism that is sensitive to the natural environment and historical monuments. Tourism development should not only be focused on individual geographic locations, but linked across the entire northeast corridor by way of thematic topics. Examples of these could be the industrial archaeology of sugar, sisal and indigo plantations; the European Colonial and Haitian military forts and fortifications linking the historic development of Haiti as a free republic; the evolution of Creole housing prototypes, and other such topics that will develop out of further evaluation of the region.

7.8 Disaster Mitigation and Response

With the exception of a few isolated areas, the region's vulnerability to multiple hazards is assessed as high and very high in coastal areas. Since risk management is a relatively new concept for Haitians, especially urban dwellers, living with risk needs to become a purposeful constant in everyone's life. The National Early Warning Program – Programme National d'Alerte Précoce PNAP can spearhead a national program that can be adapted to each commune. Personal awareness and commitment to resilience can begin at home and in schools as a life affirming activity with the guidance and support of national and local government agencies.

General recommendations include can be broken down into structural and non-structural remedies. Structure recommendations includes requiring, at a minimum, that all public institutions be built to above 5 meters above sea level, withstand earthquakes and 100-year storms, and design them to also serve as refugees and disaster relief centers. Similarly, major businesses, private investments receiving public subsidies, and donor-funded projects should achieve similar standards. In addition, national and local authorities will need to identify informal settlements that are at the greatest risk to coastal and inland flooding, build mitigating infrastructure or relocate households, and/or provide households with financing to elevate their homes.

Given the lack of material and economic resources, non-structural measures will be the most critical for the region. Structural measures will need to be prioritized through cost-benefit analysis. For some risks, such as seismic reinforcement of existing critical infrastructure, the benefit is clear and needs to be a priority in every community. The PNAP should adopt a risk reduction program at the national and local level, publicize it widely, and organize an annual national risk awareness day in every commune that engages all citizens. Specific activities include:

- Establish responsibilities from individuals/household scale, to neighborhood scale, to commune scale, department/region scale and national scale. All planning needs to be a concerted effort.
- Develop core curriculum programming for each age group and require implementation in both public and private schools
- Develop citizen toolkits with graphics and maps for awareness building

Experts indicate that the main question is not whether large earthquakes will strike the region, but when. As such, strengthening building codes, construction practices and public education and awareness of emergency response will be critical to reducing public risks. As well, stronger building codes will help improve the insurability of cities in the region, which in turn will help catalyze economic development and investments.

7.9 Economic Policies to Promote Implementation

Le gouvernement haïtien et les agences de financement internationales impliquées dans la réalisation de ces projets, misent sur le développement de petites et moyennes entreprises pour servir de moteur de croissance. En d'autres termes, la trame de succès de ce développement régional se situe dans la traduction de l'impact de ces projets en la création de grandes, moyennes et petites entreprises pourvoyeuses d'emplois durables, et leur manifestation en l'émergence d'une masse critique d'entrepreneurs agricoles, industriels, et de ceux œuvrant dans le secteur services, qui constitueront une demande solvable à même de viabiliser un niveau d'investissement acceptable, et parallèlement, une base taxable adéquate permettant à la gouvernance locale et régionale d'assurer le maintien et l'expansion des infrastructures.

Dans cette perspective, cette nouvelle forme de structuration de l'économie régionale, pour répondre à un développement harmonieux du pôle, sera confortée d'une part par:

- Des mécanismes de financement efficace des PME/PMI

- Des services d'incubateurs d'entreprises
- La formation professionnelle

A titre d'exemple, le projet «LEVÉ» de la USAID, comprend tout un volet de formation professionnelle dans le textile, l'agro-industrie, et la construction. L'OGD financée par la BID appuiera le développement des entreprises dans le secteur du tourisme, et le FTFNC, au travers des nouvelles technologies et l'innovation, travaillera à l'augmentation de la productivité et la commercialisation des entreprises agricoles.

Et d'autre part, cette structuration sera soutenue par des mécanismes institutionnels tels

- Règlement de la tenue foncière qui permette de sécuriser les exploitants des terres, et faciliter les transactions avec les institutions financières ; le projet de sécurisation foncière financé par la BID peut aider dans ce regard ;
- Politiques fiscales et monétaires qui répondent aux exigences de développement de la région ;
- Douane avec des fonctionnalités qui ne reproduisent pas les tracasseries administratives en cours ;
- Services sociaux (éducation et développement de la force de travail, logements, santé, eau potable, etc.),
- Gouvernance adéquate

Absorption de cette augmentation de main d'œuvre. Le point d'ancrage pour fixer cette main d'œuvre se situe au niveau du renforcement du secteur privé par le développement de grandes, moyennes et petites entreprises dans les secteurs agricole, du tourisme, de l'agro industrie, du textile et des services. En regard des contraintes diverses des structures de gouvernance et des ressources, un développement harmonieux du pôle de croissance sera articulé autour de certaines exigences.

La mise en place d'un Hub financier

- Qui facilitera l'accès au financement aux entrepreneurs avec un projet viable.
- Qui permettra la fluidité du système de paiement au travers de satellites situées dans les différentes communes, mais avec une réserve suffisante pour répondre en tout temps aux besoins de la clientèle de la région.
- Qui assurera la facilité des transactions au travers de satellites dans les communes périphériques ;
- Des assurances qui appuient les risques ;

Ce mécanisme est essentiel au développement des entreprises. L'intermédiation financière en Haïti est très peu profonde due aux rigidités du marché et de certaines contraintes comme le foncier. Des mesures d'envergure doivent être considérées pour répondre à ces goulots d'étranglement du marché.

Trou-du-Nord de par sa centralité par rapport à la grappe de communes considérée, pourrait héberger ce hub financier. Incubateurs d'entreprises. D'un lieu ou de plusieurs lieux d'incubation de petites et moyennes entreprises qui accompagnent les nouveaux investisseurs dans des « venture » entre locaux, ou des locaux avec la diaspora ou autres investisseurs étrangers. Les opportunités seront certes au rendez vous, mais l'expérience pas toujours. Ces espaces d'accompagnement permettent à bien des entrepreneurs de franchir les étapes « d'infancy ». Le support nécessaire peut être technique ou financier. Il varie avec les individus initiateurs du projet.

Terrier Rouge avec son histoire avec la plantation Dauphin peut accueillir avec succès de tels centres. Caracol, Ferrier, et Limonade, de par leur vocation peuvent servir également d'espace de domiciliation de pareilles entreprises.

De centres de formation professionnelle qui alimenteront le marché en ressources humaines qualifiées. Pour le renforcement du secteur privé, il est essentiel d'avoir les ressources humaines capables d'assurer la prise en charge des entreprises tant du point de vue technique que managériale.

La faiblesse se fait ressentir à plusieurs niveaux : Tourisme, hôtellerie, mécanique, construction, agroindustriel; Communes : Limonade, Trou du nord, Terrier Rouge, Fort Liberté, Ferrier.

Mécanismes Institutionnels pour la Croissance

Gouvernance. L'économie régionale est atrophiee par une centralisation à outrance. Par rapport au développement anticipé, les représentations des organismes de l'état central doivent être outillées pour répondre aux nouveaux défis. Les mairies n'ont pas les ressources financières pour répondre aux besoins actuels d'administration des municipalités. Actuellement, les subventions représentent 46% des ressources du budget du département. Ce qui augure des problèmes croissants avec la nouvelle dynamique de la région.

Pour les routes, au niveau municipal, les autorités locales devraient compter sur des provisions de 500 dollars américains par kilomètre pour des entretiens de routine ; et au niveau régional entre 500 et 750 dollars (Burningham, 2005). Dans cette perspective, la décentralisation doit cheminer avec la déconcentration effective de ces institutions pour faciliter la création d'entreprises, la conduite des affaires administratives liées au fonctionnement des entreprises ; et bien sur, la gouvernance locale doit être pourvue des moyens efficaces pour collecter et administrer les redevances fiscales qui lui permettront de faire face aux demandes d'une population grandissante.

Commerce

- Système en ligne qui vient d'être installé n'est pas à point. Des difficultés énormes pour faire sortir les marchandises au niveau du port ;
- Tracasseries administratives ;
- Les couts de tonnage différents entre les ports de province et celui de PAP. Même le taux de change peut varier entre le Cap et PAP, au niveau de l'APN; alors que ce doit être le taux de change édicté par la BRH pour le jour ;
- Infrastructures portuaires inadéquates ;
- Les couts du port trop élevés par rapport au port dominicain le plus proche ;
- Les fonctionnaires n'ont pas les compétences administratives leur permettant de prendre des décisions

Perspectives et Recommandations. Ces transformations tant anticipées au niveau du Pôle Nord, ne peuvent se faire en dehors de mesures de politique qui facilitent la création d'entreprises, et un renforcement de la gouvernance locale qui permettra de financer les infrastructures de base. Dans cette perspective des dispositions fiscales, monétaires et administratives doivent être considérées.

Une politique fiscale bien pensée doit prendre en compte les faiblesses de l'économie locale, et encourager leur renforcement. La politique fiscale au niveau local doit se traduire en un élargissement de l'assiette fiscale, par la prise en considération de champs négligés au niveau régional, et aussi la mise en place de structures qui permettent de régir une série de taxes de masse, de patente, et d'autres droits communaux.

Une politique monétaire qui favorise les investissements au niveau local, au travers d'incitatifs de prêts pour l'établissement d'entreprises dans les provinces : ex. assouplissement de taux, les garanties acceptées en regard des normes prudentielles, etc. Les propositions suggérées par la BRH dans son mémorandum¹⁷ du 7 février 2010 permettront certes d'apporter certaines flexibilités de crédit dans le

17 Pour faire face à ce problème, il faudra sensiblement renforcer le capital-risque à la disposition du système bancaire, à travers entre autres les mesures suivantes :

1. Etablissement de fonds de garantie partiel, couvrant les crédits offerts par les banques en vue aussi bien d'assurer la relance de l'économie;
2. Emission de dettes subordonnées par les banques commerciales en vue de renforcer leur capital.
3. Elargissement des mécanismes de garantie acceptables par la BRH, incluant le warrant de marchandises.
4. Encouragement aux banques à utiliser au mieux les mécanismes juridiques disponibles, tels le leasing d'équipement.

système bancaire, mais des mesures ciblées pour le crédit au niveau des provinces sont à elles seules capables de reconfigurer la géographie du crédit bancaire haïtien.

Une politique commerciale qui ne pénalise pas l'entrepreneuriat local. Le gouvernement doit adresser dans l'immédiat les mesures en vigueur, les pratiques actuelles, et les conditions matérielles de fonctionnement des ports, et de la douane, qui rendent le port du Cap non compétitives par rapport aux ports de ses voisins les plus proches. D'autre part des mesures doivent être envisagées pour permettre à des associations de jeunes entrepreneurs de mobiliser les produits locaux, s'assurer de leur conditionnement, et de leur distribution au niveau de la Caraïbe et ailleurs. Le gouvernement pour répondre à ces nouvelles exigences doit nécessairement revisiter les contraintes liées à certaines dispositions de lois ou de convention en vigueur.

Table 35 summarizes the issues of concern, significant cumulative impacts, mitigation and management interventions, indicators and responsibilities. These will be discussed at the September workshop prior to finalization in the regional and local plans.

Table 35 Cumulative Environmental Impacts and Mitigation Strategies by Valued Environmental System

VES	Issues of Concern	Cumulative Impacts	Mitigation / Management Interventions	Indicators	Lead Entities for Implementation
1. Surface and ground water resources	<i>Quantity:</i> Significant increases in demand for water by domestic, industrial and agricultural users, with the PIC as the largest individual user; additional stress on water and sanitation infrastructure; more charcoal production in montane communities could increase erosion and exacerbate flooding downstream.	Possible risk of diminishing supplies from the aquifer; potential changes to water quality and quantity; synergistic impacts of pollutants in supplies upon users and the natural environment; risk of pollutants entering the food chain through coastal salt production ponds and fisheries; drainage ditches increasingly filled with wastes; increased vulnerability to flooding.	Undertake a hydrological survey to help determine state of surface and ground water conditions, the impact of estimated future withdrawals of water on saline intrusion and groundwater levels, especially from wells serving local populations. Invest in human and solid waste collection and disposal systems; invest in drainage systems and roadways that mitigate flooding; invest in silvicultural and upland forestry projects; invest in irrigation and agricultural productivity projects; protect and rehabilitate riparian habitat; limit range of cattle and livestock to reduce surface water pollution. Prioritize the development of an integrated watershed resource management plan for the Trou du Nord Watershed that addresses industrial, agricultural, urban and local, and environmental needs.	Number of cases of waterborne diseases each year; percent of children under 5 who die or are affected by waterborne disease; volumes of water withdrawal and rates of change; pollutant loading of surface and ground water measured (BOD, fecal coliform, turbidity, heavy metals, etc); percent of people with access to adequate sanitation and solid waste services; percent of liquid and sold waste treated and disposed; number and severity of flood events; water quality index, sediment quality index, benthic index, fish tissue contaminants; improved agricultural productivity. Continually update projected water demand for the region; establish community system to maintain wells, monitor water quality, and develop early warning system. Progress in managing watersheds.	Ministry of Environment (water quality concerning the application of standards and regulations, watershed planning and management); Ministry of Agriculture (state of watershed and agriculture) supported by World Bank, IDB, USAID, and FIDA agricultural and forestry projects; DINEPA, STDs and commune mayors/ leaders for water quality/quantity monitoring, and extension of water, sanitation and solid waste services; MPCE, MOI, MOF – finance, investment; CIAT – monitoring and donor coordination IDB/PIC Management (environmental services maintenance and monitoring of facility)
	<i>Quality:</i> Flow changes and pollution loading (solid and liquid wastes) to Trou du Nord River by the PIC; continued and increased dumping of wastes into Trou and other rivers entering Caracol Bay and modification of runoff and impermeability patterns from other developments; seepage of human waste into aquifer through leaking latrines and septic tanks placed in the water table; upper watershed in degraded state contributing to erosion and diminishing quality of riverine and estuarine water and impacts upon users and the natural environment.				
	<i>Aquifer Salinity:</i> saline intrusion confirmed; projections on future extent/impacts being studied.				

VES	Issues of Concern	Cumulative Impacts	Mitigation / Management Interventions	Indicators	Lead Entities for Implementation
2. Aquatic resources (estuarine, coastal, marine and freshwater)	Significant increases in industrial, mining and domestic wastewater projected to flow into the Parc de Trois Baies. Designs for the PIC's wastewater treatment are not yet known; funding allocation for management of waste streams from urban areas outside of PIC unclear; projected contamination of water quality to affect fish populations and catch, invertebrate populations, coastal reefs, and salt basins, with consequence for food quality. Fragmentation and isolation of mangrove and riverine habitat due to: investments in a series of coastal industrial and transportation facilities (such as ports, PIC, possible new airport); over fishing/extraction of marine resources; demand for charcoal and salt basin expansion.	Mangrove and fish loss; potential loss of species/habitats; economic impact on communities dependent on fisheries and salt basins; reduction in local food security; loss of potential tourism value of coastal environment; increased pressure on other environmental resources as a result of loss of current livelihood (e.g. increase mangrove-based charcoal production).	Studies on Caracol Bay being considered via a UNDP/GEF/IDB/GoH initiative; will include determination of mitigation measures and management arrangements and preparation and implementation of a protected area plan. As a preliminary concept, strategies will likely need to include prioritizing local communities whose livelihoods are most affected for employment at the PIC; investment in alternative energy for cooking; promoting sustainable fisheries management; investing in rehabilitating and securing existing transportation investments prior to developing duplicative structures along the coastline.	Health and status of targeted species including endangered species; water quality index, sediment quality index, benthic index, fish tissue contaminants; fish catch levels and trends; effectiveness of control measures; effectiveness of the implementation of management measures for the Bay and associated rivers. The effective implementation of the protected area and associated natural resource management initiatives for mangroves, fisheries, and the coral reef	Ministry of Environment (monitoring of population trends and implementation of a protected area plan, environmental impact assessments, endangered species protection and plans); Ministry of Agriculture (fish catch and other food sources). UNDP/GEF/IDB/ GOH (developing Caracol Bay management plan) CIAT – regional plan implementation and donor coordination to ensure future investments conform with plan and environmental standards

VES	Issues of Concern	Cumulative Impacts	Mitigation / Management Interventions	Indicators	Lead Entities for Implementation
3. Highland Watersheds and Riparian Habitat	An estimated 65-130% increase in charcoal consumption by 2030 would exert significant additional pressure on existing wood resources. Watershed degradation due to historic deforestation, which could be exacerbated by growing demand for charcoal and construction materials; erosion and habitat destruction for mining, sand and soil extraction from mountains and streams; lack of reforestation or structural stabilization for unstable slopes leading to erosion.	Loss of topsoil; siltation of rivers and streams; deposition in mangrove area; potential for increased flooding.	Initiation of a watershed management plan for the region; invest in stabilization of stream banks and steep slopes; regulate mining and excavation activities; invest in community-based, sustainable silvicultural and forestry projects; promote agroforestry and perennial crops on slopes (e.g. biofuel cultigens), sustainable charcoal harvest, and alternative energy sources; invest in rural road maintenance and upgrading to improve rural access to markets for sustainable products. Site new developments and investments in areas at lower risk of flooding; foster economic viability of sustainably produced materials and strengthen enforcement capacity for projects built with public funding; promote construction waste recycling.	Effectiveness of watershed management practices; % of vegetative cover; stabilization of erosion; increased agricultural productivity.	Ministry of Environment; Ministry of Agriculture (watershed management and monitoring of vegetative cover and changing agricultural land use), supported by PMDN, PPII and GAFSP projects; MPCE, CIAT, MDE for watershed planning and management MPCE / IDB – road projects

VES	Issues of Concern	Cumulative Impacts	Mitigation / Management Interventions	Indicators	Lead Entities for Implementation
4. Air Quality	PIC power plant to use latest control technology, but emissions from PIC should be monitored together with local vehicular exhaust due to commuter traffic to the PIC. A number of proposed or under construction EDH power plants will add to local emissions. Increased charcoal consumption, vehicular exhaust, and solid waste burning (which could lead to 40-54,000 additional pounds of air pollutants per day in the region) will worsen air quality in urban areas.	Increased localized air pollution in all urbanizing areas poses a public health concern. Existing EIA of the PIC power plant is unsubstantiated and requires additional study; air quality around PIC should be projected in tandem with commuter traffic.	Pollution control technology to be adopted in PIC to offset carbon contributions and protect natural and human resources. Monitoring of emissions at plant for set ambient and emission standards and within the region to assure quality meets WHO and other relevant standards. Mitigate residual air quality impacts through standard pollution control and appropriate stack height of new facilities, including EDH. Need also to consider cumulative impact on air quality when designing new facility. Invest in solid waste collection, alternative cook stoves, cooking fuels. Design transport networks to promote a high share of walking and biking to the various new employment centers	Measurements of air quality at source and ambient conditions as appropriate; number of cases of and percent of children affected by acute and chronic respiratory disease and deaths each year. Use results of modeling (if undertaken) to position monitoring equipment and measure air quality and ensure compliance with standards.	Ministry of Environment (monitoring air quality) GOH /MPCE/ DINEPA / CIAT / communes in transport, solid waste and energy investments.

VES	Issues of Concern	Cumulative Impacts	Mitigation / Management Interventions	Indicators	Lead Entities for Implementation
5. Soils and Agricultural Valuable Areas	Loss of significant amount of prime agricultural land; displacement of people from areas used for cultivation due to major industrial and transportation investments as well as continued urbanization; estimate 3.8-5.4 fold increase in solid waste generation in the region, leading to increased pollution of region's soils from domestic and industrial solid and liquid wastes as well as stormwater runoff; heightened demand for wood-based construction materials and charcoal; exploration of mining potential likely to cause loss of topsoil, and increase erosion and sedimentation.	Land conversion and displacement of farmers and ranchers have major impacts on food security, with potential price instability. The poor are at the greatest risk. Soil quality deteriorating in some areas due to pollution and poor drainage. Increased land conflicts between farmers, rural-urban dwellers, and between private-public landowners and tenants as urbanization expands.	Undertake local property census in urban areas, as well as land survey/ mapping of private and publicly owned land and town/commune boundaries. Concentrate future developments and major investments near existing urban centers and apply principles of smart growth to future plans and construction to reduce agricultural fragmentation and create economies of scale for public infrastructure. Invest in improved tillage methods to retain rainwater on site; modify gullies in mountains to moderate and store floodwaters and create systems for crop watering; promote perennial cultigens and agroforestry on slopes; support expansion of irrigation; promote conversion of sludge, compost and green waste for agricultural inputs; improve roads and market facilities in urban areas to promote agricultural sales and storage. Implement a compensation and livelihood restoration plan developed for the PIC; develop plans to resettle and/or restore livelihoods of other persons affected by new projects in the region (such as the port, airport). Establish a policy and procedures to address resettlement issues.	Levels of local food security; total volume of regional agricultural production and farmer income; land areas for agriculture, protected zones, urbanization and rates of change of different land uses; volume of waste converted for agricultural inputs. Number of people whose houses, farmland or businesses are affected by displacement and resettlement; numbers of people taking different resettlement options; number of land conflicts. Number of products locally sourced to support population food security. Establishment of a Famine Early Warning System (USAID).	Ministry of Agriculture (use of water retention schemes, irrigation works, drainage canals) Ministries of Environment/Agriculture (adoption of waste mgt. practices for agriculture) Ministry of Interior, Ministry of Finance, Direction Générale des Impôts. And local governments (land survey and mapping) CIAT and local governments (implementation of regional and local plans) USAID (establishment of FEWS) CASEC and Communes (enforcement of Code Rural regulations)

VES	Issues of Concern	Cumulative Impacts	Mitigation / Management Interventions	Indicators	Lead Entities for Implementation
6. Cultural Valuable Areas	Proximity of developments to the region's built cultural heritage, in particular the impact of a proposed port on the heritage of Fort Liberté; danger of destruction of historic fabric under urbanization; impairment of corridor's visual beauty for tourism value.	Concern for the preservation of the historic centers of Trou du Nord, Fort Liberté, Quartier Morin and Limonade. Fragmentation of landscape could dampen potential for tourism.	Implement tourism master plan for the region; apply measures of protection established in 1997; designation of protected zones; preserve vernacular settlements; preserve landscapes with significant cultural heritage; and, develop a master plan for cultural heritage.	Monitor application of protection measures and designated protected zones; implementation of tourism and heritage master plans; percentages of historic cores protected and maintained; economic indicators for the tourism sector.	Ministry of Tourism, Ministry of Culture, ISPAN, Communes and MTPTC (building codes and standards, permitting process)
Vulnerability to Natural Hazards	Current and future populations in the coastal corridor are at high risk to earthquakes and flooding, with some areas also at risk to drought and landslides. Climate change will exacerbate the intensity of these risks. Cities tend to be located in river floodplains, and new growth will increasingly take place in less desirable and more flood prone areas. Increasing land values will make it more economically feasible to build multi-story buildings that will likely not be earthquake proof. Employment centers like are also vulnerable to flooding, placing the region's overall economy and household livelihoods at risk.	Increased population and development in areas at high risk to natural hazards, placing households and economic centers at physical and economic risk.	Undertake elevation studies and establish detailed flood maps, along with development requirements and limitations for each zone; develop integrated regional flood, drainage, irrigation, storage and aquaculture system that diverts, slows and absorbs floodwater and wastewater away from cities and sensitive habitats. Require, at a minimum, that all public institutions be built to withstand earthquakes and 100-year storms, and design them to also serve as refugees and disaster relief centers. Require major businesses, private investments receiving public subsidies, and donor-funded projects to achieve similar standards.	Number of homes affected by or deaths caused by disasters (flooding, drought and earthquakes) Cost of community relocation or reconstruction % of population located in at risk land areas % of homes and buildings built to seismic code Percent of public buildings equipped to withstand and serve as community refuges in case of emergency	Ministry of Public Works (update of building codes; development of standards) CIAT, MDE, Communes (implementation of plans and zoning) MDE (environmental impact assessments)

VES	Issues of Concern	Cumulative Impacts	Mitigation / Management Interventions	Indicators	Lead Entities for Implementation
<i>Social and Cultural Dimension</i>	Déplacement de personnes, activités commerciales, fermes. Impacts négatifs sur l'emploi, spéculation immobilière, tension sur les prix alimentaires (problèmes de sécurité alimentaire); problèmes de sécurité, crime, violence; manque d'infrastructures publiques pour faire face à l'afflux de population (particulièrement santé et éducation)	Increased pressure on already deficient social infrastructure including (housing, health services, education, police); Risk of health issues (cholera and other water borne diseases, vector borne diseases including malaria and dengue, STIs including HIV/AIDS. Potential for increased crime and loss of social cohesion.	Social Monitoring Plan to coordinate with relevant ministries on monitoring cost of basic foodstuffs, trends in crime and violence, epidemiology. Coordinated institutional planning in health sector. Increased support for community health and education. Coordinated institutional planning for agriculture, value chain development, and local sourcing for viable commodities. Increased resources for police and community based mediation structures.	Social Monitoring Plan to outline: Cost of basic foodstuffs in local markets, crime registries, traffic accidents, etc. Number of community health workers, local police, community-based mediation associations – total and per capita.	Ministries of Health and Education (investments in schools and clinics) CIAT and local commune governments to implement and monitor USAID (develop social monitoring plan)

ANNEX 1: SUMMARY ANALYSIS OF GOVERNANCE ISSUES

Guiding questions: Who has authority over regional planning? How can municipal and regional plans for the Nord/Nord-Est region be effectively implemented?

Governance institutions are weak. Informal arrangements tend to prevail over the formal or legally established structures and procedures. Regional and municipal plans are unlikely to be implemented without close attention to the real context (i.e., how do things really get done here?), and without close accompaniment and support for local governance. The focus of effort for regional planning is local capacity building, i.e., institutional development.

1. Regional jurisdictions: It is essential to define the operative jurisdiction for regional planning since the targeted area of interest is composed of two distinct governmental *départements* and does not constitute a single jurisdiction for purposes of planning or regional decision-making.

2. Département. The Nord and Nord-Est *départements* are themselves regional jurisdictions within the targeted geographic area for regional planning. According to the Constitution, the *département* is an autonomous unit of government. It has authority, in collaboration with the central government, to prepare departmental development plans; however, constitutional provisions for departmental governance have never been implemented. This is due primarily to political barriers to establishing departmental *assemblées*, the *Conseil Départemental* and the powerful *Conseil Interdépartemental* (CID) as provided by the Constitution.

At present, there are no elected public officials at the departmental level. Other institutions of departmental governance are very limited, (i) the executive *délégation*, (ii) the *Services Techniques Déconcentrés* (STD), i.e., deconcentrated services of the central government, and (iii) a small *Agence Technique Départementale* established by the Ministry of Interior to facilitate municipal access to urban engineers. Similarly, the Ministry of Interior has also posted financial controllers at the departmental level to assist *communes* with budgeting and financial oversight.

3. Délégation. The executive *délégué* is a departmental level authority whose assignment is to represent the executive branch. The departmental *délégué* and *vice-délégués* are charged by the Constitution with coordination, monitoring and oversight of public services within the *département* (Article 86).¹⁸ As noted earlier the *vice-délégué* is assigned to the sub-departmental jurisdiction called *arrondissement*.

At present, governance functions at the level of *départements* and *arrondissements* are limited to the *délégation* and its coordination and oversight role in relation to (i) deconcentrated services (STD) and (ii) local elected governments (*communes* and *sections communales*). In current practice, the *délégation* tends to play more of a political than technical role; however, the *délégation* does hold periodic meetings with departmental heads of deconcentrated services, the *Conseil Technique Départemental* (CTD). In effect, the *délégation* exercises some oversight but lacks decision-making authority over departmental planning, public services (STD) or the decentralized bodies of local government (*communes* and *sections communales*) under its purview. Furthermore, the *délégation* is poorly funded and lacks well trained human resources.

Funding for the *délégation* flows through the Ministry of Interior, the *délégation*'s primary channel to the central government. This arrangement also tends to curtail *délégation*'s political clout as it does not directly report to the head of government or head of state. Nevertheless, given the special relationship between the *délégation* and the MICT, stronger, targeted support from MICT could strengthen the delegation's ability to actively promote and coordinate regional planning.

18 See also Décret du 17 mai 1990 sur la délégation, and, Décret du 31 mai 1990 fixant les règles appelées à définir l'organisation et le fonctionnement du Ministère de l'Intérieur.

In sum, the *délégation* and *vice-délégation* are a tangible resource and could potentially play a far more influential role than they do at present. It is imperative that the *délégation* and *vice-délégation* be actively integrated and play a leadership role in regional planning and implementation.

4. Services Techniques Déconcentrés (STD). The STDs are departmental administrations of central government ministries including Education, Public Health, Agriculture, Public Works, Environment, Social Affairs, Planning, Interior¹⁹ and Finance, especially the latter's powerful tax office, the Direction Générale des Impôts. As noted above, the *délégation* occasionally organizes meetings of departmental STD directors, i.e., *Conseil Technique Départemental* (CTD); however, in actual practice there is minimal coordination of services except during periods of crisis or disaster.

Despite efforts in recent years to expand the scope and coverage of deconcentrated services, authority over STD operations remains highly centralized in Port-au-Prince. Departmental STD directors have little authority over planning, policy and funding for the services they offer. Effective regional planning requires significant devolution of authority to the departmental level for deconcentrated services.

5. Departmental office of the Ministry of Planning (MPCE). The departmental director of the Ministry of Planning in the north also hosts periodic meetings with STD directors (*Tables Sectorielles de Concertation*). The MPCE departmental director organizes other meetings with departmental stakeholders (*Table Départementale de Concertation*) including non-governmental organizations (*Conseil Départemental de Coordination et Suivi des actions des ONG*) and communal administrations (*Tables Communales de Concertation*).²⁰ These various venues are opportunities to promote and share information regarding regional and municipal planning. It is imperative that the departmental office of the MPCE focus its activities primarily on the promotion and implementation of regional plans.

6. Responsibility for Regional Planning. The various meetings noted above foster the circulation of information but they do not constitute departmental governance. Given the institutional and political weakness of departmental governance, the *département* as a jurisdiction continues to be governed from the center including all planning, budgeting and personnel assignments. As a corollary, by default, the only hierarchical authority available for a geographic region composed of two contiguous *départements* is the central government. Therefore, it is incumbent on the central government to take specific measures to coordinate and monitor implementation of the new regional plan for the two *départements*.

Institutionally, the ministries designated for urban and land use planning are the Ministry of Public Works and the Ministry of Planning. Both ministries are represented at departmental levels and both should be deeply involved in the implementation of regional and urban plans; however, an individual departmental director lacks authority to take the lead in a region composed of two *départements*.

Furthermore, there is an absence of clarity regarding the division of labor among national land use and urban planning entities, especially the role of the Ministry of Planning versus that of the CIAT/OPM. A recent institutional evaluation of MPCE-Nord also takes note of the absence of MPCE decision making authority at the departmental level, and weakness in both internal and external communications.²¹

Institutional options for assuming overall leadership for regional planning include the Ministry of Planning, perhaps a new regional planning authority, or an inter-ministerial planning authority under the office of Prime Minister, i.e., the Comité Inter-Ministériel d'Aménagement du Territoire (CIAT). According to its legal framework, the Ministry of Planning could well take the lead in regional planning; however, in actual practice, there is structural rivalry between the Ministry of Planning and the Office of Prime Minister over planning and the territorial allocation of resources. In the end, the Office of Prime Minister retains final hierarchical authority over planning.

19 In effect, the highest ranking departmental representative of the Ministry of Interior is the *délégué* rather than a separate departmental director as in the case of other ministries.

20 See description in EUNIDA, MPCE Département du nord (2011, p.17-18).

21 EUNIDA (Novembre 2011, p 35). MPCE. Département du nord. Mission EUNIDA d'évaluation des services Déconcentrés de cinq ministères dans la région du « grand nord ». Préparé par F.Toussaint.

7. Role of municipalities in local, urban and regional planning. In addition to the need for overall coordination and promotion of regional planning, it is essential to identify a defensible legal basis for regional and municipal plans. At present, the most readily available legal framework for promulgating plans, including zoning and land use requirements, resides with municipal governments (*communes*).²²

The legal framework for *communes* provides authority to promulgate and implement local development plans, including zoning requirements for construction, land use and flood control. Urban plans can be issued by municipal *arrêté* (city ordinance), thereby endowing local development and zoning plans with the force of law. These plans and related municipal *arrêtés* are subject to central government approval and oversight by the Ministry of Interior (MICT).

As a local body of government the *commune* does not have wider regional authority and jurisdiction; however, in point of fact, all land affected by the regional development plan falls within the borders of a local *commune*. Since *communes* also have legal competency to establish inter-communal agreements, it is conceivable for *communes* to underwrite a regional plan via inter-communal agreements and *arrêtés* that have the force of law.

8. Construction permits. The *commune* also issues construction permits, a critical tool for urban planning and zoning including regional planning. According to law, the Ministry of Public Works provides technical review of requests received by the *commune* for construction permits and housing developments.²³ In principle, this review process allows for the enforcement of norms and standards for construction including anti-seismic standards for which there is heightened concern in the post-January 12 era.²⁴

According to recent field interviews in target municipalities, many recent constructions in targeted *communes* have been undertaken without the benefit of construction permits or technical review of construction plans. This is due to the lack of enforcement by municipal administrations.

Poor enforcement is attributable in large part to the limited human and financial resources of targeted *communes*, and also to a feebly developed linkage between the permitting process and urban planning including disaster mitigation and risk management. Recent field interviews with municipal engineers and mayors suggest that fears of personal recrimination or political risk may also play a role in the issue of construction permits, especially a perceived sense of personal or political risk when denying or delaying requests for construction permits. According to field interviews with mayors, departmental personnel of the Ministry of Public works are not always readily available to review and process requests for construction permits in a timely fashion.

Another limiting factor is the need to update national construction norms and standards that take into account earthquake resistant construction. Finally, construction permitting is a relatively complicated and time consuming process. Compliance would increase if review were simplified and turned around quickly without sacrificing its effectiveness as a tool for enforcing norms and standards.

9. Discontinuity of personnel due to the absence of a municipal civil service. Electoral rotation of mayors tends to result in wholesale changes of municipal personnel due to job patronage. Therefore, the discontinuity of human resources in municipal government is an enormous constraint to effective implementation of regional and local plans over time. Career oriented assignments for municipal engineers are not available at the *commune* level. Yet city engineers play a critical role in the permitting process for construction and housing development including technical review of construction plans,

22 Décret du février 2006 sur le cadre de la décentralisation.

23 Article 1 du décret du 29 mars 1971 modifiant l'article 29 de la loi du 22 juillet 1937 sur l'urbanisme.

24 At the time of this writing, the Ministry of Public Works has not yet updated and adopted new national norms and standards for building construction and housing developments. It is reportedly considering the formalization of standards consistent with the International Building Code (IBC).

referral to the MTPTC for norms and standards, and site monitoring and inspection with a view to enforcing norms, standards and zoning criteria.

There is legal provision for a municipal civil service (*fonction publique territoriale*), but this decree has never been implemented. Upcoming local elections that may coincide with plan implementation.²⁵ Newly elected mayors are under tremendous pressure to hire their own people. Therefore, pressures for patronage and personnel discontinuity are unlikely to diminish so long as the central government does not take active measures to establish a municipal civil service.²⁶ This discontinuity constitutes a serious constraint to implementing regional and municipal plans in a consistent and sustainable manner.

10. Agence Technique Départementale (ATD). To help fill the gap in trained personnel and to ensure some degree of technical continuity, the Ministry of Interior recently established a small corps of municipal engineers and also financial controllers assigned to *départements* as a service to *communes*. These are career posts paid directly by the Ministry. The controllers assist *communes* with budgeting and financial reporting.

City engineers of the ATD provide assistance to municipalities in response to mayoral requests for their services. This includes inspection of construction sites and technical review of requests for construction permits and housing developments submitted to city administrations. The ATD engineers thus serve as interface between *communes* and the Ministry of Public Works to ensure application of ministry norms and standards for urban constructions.

Ministry expansion of this Agence Technique Départementale can help fill human resource gaps in city services and also the discontinuity of municipal personnel that results from elections. The ATD is a partial solution to municipal human resource deficits; however, there is a certain risk that continued expansion of the ATD will create a permanent new service controlled by the MICT rather than local mayors, thereby further weakening mayoral authority over city planning. In the long run, this dilemma could be addressed by implementing the law on Fonction Publique Territoriale; however, this requires the political will to do so.

25 According to recent statements (May 2012), the newly established Lamothe government anticipates municipal and parliamentary elections in late 2012.

26 Décret du 1er février 2006 sur la fonction publique territoriale.

ANNEX 2: ACTIONS PRIORITAIRES POUR UNE INTENSIFICATION DE LA PRODUCTION AGRICOLE ET POUR LA CONSERVATION DES SOLS ET DES EAUX

La maîtrise et la valorisation des ressources en eau doit être le principe directeur de tout programme de mise en valeur intensive de cette zone.

Pour les plaines, deux axes majeurs d'intervention doivent être retenus:

- L'extension des surfaces irriguées à partir des eaux souterraines et des eaux de surface afin de valoriser ses sols fertiles.
- la mécanisation des opérations de labour

Dans l'aire de montagne, la priorité doit aller aux ouvrages de maîtrise du ruissellement et d'intensification agricole dans les ravines afin de favoriser l'infiltration de l'eau, facteur essentiel au développement agricole et industriel des plaines et des villes, et d'augmenter en même temps le revenu des agriculteurs en montagne.

Extension des surfaces irriguées

Même si les surfaces irrigables par les eaux de surface peuvent paraître plus importantes, la priorité dans un premier temps doit aller à la exploitation des eaux souterraines à partir de petit matériel de pompage, tel que cela est déjà pratiqué par les couches d'agriculteurs plus aisés dans la zone.

L'exhaure des eaux souterraines par de petites pompes mobiles de 2 à 3 pouces constitue en effet une solution plus durable pour plusieurs raisons. D'abord en raison du coût des infrastructures d'irrigation à partir des eaux de surface et des risques de dommages qu'entraînent les fortes crues qui caractérisent les cours d'eau de la région. L'expérience montre par ailleurs qu'une gestion correcte de la répartition des eaux de surface sur les périmètres est rarement assurée tout comme l'entretien des canaux dans un contexte social où les inégalités de moyens et de pouvoir sont prononcées. Le retour sur l'investissement prévu par ces périmètres est souvent difficilement atteint.

Un petit matériel de pompage associé à des puits fouillés manuellement permet de gérer individuellement à la fois l'approvisionnement en eau et son utilisation ultérieure, requiert un investissement de départ plus faible par unité de surface irriguée et est peu affecté par les risques de crues. L'eau souterraine se situe à faible profondeur sur une bonne partie du territoire et il existe déjà un savoir-faire local en matière de fouille de puits, pour l'élevage principalement. Le coût de la fouille d'un puits, d'une pompe à essence et de tuyaux en PVC pour l'arrosage est de l'ordre de US\$ 2.500. Ces coûts sont rapidement amortis par des cultures rentables de banane, de haricot ou de légumes et condiments sur ces sols fertiles. Ce matériel mobile peut aussi être loué par les propriétaires à d'autres agriculteurs tel que cela se pratique couramment dans certaines parties de l'Artibonite.

Mécanisation des opérations de labour

Les producteurs de la région ont du faire face ces dix dernières années à une augmentation rapide du prix de la main d'oeuvre agricole découlant des mouvements migratoires vers les villes et la République Dominicaine. Le coût d'une journée de 7 heures de travail agricole, comme relaté les monographies par commune plus haut, se situe actuellement entre 5 et 6 dollars américains selon le lieu. Ce phénomène a conduit à une extension de la culture attelée dans la région, pratique autrefois inconnue, et à une forte demande pour les services de tracteurs et motoculteurs. Une partie de cette demande est satisfaite par des opérateurs dominicains dans les zones proches de la frontière mais l'offre de services de labour reste largement insuffisante sur le reste de la zone.

L'extension du labour mécanisé permettra surtout de mieux valoriser l'eau et de réduire le ruissellement dans les sols argileux lourds de plaine et de piedmont. Un labour plus profond permet en effet une meilleure infiltration des pluies pendant que l'enfouissement des herbes adventices limite leur repousse ultérieure et la concurrence pour l'eau avec les plantes cultivées. Le temps de travail est ainsi réduit en même temps que l'eau est retenue dans les sols et les rendements sont améliorés. Des sols qui ne

peuvent être travaillés manuellement, tel que les 7.000 hectares de la Savane Declé dans la commune de Fort-Liberté, pourront ainsi également être mis en valeur. Il ne s'agit pas nécessairement de mécaniser l'ensemble des opérations culturales, difficile avec des systèmes à cultures associées, mais de favoriser l'extension des opérations mécanisées de labour, essentielles pour la réussite des cultures, à l'aide de motoculteurs, tracteurs ou charrues à traction animale.

Maîtrise du ruissellement et valorisation des espaces de ravine en montagne

La régularisation du débit des rivières et la recharge de la nappe phréatique sont essentielles pour sécuriser la production agricole et industrielle et assurer par ailleurs les besoins en eau pour usage domestique d'une population croissante. Les caractéristiques du relief et de la pluviométrie dans les parties amont des bassins versants (fortes pentes et forte intensité des pluies) font que, même avec un couvert arboré important, les écoulements demeurent souvent violents. Ceci est confirmé par les chroniques de l'époque coloniale qui relatent des épisodes fréquents d'inondation dans la plaine malgré des surfaces boisées bien plus étendues qu'elles ne le sont actuellement.

Ainsi, avant de penser à limiter les écoulements en étendant les surfaces boisées, il est nécessaire de retenir autant que possible les eaux de ruissellement là où elles se concentrent en amont. Ceci peut se faire à travers une combinaison de seuils mécaniques et biologiques de freinage du ruissellement dans les ravines. L'expérience montre que ces ouvrages doivent être correctement conçus et exécutés pour garantir leur pérennité, en intégrant au besoin des seuils en maçonnerie dans la gamme des techniques employées.

Du point de vue des agriculteurs, par rapport à des aménagements sur les versants, l'aménagement de ravines présente l'avantage de créer rapidement des micro-milieus plus humides et fertiles où sont captées à la fois les eaux et les sédiments fins. Ces espaces peuvent alors être valorisés par la culture d'espèces annuelles, pluri-annuelles ou pérennes à forte valeur ajoutée (banane, canne de bouche, taro, igname, bambou...) qui augmentent leurs revenus. Cette végétalisation des ravines permet en retour de favoriser une meilleure infiltration de l'eau et de consolider les structures établies. Les eaux de ruissellement peuvent aussi être stockées pour satisfaire les besoins en eau du bétail en montagne et en plaine ou pour faciliter des plantations de petites surfaces de cultures rentables telles que les légumes et condiments. Des ouvrages de ce type ont déjà été construits par divers intervenants dans la zone.

Ceci n'exclut pas que parallèlement des interventions soient conduites afin d'étendre les surfaces en cultures pérennes ou pluri-annuelles sur les versants. Il convient cependant, comme pour les aménagements de ravines, de promouvoir des solutions qui combinent objectifs de conservation des sols et des eaux et intérêt économique des producteurs. La région bénéficie par exemple de conditions favorables dans le piedmont et la montagne pour la culture d'espèces de bois noble et de bois d'œuvre ordinaire (chêne, acajou, frêne, pin, laurier...). Ces espèces présentent des opportunités de revenu et d'emploi conséquents (sciage, menuiserie). Il conviendrait ainsi dans ce cas précis de pourvoir les agriculteurs en semences ou plantules sélectionnés pour leur architecture désirable.

Pour les fruits, il peut s'agir de diffuser des variétés d'avant et arrière-saison qui offrent des prix plus élevés sur le marché local (mangues et avocats principalement) ou encore de développer des circuits d'exportation pour des variétés de qualité autres que la mangue Francisque (telles que les mangues Baptiste et Jean-Marie spécifiques à la région). On peut aussi créer des conditions favorables à l'extension sur les versants de cultures telles que la canne pour la production de sirop (à Sainte Suzanne notamment), la banane ou le cacao en agissant sur les contraintes limitant la production, la transformation ou la commercialisation de ces produits. L'aménagement d'un réseau de routes de desserte approprié pour l'écoulement de produits volumineux et périssables est une des conditions de réussite de ce type d'intervention.

Mise en oeuvre et actions d'accompagnement

Durant les cinq prochaines années, il est prévu que des sommes conséquentes soient allouées au développement de la production agricole et à la protection de l'environnement dans les départements du Nord et du Nord-Est. On dénombre quatre projets d'envergure, totalisant plus de \$150.000.000, et qui toucheront différents domaines.

Les propositions et démarches d'intervention développées plus haut peuvent être intégrées dans un processus d'articulation des activités de ces projets. Les actions relatives à l'extension de l'irrigation par pompage et à la mécanisation rencontrent par ailleurs les options de financement définies par une des grandes banques commerciales qui vient d'initier un programme de crédit agricole dans la région. On peut donc envisager avec le GAFSP une collaboration dans le domaine de l'équipement des agriculteurs qui combine crédit commercial et subventions. Il faudra également développer les capacités de maniement et d'entretien du matériel. On peut mobiliser à cet effet différents types d'intervenants (instituts techniques tels que le Centre St. Barnabas à Terrier Rouge, propriétaires d'ateliers mécaniques, ONG spécialisées telles que le GRADES).

ANNEX 3: PROPOSED TRANSPORTATION PLAN

L'amélioration des transports aura un impact positif important sur la qualité de vie et la productivité de la région Nord de Haïti. Elle doit être à la base du plan de développement économique proposé par le Gouvernement Haïtien.

Le Nord constitue l'un des quatre pôles de croissance retenus par le gouvernement haïtien dans sa stratégie de développement économique (DSNCRP). Comme conçus par les autorités, ces grands espaces d'investissements, de par leurs effets d'entraînement, constitueront des engins de croissance pour le reste de l'économie. Dans cette perspective, quatre grands projets, à des phases différenciées de mise en oeuvre, auront des implications certaines sur la production des biens et services, la circulation des marchandises, et le financement des entreprises dans la région du nord. Il s'agit du Parc Industriel de Caracol (Département d'état Américain, BID, la firme coréenne SEA, et le gouvernement Haïtien), de l'Université Roi Henri 1er à Limonade (RD), du projet Tourisme de la BID, et du projet FTFCN de l'USAID. Les décideurs politiques haïtiens, et les institutions de financement internationales, engagés de manière concertée dans ces initiatives, anticipent déjà des mouvements de populations, de nouvelles formes d'occupation des sols, et l'émergence de nouvelles entreprises industrielles et commerciales, qui redéfiniront l'espace compris entre Cap-Haïtien et Ouanaminthe, identifié depuis tantôt comme « **Le Couloir Économique du Nord** ».

L'amélioration proposée ne repose pas uniquement sur le développement de grandes infrastructures. D'autres stratégies doivent être développées afin de construire un secteur durable qui puisse contribuer de manière importante au développement économique tout en limitant les externalités négatives. Le Plan proposé considère 5 programmes principaux :

- Un programme d'amélioration du système de transport en commun
- Un programme de renforcement du transport non motorisé
- Un programme de transport efficace des marchandises
- Un programme de sécurité routière complémentaire aux trois précédents
- Un programme d'infrastructures pour le désenclavement régional

Table 36 Les Programmes du Plan de Transport

Programme	Principaux projets
Transport en Commun	- Création d'entreprises - Capacité institutionnelle - Nouveaux véhicules - Nouveau modèle d'exploitation - Infrastructures
Transport non motorisé	- Support à l'industrie locale - Infrastructures (Trottoirs, voies cyclables) - Promotion de l'utilisation du vélo et la marche
Transport de marchandises	- Support aux entreprises privées - Nouveaux véhicules - Infrastructures logistiques
Sécurité routière	- Formation de conducteurs professionnels - Renforcement de l'autorité - Comportement, éducation

Amélioration du transport en commun

Eléments de Diagnostic	- Une forte activité régionale - Un système de petits entrepreneurs avec peu de capital - Un parc de véhicules anciens de basse capacité - Une forte croissance de la moto
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	- De nouveaux projets (parc industriel, université) qui demandent de nouveaux services - Absence de transport maritime régional
Objectif	Mettre en place un système de transport en commun fiable, performant, qui donne du confort et de l'accessibilité aux déplacements régionaux
Projets	 - Promotion d'entreprises coopératives ou privées qui gèrent l'exploitation de véhicules plus modernes et confortables - Mise en place d'une régulation économique qui protège les entreprises face au transport informel et qui soit en mesure de garantir une qualité à l'usager - Création d'un réseau de lignes de bus, à horaires et arrêts fixes qui desservira l'axe du nord, en particulier les nouveaux centres d'activité - Mise en place d'arrêts de bus et terminaux dans les principales communes - Exploration du transport maritime (Liaisons entre communes)
Localisation des infrastructures	 - Arrêts de bus sur la RN 6 chaque km. - Arrêts de bus dans les zones urbaines, chaque 500 m - Aménagement de terminus de transport dans chacune des communes de l'axe Nord - Terminaux maritimes à Fort Liberté, Caracol, Cap Haïtien
Besoins d'expertise	- Expertise institutionnelle - Expertise création et gestion d'entreprises de transport en commun - Expertise en définition et exploitation de lignes de transport - Expertise en design de terminus et arrêts - Expertise transport maritime
Le court terme	- Lignes « pilote » à bus de plus grande capacité entre Cap Haïtien et Limonade et Cap Haïtien et Trou du Nord - Lignes pilote à l'université de Limonade et le parc industriel de Caracol - Programme d'échange de tap-tap contre financement pour des bus à plus grande capacité

Transport non motorisé

Eléments de Diagnostic	 - La marche à pied et le vélo sont des modes importants de proximité - Le principal axe de transport, la RN 6 n'a pas de trottoirs, ni d'espace sûr pour les vélos - Dans la région il existe des fabricants et commerçants de vélo - C'est un mode économe, qui peut être utilisé comme mode local et intermédiaire
Objectif	Développer un système de transport régional qui donne la priorité au transport non motorisé, avec des interventions qui permettent des déplacements sûrs et confortables.

	
Projets 	- Promotion d'entreprises de fabrication de vélos déjà en place - Création de programmes de vélos en libre service dans les communes de Trou du Nord, Fort Liberté et Ferrier, comme mode intermédiaire, d'accès à la RN 6. - Construction de trottoirs et voie cyclable pendant 3 km à l'entrée des communes de l'axe Nord. - Programmes pour donner accès au vélo
Localisation des infrastructures	- Construction de trottoirs le long de la RN 6, à proximité des communes - Construction de voies cyclables dans les communes - Construction de stationnement pour vélo dans les terminus - Construction de stationnement pour les vélos en libre service
Besoins d'expertise	- Expertise en promotion de micros entreprises liées au vélo - Expertise gestion de vélo en libre service - Expertise infrastructures sûres pour les piétons et cyclistes
Le court terme	- Promotion du vélo - Infrastructures à l'entrée des communes - Vélo gratuits pour les parcours à Fort Liberté et Ferrier

Transport de marchandises

Eléments de Diagnostic 	- Les échanges de marchandises sont importants dans la région - Le marché de Ouanaminthe est un élément important de l'économie régionale - Les entreprises de transport sont peu développées - Il y a une forte présence de pick-up et camions de faible capacité - Les installations logistiques sont précaires
Objectif	- Développer un secteur du transport de marchandises efficace et moderne
Projets	- Modernisation des entreprises de transport - Révision d'aspects réglementaires - Modernisation de la flotte de camions et de leur capacité - Aménagement des marchés afin de les transformer en sites logistiques qui minimisent les impacts urbains et environnementaux
Localisation des infrastructures	- Construction de marché à Ouanaminthe, Cap Haïtien et Limonade - Amélioration de l'accès au port du Cap Haïtien
Besoins d'expertise	- Expertise création et amélioration de petites entreprises de transport de marchandises - Expertise design de sites logistiques
Le court terme	- Crédits pour l'acquisition de camions plus performants

	- Amélioration des marchés, en particulier celui de Ouanaminthe
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Sécurité routière

Eléments de Diagnostic 	- Haïti est l'un des seuls pays d'Amérique à ne pas reporter de statistiques d'accidentalité à l'Organisation Mondiale de la Santé (OMS) - Le parc de véhicules est ancien et peu fiable - Les vitesses de circulation sont importantes - Les infrastructures n'ont pas de signalisation - Les piétons et cyclistes sont très vulnérables - Le grand nombre de motos contribue à l'accidentalité
Objectif	Construire un système de transport régional durable qui considère la vie humaine comme sa priorité principale
Projets	- Révision de cadre juridique pour l'obtention des licences des conducteurs professionnels (mototaxi, tap-tap, bus, pick-up) - Formation périodique de ces conducteurs - Programme de signalisation routière - Programme d'infrastructures et éléments de protection pour les piétons et les cyclistes
Localisation des infrastructures	- Signalisation le long des principales voies de l'axe Nord - Infrastructures de protection pour les piétons et cyclistes
Besoins d'expertise	- Expertise en sécurité routière - Expertise en signalisation de voies interurbaines et à l'entrée des communes
Le court terme	- Formation des conducteurs professionnels - Signalisation

Infrastructures régionales

Eléments de Diagnostic 	- Le nord possède des infrastructures de transport qui permettent une connexion acceptable avec le reste du pays et les pays voisins, tenant compte des niveaux de demande actuels - Le port du Cap Haïtien opère en dessous de sa capacité - L'aéroport doit faire des améliorations en termes de sa capacité - Le réseau routier est aussi à un niveau acceptable - Divers projets supportés par l'Etat Haïtien et les banques multilatérales supportent des projets d'amélioration et entretien des grandes infrastructures
Objectifs	Poursuivre le développement d'un réseau intermodal qui permette une bonne connexion de la région nord aux marchés locaux et internationaux
Projets	- Amélioration du port de Cap Haïtien - Plan d'entretien du réseau routier RN3, RN 6 - Plan d'amélioration des voies secondaires et tertiaires donnant accès aux zones agricoles - Amélioration de l'aéroport du Cap Haïtien
Localisation des infrastructures	- Port et aéroport du Cap Haïtien - Voies d'accès au port - Voies d'accès aux zones agricoles dans les communes de Terrier Rouge, Sainte Suzanne, Trou du Nord, Fort Liberté

	et Ferrier, entre autres
Besoins d'expertise	- Expertise en ports - Expertise en aéroport - Expertise en gestion de l'entretien routier
Le court terme	- Projet d'expansion de l'aéroport - Accès au Port - Amélioration de routes secondaires et tertiaires

ANNEX 4: FLOOD AND STORMWATER MANAGEMENT RECOMMENDATIONS

Due to the nature of the regional topography, soils, surface and groundwater conditions, flooding has been a historic problem in the North/Northeast region. Natural flooding will only increase as vegetation is removed and development occurs. Providing planned areas for flooding, protecting existing vegetation, reforesting denuded areas, limiting the construction of impervious surfaces, and sustainable stormwater management strategies are critical components to maintaining the water balance.

Recommendations for Stormwater and Flooding mitigation include:

1. Establish Flood Zones
2. Manage stormwater at the source
3. Control erosion, protect existing vegetation and revegetate
4. Provide offline water storage for irrigation or domestic use

Establish Flood Zones

Flooding has historically been and will continue to be an issue in the region, but by planning for areas that are intentional floodplains, risks to communities can be reduced and the water balance can be maintained. There are many examples of growth in the region that has taken place in unsuitable areas, such as floodplains. Designating no-growth areas within floodplains and stream buffers allows for the protection of these valuable natural areas that provide important environmental services, such as reducing stormwater flow rates, providing aquifer recharge, and mitigating damage to nearby properties.

In order to determine optimal flood zones, more precise elevation data must be obtained. Currently, twenty meter elevation data is available. Because the majority of the region is so flat, the data is insufficient for mapping purposes. Once better data is obtained, flood zones should be mapped in more detail and development should not occur in these areas.

Manage Stormwater at the Source

Stormwater management should be integrated into the urban green network of town centers. For increased water quality benefits, it is recommended that stormwater be managed in vegetated systems whenever possible. Such systems may include grass/vegetated swales, rain gardens or tree trenches with native vegetation. Beyond providing stormwater management and water quality benefits, these vegetated systems provide beautification to the harsh hardscape typical of town centers.

Household

Rainwater harvesting at the household level significantly reduces the amount of stormwater generated on the property. Roof runoff can be captured and reused, providing a benefit to residents, reducing pressure on groundwater extraction, and maintaining water at the source.

Roadways

Runoff from roadways should be managed in vegetated swales alongside of the road, between vehicular travel lanes and sidewalks, or beneath the sidewalks themselves. The type of stormwater treatment will depend on available space. In urban settings where building footprints come up to the street, stormwater can be managed in subsurface stone beds, as opposed to vegetated systems on the surface. Swales constructed between sidewalks and vehicular travel lanes double as a stormwater management feature and a safety barrier for both pedestrians and motorists.

Green Street Project

A “Green Street” project could be implemented that incorporates the need for pedestrian and motorist safety and sustainable stormwater management anywhere that an existing street needs improvement or a new street is planned. It would be most beneficial to locate this project in an area with trash collection practices already in place to protect the functioning of the stormwater system.

Plaza/Community Center in Trou du Nord – There is an existing plaza near the bridge crossing the Trou du Nord River that is in need of improvements. Currently, a new community center is being constructed adjacent to the plaza. Both of these areas are opportunities for projects that demonstrate green stormwater management, rainwater capture and reuse, and flood prevention.

Example: New Housing Developments – When relocating residences from Flood Zones to reduce vulnerability and where new housing projects are planned, rainwater harvesting, onsite wastewater, and green stormwater management techniques should be incorporated into the site design. These housing sites can serve as demonstration projects to educate communities on low-tech, low-cost ways to have access to potable water, protect public health with sewage treatment, and recharge groundwater. The sites for these residential projects should take into account access to other public amenities, such as roads and schools, as well as sensitive environmental resources.

Example: St. Suzanne – The clearing of vegetated slopes has led to severe erosion of hillsides and increases downstream flooding issues. Reforestation and erosion control efforts should be implemented that include income generating crops (alternative fuel sources is an option), as well contour or terrace farming.

Recommended street designs include:

Figure 38 Drawing of Mountain Road Section

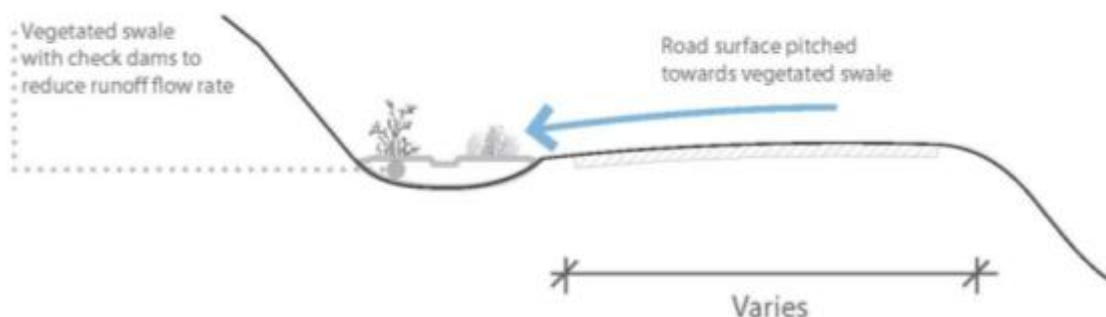


Figure 39 Drawing of Highway Section

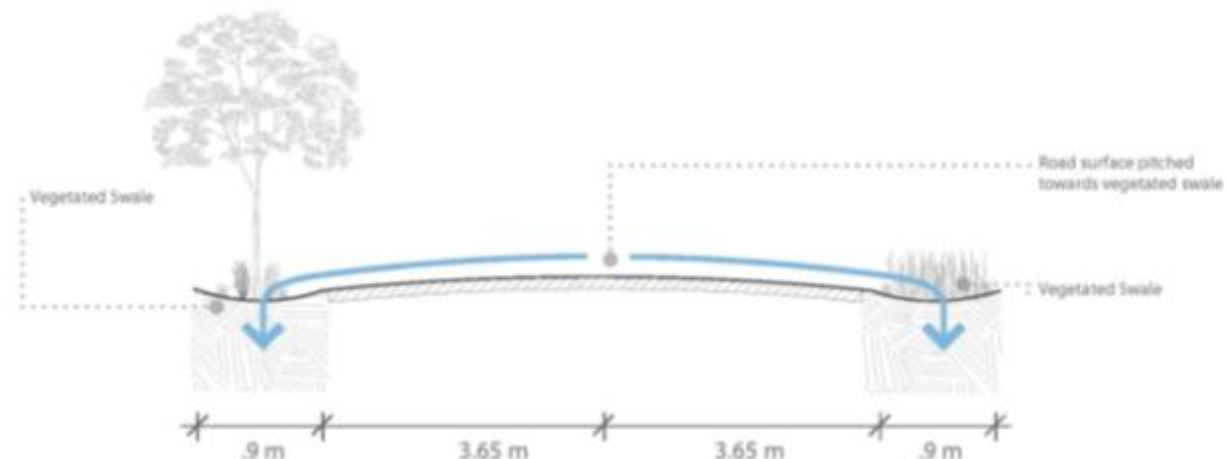


Figure 40 Drawing of Town Gateway Section

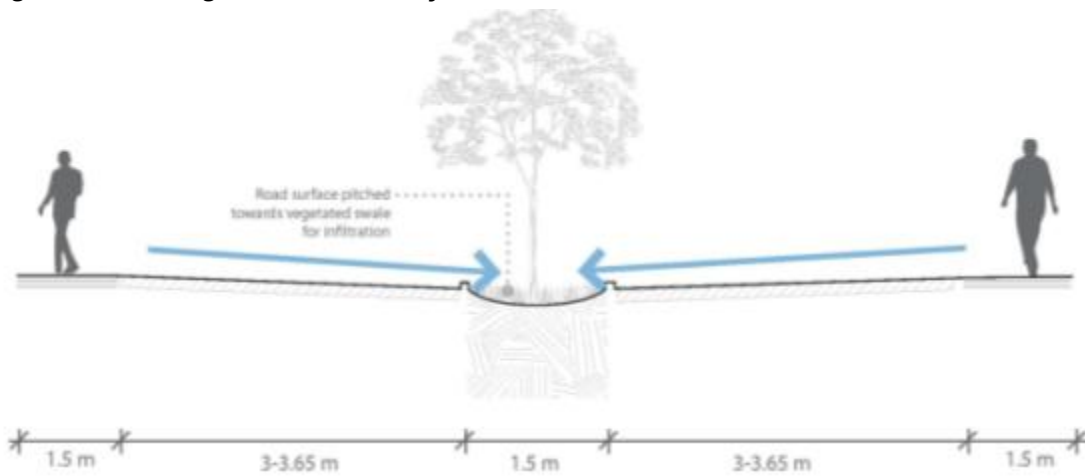


Figure 41 Drawing of Urban Street Section

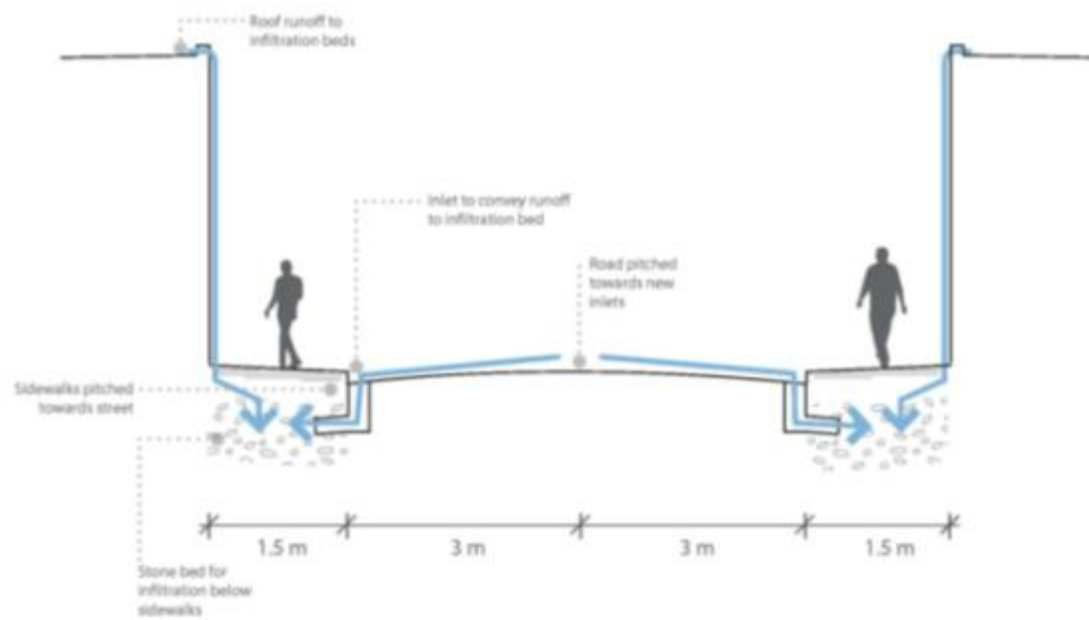
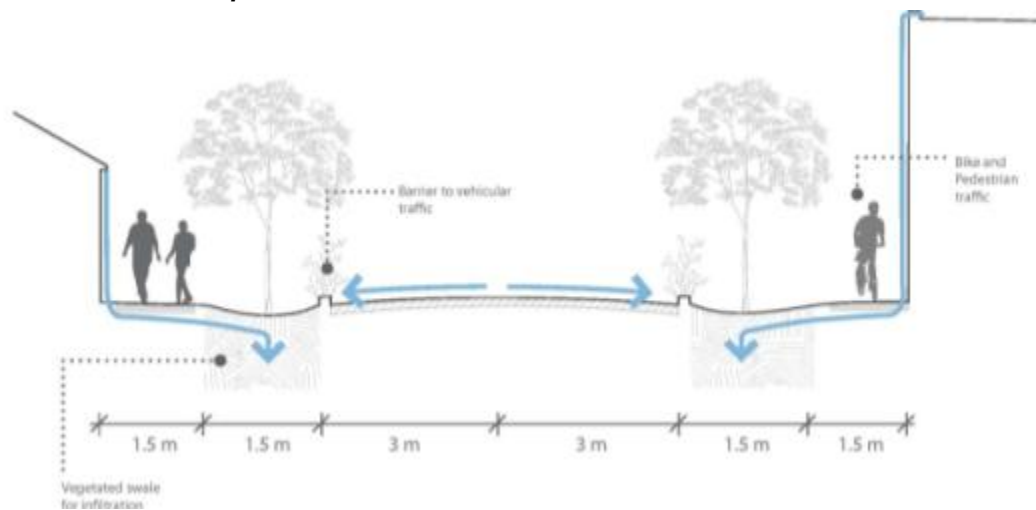


Figure 42 New Development Street Section



Control erosion, protect existing vegetation and revegetate

Erosion from steep hillsides with little or no vegetation causes sedimentation to occur in waterways, which affects the stream health and can also reduce the potential uses of this water source for human uses. Restoring water quality through the reduction of erosion and sedimentation is critical to protecting the environment and human health.

- Plant along the contours / terrace farming
- Agroforestry
- Reforestation
- Limit deforestation
- Limit construction on steep slopes

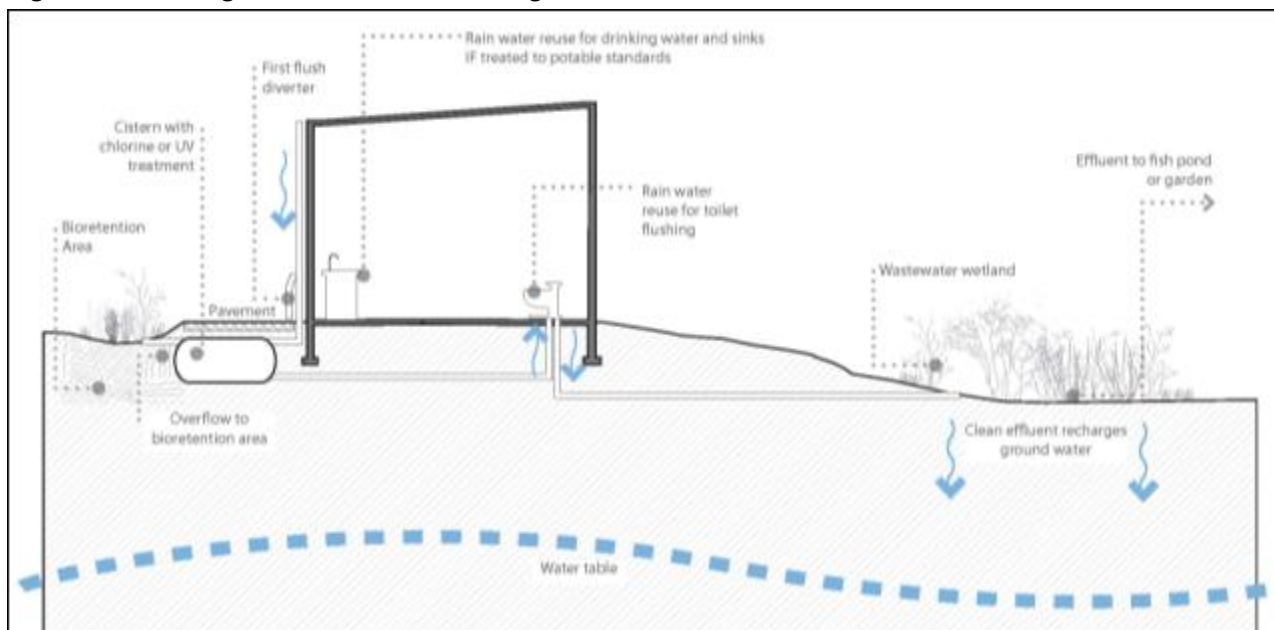
Offline water storage for irrigation and domestic use

Irrigation needs exist throughout the region to support local agriculture, especially during the dry seasons. During times of heavy flow, water can be diverted from rivers and streams into small, offline storage reservoirs to be used by local farmers for irrigation or by households for non-potable uses. These systems should be sized according to local irrigation needs and should not extract a large quantity of water that would disrupt the flow required of downstream communities and aquatic habitats.

Example: A water reservoir above Quartier Morin along the Grande Rivere du Nord was lost when the dam that created it failed several years ago. Farming production has decreased as a result, and the community has lost a valuable water source. Rather than replacing the dam within the river, offline reservoirs that divert only a portion of the river flow into small reservoirs should be considered. These reservoirs will provide water for agricultural irrigation and a supplementary domestic water supply, as well as remove a portion of stream flows contributing to flooding, without completely altering the stream ecosystem. All water reservoirs should have vegetated buffers and be fenced in to reduce the risk of contamination from grazing livestock.

Example: New Caracol School Site – Incorporate rainwater harvesting, onsite wastewater, and low-impact development (maintain existing vegetation where possible, avoid excessive grading and land disturbance) into school development plans.

Figure 43 Drawing of On-Site Water Management



ANNEX 5: WATER SUPPLY RECOMMENDATIONS

Implementing Local Rainwater Harvesting (RWH) Systems

RWH has been utilized for non-potable and potable water consumption for centuries all the world, but has seen a resurgence in developing countries in the Middle East, Asia, Africa, and South America in the last twenty-five years. This is in large because of the failures of existing piping systems due to operational and maintenance constraints, ground and surface water contamination, higher demand due to population growth, and an increase in impervious roofing materials (Fewkes, 2006). The Caribbean Environmental Health Institute (CEHI), in collaboration with the Global Water Partnership (GWP), developed the Toolbox: Rainwater Harvesting in the Caribbean²⁷ as an ongoing program to promote and develop RWH. There is also an accompanying RWH Handbook.²⁸ Much of their research and documentation is also applicable to RWH in the North/Northeast region of Haiti, and should be used as a resource when developing the RWH program.

The Handbook provides an excellent resource to the basic components of RWH, maintenance guidelines, water quality considerations, cost, and non-domestic RWH applications (CEHI, 2009).

According to a CEHI presentation (2011), in order for proper execution of a successful RWH program, several non-design components must be considered:

- Public education and outreach is essential. Residents should be surveyed to assess their current knowledge and gauge interest in RWH. Programs, training, and implementation can begin from there. (Peters & Mandeville)
- Training for plumbers, architects, and contractors should be provided to promote the design and development of RWH systems.
- RWH must be integrated into policy documents, building codes, master plans, etc.

Availability. At the local level, Rainwater Harvesting (RWH) can provide a significant source of non-potable water for individual households and communities. The availability of water varies seasonally because Haiti has two rainy and two dry seasons, but the overall annual rainfall of 1,000 to 1,500 mm per year, with higher levels in Trou du Nord provides opportunity for catchment a re-use. The roof of an average residence is approximately 45 square meters, which could potentially provide up to 67,500 liters per year for non-potable uses such as clothes washing, toilet flushing, and local irrigation. With additional household treatment, such as boiling, chlorination, and UV filtration this may be considered for potable use as well. However, total yearly rainfall capture is likely infeasible due to the precipitation patterns during wet and dry seasons. During the wet season, some overflow of the RWH system may occur, and conversely, the storage facility may not be large enough for residents to use during the entire dry season.

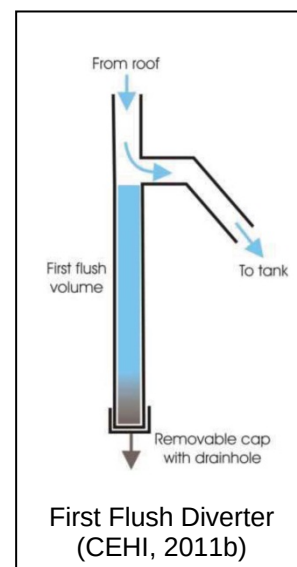
To most accurately size RWH systems, rainfall data should also be collected early on in the development of the RWH program, in several locations across the region. While there are simpler methods for sizing RWH storage facilities (CEHI, 2009), the more accurate the data is, the more accurately the storage system can be sized. Sizing of the RWH storage component is essential to several important factors such as volume of water stored, installation costs, and water quality, both in terms of retention time and frequency of system overflow (Fewkes, 2006).

Water Quality. Water quality can be a big concern with RWH, especially when considering potable uses. In RWH systems, pollution typically comes from both wet and dry atmospheric deposition, chemical and/or physical reactions of rainwater with the collection system (roof, piping, storage tank material, etc.), and also from animal feces (Fewkes, 2006). Depending on the extraction method, contamination via human interaction with the storage tank is also possible.

27 RWH Toolbox is available at <http://www.cehi.org.lc/Rain/Rainwater%20Harvesting%20Toolbox>

28 http://www.cehi.org.lc/Rain/Rainwater%20Harvesting%20Toolbox/Media/Print/RWH_handbook.pdf

To address the wet and dry atmospheric deposition, RWH designs should include at a minimum a first-flush diverter. There are several configurations of this, but these are typically vertical pipes or tubes which fill up, trapping the roof debris and pollutants which typically are carried from water at the beginning of a storm event, before then allowing the cleaner water to bypass this pipe to enter the storage chamber (CEHI, 2009). Below is an example of a simple first-flush diverter (CEHI, 2011b).



Animal fecal and other organic contaminants greatly increase the risk of bacterial contamination, which can be especially harmful when considering potable water use. The World Health Organization (WHO) guidelines state that for potable use, the bacterial count in water for *E. Coli*, *Enterococci* and *Clostridium* should be less than one one-hundredth (1/100) milliliters, expressed in coliform-forming units (CFUs) (CEHI, 2011a). CEHI surveyed residents in several Caribbean countries on their current treatment practices for RWH, and up to ten percent (10%) of survey takers reported that they did not treat their collected water, even though all of the water tested contained bacteria levels over the WHO limit for safe drinking water (CEHI, 2011a). RWH designs should include, whenever possible, in-tank treatment systems such as chlorination and UV filtration, especially if water may be considered for potable use.

General maintenance, including periodic inspection and removal of large and small particulates and general upkeep of filtration methods, will also increase the quality as well as the quantity of water (CEHI, 2011a).

General public education, specific job training, and regulatory shifts are necessary before implementing a RWH program at the residential, community, or municipal level. The availability of water is vital to the design, specifically in regards to sizing and filtration methods. Rainfall data should be collected as early in the design as possible for accurate sizing. Filtration devices such as first flush diverters, and treatment (i.e. chlorination, UV filtration) for bacterial contamination should be included in the design. Maintenance should also be considered in both educational and design components, as it too will affect the long-term quality and quantity of the collected water.

Example: Rainwater Capture and Reuse in areas with Saline Wells – Areas with wells already contaminated with salt have a great need for alternative water supply sources. These areas should be prioritized as areas to demonstrate rainwater collection from roofs into storage cisterns or tanks for domestic use. Alternative well locations may still be planned and necessary, but private rainwater collection provides water security and resiliency at a low-cost.

Practices and policies for local well installation and data tracking (to prevent aquifer contamination)

Given the current lack of adequate sanitation and frequent poor construction techniques, it is critical that all wells be properly installed and located to both assure that the system provides potable water, and to prevent groundwater contamination from surface water or fecal matter. Local wells that are improperly installed can serve as a “conduit” of contamination to the aquifer. The installation of such wells should be tracked and regulated by DINEPA, with installations standards developed and enforced. (we should see if DINEPA has any standards or any tracking of well data. If not, maybe there are some Caribbean standards we could reference? It would also be good to cite a Caribbean standard for well construction).

ANNEX 6: SANITATION AND WASTEWATER RECOMMENDATIONS

Recharging the groundwater aquifer through both treated wastewater and stormwater/floodwaters

There are a number of techniques that can both address other water infrastructure needs and also safely recharge the aquifer to maintain potable water needs and prevent saline intrusion. In all of these techniques, it is important that the intentional recharge waters be done in such a way as to prevent aquifer contamination. The recharge options can include:

1. Reuse of Treated Wastewater for Irrigation Needs
2. Land application of Treated Wastewater (and avoidance of stream discharges)
3. Protection of floodplains and defined areas of intentional flooding for aquifer recharge
4. Treatment and infiltration of separated stormwater flows in urban areas.

Wastewater Treatment

Wastewater, when properly treated, is an important resource for groundwater recharge. Whenever possible, treated wastewater (or effluent) should be infiltrated. In order to ensure that water quality is not compromised, all wastewater systems must be separate from water supply systems. Strategies for wastewater treatment have been developed for three different population densities ranging from rural individual dwellings, to large regional systems treating wastewater and sludge for thousands of people.

Rural/Household Systems

The most cost effective and ecological means of handling human waste in a rural setting with shallow groundwater is the dry composting latrine. Dry composting latrines are elevated structures which contain two concrete pits at the ground surface. The pits are prepared with a mixture of soil and lime before use. These pits are used one at a time, rotating every few months. The ecological toilet separates urine from feces. The urine is discharged into the ground, and the feces are collected into the active pit. Soil is placed into the latrine pit after each use, and a cup of lime is added several times a week. After several months of use, the composted waste can be removed from the pit, and used as a soil amendment for crops that are not directly consumed by humans. Dry composting latrines have been used in Central America, Mexico, South Africa, Vietnam, and China (Dry Ecological Latrine, and Redlinger et al. 2000).

Community Systems

For community systems, such as churches, schools, and small clusters of houses, septic tanks with wetland treatment systems are recommended. Primary treatment is performed by the septic tanks which act to remove large solids and a fraction of the suspended solids. The overflow water is conveyed into a small scale horizontal flow wetland system. The wetland consists of a bed of stone on which reeds are planted. The stone acts as a trickling filter, with a film of facultative microorganisms that develop around the surface area of the stone. Microbial degradation of organics, combined with the filtering/settling of suspended solids are the primary pathways for water quality improvement. Nutrient removal occurs through de-nitrification in the anoxic conditions that exist in the bottom of the wetlands. The result is a high quality effluent that can be discharged into the ground through a drainfield to replenish the groundwater supply (Vymazal 2010). Horizontal flow wetland systems have been used around the world in places like the United States, India, China, Australia, Mexico, Germany, and Canada with success in treating both municipal and industrial wastes.

Another treatment option utilizing a septic tank as primary treatment conveys the overflow water into a stone infiltration trench below ground. An inverted siphon is used to ensure that minimal amounts of gross solids are allowed to enter the infiltration trench. As the infiltration trench is below ground, and requires infiltration into the subsurface, this option requires a groundwater depth of greater than 3 meters. The infiltration trench acts, similarly to the horizontal flow wetland, as a trickling filter with organics removed via microbial degradation and suspended solids filtered/settled through the stone media. The advantage of this system is that the effluent is directly discharged into the ground to replenish the aquifer

without the necessity of a drainfield. In both wetland and trench systems, periodic maintenance will reduce the likelihood of failure.

A final strategy for the treatment of wastewater from small communities is the purchase of a small package wastewater treatment plant. Package plants require a range of energy input (minimal to high), maintenance and monitoring, but yield a very high quality effluent that can be discharged directly into the ground. Package plants use a variety of design processes, such as return activated sludge, sequencing batch reactors, upflow anaerobic sludge blanket (UASB) digestion, and trickling filters.

The suggested method for sludge removal for all systems is air drying. Air drying effectively treats sewage sludge with 0.5 to 4.0 log removal of bacteria, viruses, and parasites (USEPA 2003). The sludge is removed from the collection device and spread evenly over a shallow depth above the top of a sand bed or a paved basin. The sludge must dry for a minimum of 3 months, after which the result is USEPA rated Class B biosolids, which are suitable as a soil amendment for crops that are not intended for direct human consumption. Care should be taken to extensively dry the sludge as there are resilient species of helminth ova that may remain (USEPA 2003).

Example: Wastewater Management in Quartier Morin – A community-level wastewater treatment system, such as a wastewater wetland or a floating wetland system, could be developed for Quartier Morin where there were numerous cholera deaths due to the use of drainage ditches for sewage disposal and as a water supply source. Rainwater harvesting at the existing residences could also be implemented to provide a supplementary water supply. All systems should be low/no energy, low-tech, and maintainable by the local community.

Regional Systems

Waste stabilization ponds (WSPs) are the suggested method for treating the waste generated by a larger regional group of several thousand. WSPs have been used in Mediterranean France, Spain, and Portugal, as well as in the United States, the Middle East, Africa, Asia and Latin America (Ramadan and Ponce 2003). WSPs have many process designs but often consist of a settling pond for solids removal, followed by an anaerobic pond, a facultative pond, and a maturation pond. WSPs produce a high quality effluent with high pathogen reduction due to the long hydraulic detention time (Parkison and Taylor 2003). WSPs require a large land area but no energy input if the waste can be delivered to the system by gravity. Water exiting the ponds can be returned to the groundwater aquifer. The recommended sludge treatment is air drying.

The maturation ponds can be used to support aquaculture such as the raising of fish such as tilapia (Parkison and Taylor 2003). Tilapia are larvivorous fish that help to control mosquito vectors (WHO 2010). An excellent example of the implementation of aquaculture with a WSP treatment system is in Mirzapur, Bangladesh. The system was constructed in 1989 to provide treatment for the waste produced by several thousand people. The system consists of an anaerobic pond, followed by a meandering plug flow lagoon. Duckweed is grown on the lagoon, which is then harvested and used to feed three neighboring fish ponds. Removal efficiencies BOD₅, nutrients, and fecal coliform average 74 to 99.9 percent. The revenue from the fish production has produced revenues of nearly US\$3,000/ha/year. (UNEP 2000)

Example: Urban Zone Wastewater Treatment Plant – In order to have clean, potable water supplies, wastewater treatment is absolutely essential. All areas within the study area are in great need of sanitary sewage treatment. In more rural areas, onsite, community systems, such as wastewater wetlands can and should be implemented, but in urban areas, the density of development makes these practices less feasible. In existing urban areas, centralized wastewater treatment plants may be a necessity, and these treatment facilities should be a priority for improving public health. One town could be selected as a demonstration project to showcase the benefits of proper sewage treatment, but all urban areas are in need of wastewater treatment. The careful disposal of treated wastewater may serve to supplement groundwater withdrawals and should be managed locally to “balance” the groundwater extraction.

ANNEX 7: SOLID WASTE RECOMMENDATIONS

The ministries of the Haitian government are developing a number of solutions to address the infrastructure deficit in northern Haiti. The National Plan for Solid Waste Management is underway to provide policy improvements, as well as a comprehensive network of engineered landfills throughout the country, including the two in the North and Northeast departments. The solid waste problem is too vast to be dealt with on a local level, however, and the Departments will benefit from a national and regional strategy with common facilities and customized solutions that take into account the population size and geographic challenges of each community. In addition, approaching the problem as an opportunity to address the components of the waste stream by

Two landfills are planned by the federal government at the East and West sides of the study area in Limonade and Ouanaminthe. If the national government allocates the resources to construct and maintain these landfills, this will be of enormous benefit to the future health and growth of these Departments. This plan would be a tremendous advancement as there are currently no legal landfills in the North and Northeast Departments. To address the needs of the diverse cities and communes of this region, and to prepare for the additional pressure the construction of the industrial park and population growth will place on its natural resources, a regional solid waste strategy should create differentiated solutions for small, medium and large communities, as well as those located in remote areas. Distance and time of travel, given road conditions and fuel costs, may be too great for communities in between to benefit from these facilities to the east and west. At least one more landfill facility will be needed to adequately serve the communities.

A regional approach to the problem of solid waste will allow both large and small communities to pool their resources, and potentially raise the funds needed for ongoing maintenance and operations costs. While major urban areas like Cap-Haïtien may demand large facilities, smaller communities may benefit from transfer stations to account for less frequent garbage pickups. In more remote areas, strategies are needed that prioritize reducing the waste stream by handling waste on-site. Backyard composting, for example, could take up as little as three cubic feet of a yard while enriching the soils to increase the fertility of farmland and gardens.

National solid waste management policy anticipates incentivizing a new private industrial sector for solid waste management to help the public sectors achieve its goals. Increased support for the nascent recycling initiatives in the area should target reuse for plastic waste, and providing communities or individuals with a financial incentive to separate them from other household waste. A more professionalized, trained cadre of personnel could ensure smooth functioning of these new enterprises and create a pool of qualified applicants to promote the proper implementation of local solid waste plans. They can also serve as spokespeople for the many benefits of keeping plastic, textiles, food and even hazardous wastes out of the area's streams and rivers. Cleaning up the region will be a long-term endeavor, but will ultimately improve the health of its people and environment, and will give citizens of these historic communities a more dignified place to live their lives.

3.1 Policy

- Adopt the Politique Nationale de Gestion des Dechet Solides (PNGDS)

- Allocate budget for national departments (MTPTE, MDE, DINEPA, MARDNR) to implement the National Plan for Solid Waste Management, which includes comprehensive national standards, plans and facilities for solid waste management.

- Provide baseline funding for solid waste planning on a commune level

- Create a funding mechanism for construction and management to implement solid waste plans (For example, \$1 per ton fee for disposal assessed to commune or municipality)

- Hire trained personnel capable of implementing the plans

- Budget for regular and long-range management of solid waste facilities and equipment

3.2 Public Education

- Start a program of teaching environmental stewardship in primary schools

- Create a trade school for learning skills to be applied to municipal and solid waste management

Develop mini-apprenticeship programs where the trained person can return to Haiti and apply their experience
Develop a campaign with women's groups and other community associations about the effects of uncontrolled dumping.
Prior to each rainy season, educate communities about the link between dumping near waterways and the risks of flooding and disease

3.3 Financing

Implement all previous recommendations to improve tourism prospects for Haiti
Implement previous recommendations to make Haiti more attractive to the world business community
Create clean, safe healthy communities to attract highly skilled residents, and build a better employment base
Capture resources that are currently wasted by instituting a recycling program for plastics, metals and other reusable materials
Where the production is great enough, develop a renewable energy source by capturing methane from newly built landfills
Create new economic opportunities to improve the tax base and local governments' ability to invest in infrastructure.

3.4 Environmental Protection and Health: Landfills, Composting & Recycling Strategies

Although collection and dumping are already occurring in communities like Cap-Haïtien and Limonade, the dump sites fail to meet the minimum standards for health, safety and environmental protection. Until properly funded and staffed landfills are constructed, collection of waste is just removing the problem, and perhaps creating greater environmental damage in another location. This is of particular importance in this region, where the large aquifer is anticipated to be the engine for future population and industrial growth.

Once contamination of the groundwater occurs, its value drops tremendously for the region's population. Because groundwater lies close to the surface, facilities must be carefully lined and engineered to prevent leachate from entering the water system. Below is a basic diagram of the structural layers of a landfill and their purpose. It is difficult to find the high and dry ground in this study that is most appropriate for a sanitary landfill. Protecting groundwater and surface water supplies will therefore depend on the quality of the protective clay layer, the plastic or geotextile liner and the leachate collection and treatment system. Regular maintenance by trained personnel is also crucial.

Careful site selection of all solid waste management sites including landfills, transfer stations, compost sites, and land application sites should avoid unstable soils, fault lines, water supplies, surface water and wetlands. Landfill siting criteria are described in greater detail in the section below. Because landfills are liable to attract pests and birds, they are also inappropriate neighbors for residential areas, and for facilities like airports that could be harmed by the excessive presence of wildlife.

Given the limited resources available at this time, however, there are multiple options to manage waste and monitor or reduce the waste stream, however, which can be implemented without the construction of a full landfill. Below are a few suggestions of how to more effectively manage waste and its effects on the environment, by not only traditional landfills, but also composting and recycling.

Develop an animal feeding program by separating organic waste from first-phase composting
Enforce the No-Build and aquifer protection zones at the municipal level
Reduce density of informal settlements to allow for effective pickup and transport of solid waste
Create a training program, like an agriculture extension program, about how to conduct back yard composting and the benefits for home gardens and small scale agriculture
Establish recycling collection areas at an accessible area in each municipality
Train youth or trade school students to test water quality and develop an education program based on the results of testing

Develop a constituency for proper waste disposal by assessing impact of dumping near rivers. Conduct water quality testing near an existing dumpsite and at a control sites upstream and share the results with communities and local officials.

3.4.1 Proper Landfill Siting

In order to protect a region's ecological resources, it's important to know certain characteristics of potential landfill sites. Soil type, slope, vulnerability to flooding and water table, as well as potential for seismic activity should all factor in to site selection. The population projections prepared as a part of this study also help predict the total demand for landfill space in the region, and where the greatest need will occur. Additional waste disposal sites will be needed and the combination of human need, available transportation and infrastructure and environmental constraints will help determine where additional waste collection and landfill sites would be most appropriate. If landfills can be located in the areas with greatest demand, they can generate fees from local governments and individual users that offset the cost of construction and maintenance as well.

There are six (6) general siting criteria required by the United States Environmental Protection Agency (USEPA) for the placement of Municipal Solid Waste (MSW) Landfills. These criteria provide a helpful guide for Northern Haiti as well as the region seeks to accommodate growth while protecting human health and the environment.

1. Floodplains

Solid waste disposal sites located in 100-year floodplains cannot restrict the flow of the 100-year flood, reduce the temporary water storage capacity of the floodplain, or allow the washout of solid waste.

2. Wetlands

Owners/operators of new or expanding municipal landfills may not build or expand in wetlands. However, states or tribes with EPA-approved permitting programs can make exceptions for units able to show:

- No siting alternative is available.
- Construction and operation will not (1) violate applicable state regulations on water quality or toxic effluent; (2) jeopardize any endangered or threatened species or critical habitats; or (3) violate protection of a marine sanctuary.
- The unit will not cause or contribute to significant degradation of wetlands.
- Steps have been taken to achieve no net loss of wetlands by avoiding effects where possible, minimizing unavoidable impacts, or making proper compensation such as restoring damaged or creating man-made wetlands.

3. Fault areas

New solid waste landfills or lateral expansions are generally prohibited within 200 feet of fault areas that have shifted since the last Ice Age, with some mitigating conditions.

4. Seismic impact zones

When a new or laterally expanding landfill is located in a seismic impact zone, its containment structures (liners, leachate collection systems, surface-water control systems) must be designed to resist the effects of ground motion due to earthquakes.

5. Airports

The owner/operator of a municipal landfill located within 10,000 feet of the end of any airport runway used by turbojet aircraft, or within 5,000 feet of any airport runway used only by piston type aircraft, must demonstrate that the unit does not pose a bird hazard. If an owner/operator plans to build a new landfill or laterally expand an existing landfill within 5 miles of any airport, the airport and the Federal Aviation Administration must be notified.²⁹

29 U.S. Environmental Protection Agency. *MSW Landfill Criteria Technical Manual*. 1993. Accessible on EPA website at <http://www.epa.gov/osw/nonhaz/municipal/landfill/techman/index.htm>

3.4.2 Composting

There are a variety of composting strategies available to reduce the total waste stream. Backyard composting, for example, can serve multiple purposes and is an especially useful for more rural areas. Its main advantage is reducing the volume of waste during long intervals between pickups. Collecting food scraps to feed family livestock reduces the volume of waste almost immediately.

For true composting that can be used to create new, fertile soil for gardening, the process can be as simple as constructing a small structure to hold food scraps and leaf litter. A compost bin such as the one shown above may be built of wooden shipping pallets if available, or the traditional woven wood construction method common in this region of Haiti. Maintenance is as simple as loading vegetable and fruit food scraps into the pile at the end of a meal, covering them with soil, and turning the pile on a regular basis. Temperatures inside the bin will be high, so this is a job for an adult in the family. To create soil at a faster rate, a second or even third bin of the same dimensions can be added where the mature compost is moved to speed up decomposition.³⁰

At a larger scale, this same strategy may be employed in a marketplace to improve sanitary conditions and prevent the spread of disease caused by rotting food and the droppings of animals feeding on this waste. Multiple pallet construction bins are one way to achieve this goal. The construction method illustrated at right represents a sturdier composting structure that provides greater aeration for the faster the decomposition of organic materials. Sharing bags of composted soil with vendors is a potential incentive to compost, as the rich soil is an asset for those who grow their own crops. In the market setting, vendors can prevent rodents from feeding on the waste by creating a floor and a latched cover to these compost bins.³¹

3.4.3 Community Recycling Program

The following is for guidance information only. Each commune or municipality should closely examine all the materials that are being generated and landfilled in its specific area and begin to look at those materials that can be recycled. During our site visit to Haiti, plastic was the most frequently visible and discussed portion of the non-organic waste stream, and so it is in plastics that recycling might provide the greatest opportunities.

Materials a community can collect in a residential recycling program:

- Plastic Bottles
- Corrugated Boxes
- Used Motor Oil
- Aluminum Cans
- Newspapers
- Scrap Tires
- Steel Cans
- Batteries
- Large appliances

Communities establishing a household pick-up recycling program would need to provide at the very minimum a reusable metal or plastic bin for each household to collect recyclables. It may be more practical in most of the communities in this corridor to establish a drop-off recycling program instead. The designated site will need to look at some type of trailer or similar drop-off collection system. The general rule of thumb is to have one drop-off location per every 3,000 to 3,500 people. Participation and public education are the key to any of these programs' success.

Equipment Needed to Operate a Community Recycling Program. Communities that choose to operate a community owned recycling facility rather than sell materials to a private recycling facility will need to invest in some of the following processing equipment.

- Vertical/Horizontal Baler
- Fork Lift
- Floor Jack
- Can Sorter
- Skid Steer Loader

30 Cornell Waste Management Institute, Cornell Cooperative Extension. *Designs for Composting Systems*. <http://cwmi.css.cornell.edu/designscompostingsystems.pdf> . Accessed 6/20/2012.

31 Ibid.

A building to process and store collected materials will be critical to the success of the operation.

Financial Management of Recycling Programs

State or federal grants, consumer incentives and investment in a commercial recycling operation are all potential ways to make recycling a stronger component of the waste management system. Grants can help communes, or even departments, establish a curbside or drop-off recycling program, purchase equipment for processing recyclable materials, establish scrap tire and large appliance collection programs and develop a recycling education program. Grants can even improve the professionalism of a recycling operations by providing part or all of the salary of an environmental enforcement officer.

“Bottle bills” represent a legislative strategy with a dual strategy aimed at reducing the waste stream. For consumers, they provide a financial incentive to recycle plastic bottles in the form of a refundable deposit, a similar method to that historically used with glass bottles. Secondly, these bills put the responsibility to appropriately reuse or dispose of packaging waste on producers and consumers. Bottle bills are in place internationally have proven a successful method to promote reuse and even fund environmental programs with uncollected deposits. Perhaps the nearby program operated in Barbados, which provides a \$0.20 refundable deposit for glass and a \$0.10 deposit for plastic containers, might serve as a model in the event this legislative strategy is selected.³² Alternatively, the private recycling programs being discussed in the area could create a greater market for recycled materials than the one that currently exists.

Participant Education on Recycling

Education is the key to a successful recycling program in any community. The more you can educate, the higher the participation you will have, the less contaminants you'll find in the collected materials, the fewer complaints you'll receive, and the more efficient your program will be in the long run. In addition, recycling participation can be greatly increased by the addition of a Pay-As-You-Throw variable rate solid waste program for the residents.³³

32 Container Recycling Institute. *Bottle Bill Resource Guide*. <http://www.bottlebill.org/about/whatis.htm>, accessed 6/17/2012.

33 MS Department of Environmental Quality. *Community Recycling Program*. http://www.deq.state.ms.us/MDEQ.nsf/page/Recycling_CommunityRecyclingProgram?OpenDocument. Accessed 6/18/2012

ANNEX 8: RECOMMENDATIONS TO EXTEND ACCESS TO ENERGY AND ELECTRICITY

The benefit of utilizing on-site renewable energy generation is that it maintains capital flows for energy within the country rather than exporting capital to import energy; greater local job creation in system fabrication, installation, service, and financing; and profound positive environmental consequences in a country whose resources are strained. The approach we are suggesting in our analysis is to focus on replicable installations, which can be monetized locally on a sustainable basis, and is cost-effective against existing, traditional energy options. The over-arching position is that these types of installations can happen more quickly than waiting for traditional grid systems to evolve, and either cannot be afforded by the majority of people or are unreliable leaving a large portion of the population without power for significant periods of time.

Common-Infrastructure

Common Infrastructure makes the most sense for priority applications because it is now primarily diesel power with inordinately high and fluctuating energy costs tied to high operations and maintenance costs and high unreliability.

For the Tier One uses: powering gasoline and water pipeline pumps, communication towers, street/signal lighting – agreements with private sector developers on monthly power cost targets to encourage fabrication of various renewable energy hybrid with battery units to meet the differing load profiles needs to be orchestrated. Working with IDB (Multilateral Investment Fund), World Bank groups International Finance Corporation (IFC) to finance a portfolio of system assembly enterprises, as well as endues financing to drive the amortization of capital costs below the traditional monthly diesel fuel costs for these purposes.

For the Tier Two uses; which focus on on-site building electric loads such as and local community buildings for shared services - education and training, meetings, health care/clinics, and possibly community refrigerators.- where power can be purchased from various types of renewable energy units using swipe cards, cellular SIM cards, etc so as to orchestrate a scenario for financing through private sector financial entities, philanthropic entities, and multilateral entities including the ones mentioned in the previous paragraph.

Both Tiers can be developed in a cooperative structure, leveraging private and public ownership, funds and technical capacity. This will leverage debt and equity from multilaterals, reducing the cost of capital; private sector investment, technical capacity and management as the risk profile is reduced; local public ownership (revenues back into the municipality, responsibility of enforcing payment) and engagement (reduce line theft, theft of equipment, local jobs created).

Community Power

Community Power commonly describes electric energy generation for multiple users for a defined local region – a group of buildings, corporate or educational campuses, or even regionally. These entities could be electric energy cooperatives, non-profit community associations, or even public/private partnerships or consortia. It has been demonstrated in the developing world, the when energy purchasers are bundled, communities can attract capital and enforce community payments to insure that the energy approach is sustainable.

Clearly this approach has merit in the region, and a series of steps need to be taken to better understand energy needs and use locally, so as to pilot a community-based energy services approach. It may be established incrementally, by first providing lighting and cell-phone charging, and then moving up the value chain to refrigeration, ironing, television, and even cooking.

We suggest the opportunity to create local cooperatives, leveraging public and private capital, technical capacity and management as described for critical infrastructure will also be an opportunity for community power. The same cooperatives can develop both infrastructures, with different private capital and technology service companies or the same.

Building-Based Power

This approach focuses on the individual small business and homeowner to establish ways for them to acquire energy efficient products that do the same work for less energy (ie LED light bulbs, etc), and then dedicated energy systems – ethanol stoves, photovoltaic cells phone charging systems, solar water heating, small wind/solar power systems for lighting and possibly small TV and/or small refrigeration – and even powering cottage industries such as sewing machines, etc.

Micro-lending and consumer lending programs for energy have valid, sustainable projects all over the world. These proven approaches need to be jump started in this region as soon as possible by linking local groups with global non-profit and for-profit implementers to begin test beds of activity as soon as possible.

Per household spend for lighting is typically 12 USD per month (not including cost of kerosene lamp itself), this typically provide 2-3 hours of light per night. This expenditure is for kerosene lanterns and or candles, it does not include EDH expenditure as the homes we visited did not have reliable EDH and therefore no consistent spend was attainable. Per household charcoal expenditure ranges from 24-35 USD per month. The economics of basic energy consumption – lighting and cooking

Suggested Government Engagement

To ensure that the standard of performance, reliability, economics and sustainability, we would encourage the government develop import tax incentives for products that meet certain standards. The standards can be developed within the investment protocol for the power cooperative projects. This should also be developed for home-based power systems, solar lanterns/flashers, batteries and appliances.

Legislation enabling IPPAs (independent power purchase agreements) are necessary for the sale of electricity for the local critical infrastructure and community power. If this is not in place, the cooperatives will have to lease the use of the equipment to the end-users. It is highly recommended that the legislation be in place, as it will be important for investment made by both public and private entities.

A complete energy audit of on-grid and off-grid energy demand and supply is critical. This should be mapped showing existing grid (transmission and distribution), EDH thermal generation sites (total MWh), resource assessment of region, town centers (with population, population growth and local economic growth, and per capital income), current cost of energy (EDH, candles, kerosene, batteries, charcoal, bwa). The map will facilitate ensuring that all decisions made in the region take into account the entire energy ecosystem, which is critical to ensure that decisions and investments are made with accurate and comprehensive information. This effort should be a Haitian government led initiative, including EDH planning department, Minister of Finance, IDB, WB, USAID and one neutral group that has support.

ANNEX 9: PUERTO RICO: CASE STUDY FOR CULTURAL PATRIMONY MANAGEMENT

Puerto Rico has had successful strategies regarding the protection of its historic zones and built patrimony. Pantel's "Beyond San Juan: Important Moments in the Preservation of the Historic Zones in Puerto Rico" details how the programs and infrastructure were set up over the past century and which initiatives have proved successful. Planning Board Regulation No. 5 "Regulations for the Designation, Register and Conservation of Historic Places and Zones in Puerto Rico" can serve as an heuristic example of how these areas and buildings have been protected through regulation enforcement and government guidance together with public participation. Established processes utilized in the United States, such as those detailed in The Secretary of the Interior's Standards for the Treatment of Historic Properties with Guidelines for Preserving, Rehabilitating, Restoring and Reconstructing Historic Buildings and The Secretary of the Interior's Standards for Rehabilitation & Illustrated Guidelines on Sustainability for Rehabilitating Historic Buildings, can likewise serve as useful models of how government can assist and promote economically sound and sustainable interventions into the existing historic fabric of a town.

Another important tool in Puerto Rico for the protection and successful reuse of historic and traditional buildings has been the creation of trade schools for the teaching of traditional building crafts. These are excellent ways to promote proper building practices for the repair of extant historic fabric, their long-term maintenance and even for the construction of new vernacular housing through the use of traditional building methods. This technical training also creates self-pride, by giving people a trade that can readily generate the creation of small industries in the region (eg. carpenters, masons, stone cutters, metal hardware and other trades). These types of trade schools were created in Puerto Rico during 1991, as part of the Quincentenary Celebration to assist in the rehabilitation efforts to revitalize a large part of the historic fabric of Island towns, as well as that of the capital city of San Juan. Though they were short-lived, they trained a group of trades people who have continued to succeed in these fields to the present.

The initiatives of the northeast corridor development should also build upon some of the processes and recommendations done to date within the Port-au-Prince area. In the World Monuments Fund publication: Preserving Haiti's Gingerbread Houses - 2010 Earthquake Mission Report, under their "Recommendations", one segment details "Material and Industries". Specifically in reference to the 2010 earthquake, they state that the disrepair caused by this natural crisis "...should be viewed as an opportunity to help further some important initiatives for agricultural and industrial growth in Haiti. Consideration should be given to revitalizing the timber, brick, lime mortar and clay mortar industries in Haiti." Under the heading "Education and Training" this document also contains a segment which states: "Encourage good construction practices in the field: Disseminate guidance documents, such as this report, and provide access to technical assistance to owners, contractors, and trades people to encourage proper repair and restoration practices..."

This same report also recommends the establishment of a "training program for builders and trades people to...develop the lost skills of wood framing and of proper masonry construction.... A certificate could be awarded after the training is complete as a means of demonstrating minimum competence to building owners. A good example of such a program can be found in the U.S.-based Falmouth Heritage Renewal program in... Jamaica." Under "Training facility, demonstration project...", they recommend an innovative initiative to "Collectively purchase a spacious property with a prominent, accessible, moderately damaged...building that exhibits all construction systems. Repair and restore the building as a demonstration project, a facility for the Training Program, and as headquarters for dissemination of information and advocacy for the repair and restoration project." Positive initiatives such as these would encourage the strengthening of community unification, pride and collaboration as well.

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