SFD
Promotion Initiative

Cap-Haïtien
Haiti

Final Report

This SFD Report – Comprehensive level – was prepared by the Inter-American Development Bank in collaboration with OREPA Nord

Date of production: 20/09/2020
Last update: 25/11/2020

SFD Report Cap-Haïtien, Haiti, 2020

Produced by: Benjamin Biscan, Independent Consultant
Sergio Pérez Monforte, IDB
Lars Schöbitz, GmbH
Anthony Kilbride, Independent Consultant

FOREWORD

The Inter-American Development Bank, through the saniBID platform, seeks to promote the development and implementation of optimal and non-conventional sanitation solutions in the Latin America region. The first step to identify solutions is to characterize the state of the sanitation situation that could serve as a baseline in the areas of intervention.

One well-known and globally accepted tool to analyse the sanitation service delivery chain to identify its strengths and weaknesses in any given area is the Shit Flow Diagram (SFD) graphic. The tool was developed by the SFD Promotion Initiative (SFD PI), a consortium of partners working together to improve excreta management in urban areas. The SFD PI is supported by the Bill & Melinda Gates Foundation and managed by GIZ (Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH) as part of the Sustainable Sanitation Alliance (SuSanA).

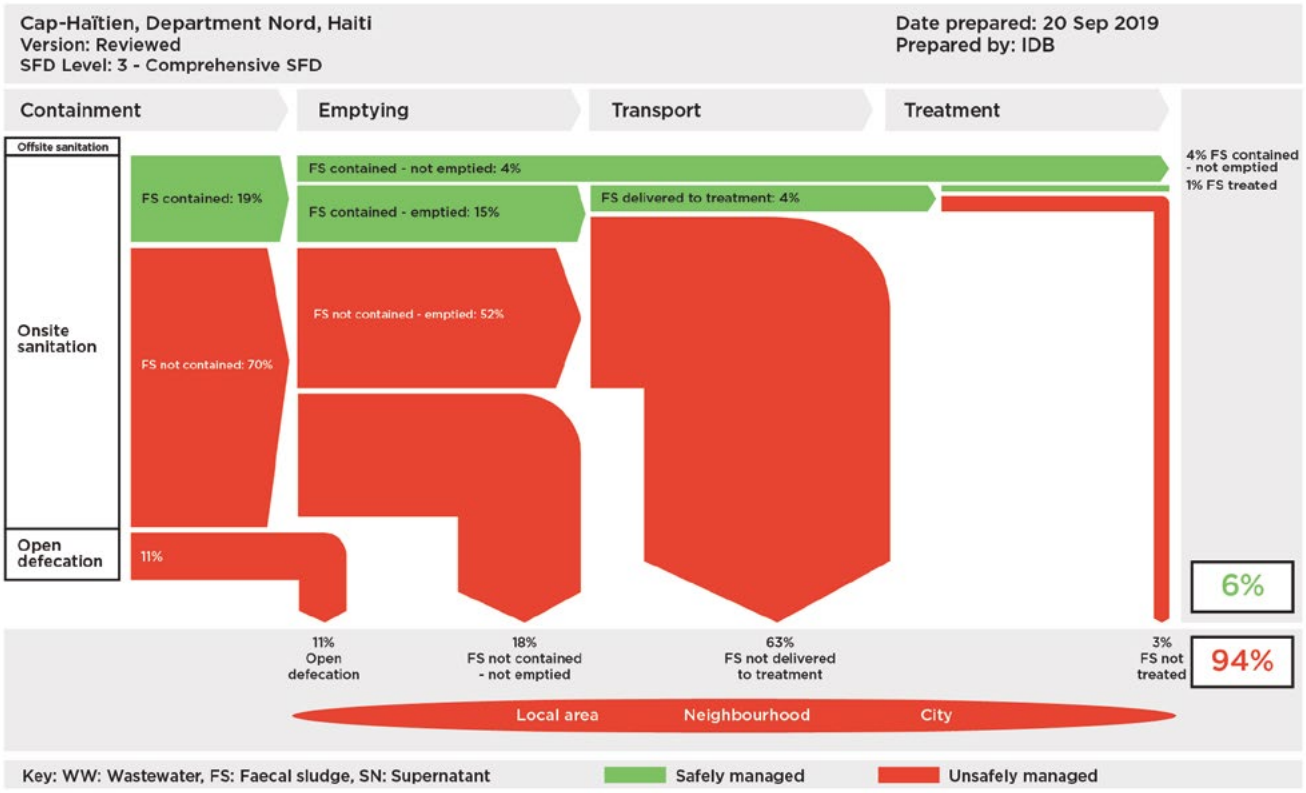
An SFD is an advocacy tool that aims to assist technical and non-technical stakeholders in order to implement plans and programs related to urban sanitation. The SFD methodology is increasingly being used to analyse the extent of safely-managed sanitation in urban areas, providing a valuable picture of the prevailing sanitation conditions, from containment to disposal. As such, it is a widely recognised advocacy and decision support tool that aims to understand, communicate, and visualize how wastewater and faecal sludge move within a city or town. As stated on the SuSanA website, the SFD methodology offers "*a new and innovative way to engage sanitation experts, political leaders and civil society in coordinated discussions about excreta management in their city*".

The SFD graphic is made using a free online tool, the Graphic Generator (GG): https://sfd.susana.org/data-to-graphic, and, to date, over 140 SFD reports, which must pass a review process before publication to assure the quality control mechanism of the SFD PI, have been uploaded to the SuSanA website.

The production and publication of an SFD report for Cap-Haïtien (Haiti) would help to visualise the current sanitation situation in the city, resulting in a potential to shift current activities and efforts towards more efficient investments in the places along the sanitation chain that need more attention, improving the urban sanitation situation and the surrounding environment of the city.

The structure of this SFD report consists of an executive summary and the SFD report. The latter includes: i) general city information describing its main characteristics; ii) sanitation service outcomes, with a thorough explanation of the SFD graphic outcome and the assumptions made; iii) the service delivery context analysis, which contains information on the regulatory framework of water and sanitation at country and city levels, and describes the city plans, budget and future projects to improve the sanitation situation and; iv) a detailed description of the surveys, Key Informant Interviews (KIIs) and Focus Group Discussions (FGDs) conducted, as well as the key stakeholders involved, field visits carried out and references used to develop this SFD report.

1. The Diagram



Produced with support from the SFD Promotion Initiative with funding from the Bill & Melinda Gates Foundation.
The SFD Promotion Initiative recommends that this graphic is read in conjunction with the city's SFD Report which is available at: sfd.susana.org

2. Diagram Information

SFD level:
This SFD is a level 3 - Comprehensive report.
Produced by:
Benjamin Biscan, Independent Consultant
Sergio Pérez Monforte, IDB
Lars Schöbitz, GmbH
Anthony Kilbride, Independent Consultant
Collaborating partners:
DINEPA
OREPA Nord
Status:
Final SFD report
Date of production:
20/09/2019

3. General City Information

Cap-Haïtien is located in Haiti, in the Caribbean region. It is Haiti's second largest city after its capital, Port-au-Prince, with an estimated population of 404,766 in 2017 (IDB, 2017). The city of Cap-Haïtien is located within the commune of Cap-Haïtien, which is divided into three communal sections (sections communales), the smallest official administrative unit.

For the SFD graphic, two of the most populous of these three communal sections were used; they were then further disaggregated into three zones, each with three different types of housing. These definitions of the urban space were defined as part of a WASH household survey in 2017 that provides representative data for the SFD graphic.

It is estimated that 28% of the population lives in informal settlements located in flood plains and in hilly parts of the city. Population density ranges between 30,000 and 50,000 people/km^2 in these areas.

4. Service outcomes

Presented in Table 1, below, is the percentage of population using different sanitation technologies. A significant proportion of the population (11%) has no sanitation facility and practices open defecation. Types of septic tanks (37%) and different forms of pit latrines (51%) are the most commonly used technologies. Cap-Haïtien is one of two locations in Haiti where a CBS toilet system (EkoLakay) is being implemented as an alternative method for sanitation (1%). The city has no sewer-based sanitation.

Table 1. Percentages of Population Using Different Sanitation Technologies in Cap-Haïtien

Sanitation technology	Percent
Pit latrine	51
Septic tank	37
Open defecation	11
CBS toilet	1

Containment

It was estimated that 82% of the population using containment technologies are located in areas of high risk of groundwater contamination and where faecal sludge is not contained. The remaining 18% are some pit latrines in informal settlements of the hilly areas, and CBS toilets located in informal settlements in low-lying areas.

Faecal sludge emptying and transportation

Four private companies were identified that use mechanical methods (i.e. vacuum trucks) for emptying and transporting faecal sludge. These services are almost exclusively provided to households with septic tanks for the reasons of their affordability, slurry-like characteristics of faecal sludge, unlike pit sludge, and accessibility to containments.

The vast majority of Cap-Haïtien's population uses manual emptying and transport services when their sanitation technologies become full. In Haiti, these service providers are referred to as *bayakous*. The number of individuals who operate cannot be estimated reliably. Services of *bayakous* are provided at night and typically in groups. Simple tools such as buckets and spades are used for clearing the pit or tank. *Bayakous* usually enter into the pits almost bare body, and without personal protective equipment.

The CBS system offers an alternative emptying and transport method. Households that use the EkoLakay service provided by SOIL are visited at least once each week to collect a full container, leave a clean empty container and provide a fresh supply of carbon cover material. Containers are collected in modified wheelbarrows or three-wheeled motorcycles and transported to a neighbourhood depot for intermediate storage to optimize logistics before they are transferred with a flatbed truck to a treatment site, which is approximately 12 km outside of the city.

Treatment

Four sites for disposal and/or treatment were documented as part of the SFD assessment. One site is located on the grounds of "*Hôpital de la Convention Baptiste d'Haïti*" and managed by the Ministry of Public Health and Population (MSPP). An unofficial discharge location commissioned by a private service provider is located outside of Cap-Haïtien in the commune of Quartier Morin (the "JEDCO site"). Daily quantities of faecal sludge disposal are not recorded, but are estimated to be 11 m^3/day, and no adequate treatment is provided. A third site was officially built by National Water and Sanitation Directorate (DINEPA) to service the portable toilets for the national carnival of 2013. It is now managed by *L'Office Régionale de l'Eau potable et de l'Assainissement* (OREPA) Nord.

The operating history of the site since 2013 is not documented, but the site has been non-functional for many years and is now closed. Considering these sites are earmarked for disposal, away from the habitat, although the sites are not appropriately designed treatment plants, it is estimated that 10% of excreta reaching the sites is safely treated. SOIL's composting (waste treatment) site in Mouchinette (Limonade treatment site) is just across the road from the OREPA Nord- managed site. Faecal sludge (FS) collected in CBS toilets and brought to SOIL´s site is safely (100%) treated. Regular quality monitoring of the treatment product, compost, is practised, and indicates that World Health Organization standards for safe treatment and re-use are met.

Final SFD graphic

The resulting SFD graphic shows that in total, 6% of faecal sludge is safely managed in Cap-Haïtien and 94% is not safely managed.

The 94% of FS not safely managed consists of: 3% of FS delivered to treatment but not treated; 63% of FS not delivered to treatment; 18% of FS not contained - not emptied; and 11% of FS that originates from people practising open defecation.

5. Service delivery context

The framework law of 2009 on the organization of the water and sanitation sector incorporates sanitation into the responsibilities of the National Directorate of Drinking Water and Sanitation (DINEPA). This law also created the OREPAs (L'Office Régionale de l'Eau potable et de l'Assainissement), which are in charge of compliance with the standards and directives developed by DINEPA. At the regional level and, more specifically, for the city of Cap-Haïtien, sanitation is the shared responsibility of OREPA nord and the MSPP, and the Mayor of Cap-Haïtien. Responsibilities for sanitation are divided among municipalities and ministries, including the Ministry of Public Works, Transportation, and Communication (MTPTC), Ministry of the Environment (MDE) and Ministry of Public Health and Population (MSPP). A memorandum of understanding (MoU) on the promotion of sanitation, hygiene, and the living environment, which was signed by these three ministries (MTPTC, MSPP and MDE 2015) in January 2016, represents a first step in organizing the sector.

While documents exist at the regional Inter-ministerial Regional Planning Committee (IBI and DAA, 2012) and municipal levels, no comprehensive diagnostic and no planning document exist for the sector at the city level. The total amount of planned investments in the water and sanitation sector over the next five years for the city of Cap-Haïtien is estimated at USD 50 million. The main contributors are the Inter-American Development Bank (IDB), the Spanish Agency for International Development Cooperation (AECID) and the United States Agency for International Development (USAID).

The sanitation sector is almost exclusively private. There is no technical or financial assistance for households or owners wishing to install sanitation technologies and there is currently no ongoing public financing for excreta collection or treatment. EkoLakay toilets, a container-based sanitation developed by the NGO SOIL, offer a promising 'zero-construction' alternative. It is an inexpensive service for households to the extent that the payment is on a monthly basis (amounting to a maximum of 3,600 HTG in a year; 42 USD) without high upfront investment. This service is therefore more accessible to low-income households and vulnerable segments of the population.

6. Overview of stakeholders

In addition to government institutions, development agencies and multi-lateral organisations highlighted in "4. Service delivery context", a number of NGOs are active in sanitation service provision. SOIL, a non-profit research and development organization,

provides CBS systems where toilets collect human excreta in sealable, removable containers that are transported to treatment facilities when full. In the private sector, a list of faecal sludge emptying service providers exists, providing mechanical and manual emptying services.

Table 2. Overview of Stakeholders

Key Stakeholders	Institutions / Organizations
Public institutions	DINEPA, OREPA, municipal government, Health Ministry
Development partners	Inter-American Development Bank (IDB), AECID (Spanish Development Agency)
Private sector	JEDCO
NGOs	SOIL

7. Credibility of data

The provided "SFD Source Evaluation Tool" was used to score the credibility of data sources. In total, 41 sources scored either medium or high if they were official, well-documented studies and conducted within the past few years. Throughout the process of producing the SFD graphic, one data source, the household survey (n = 1,518), was used the most and will continue to be used in many different ways in the future. The field-based assessment included approximately 20 key informant interviews (KIIs), 12 focus group discussions (FGDs) and a wide range of observations, which supported the triangulation of available data. Assumptions were made with regards to percentages of faecal sludge emptied and delivered to disposal sites by mechanical emptying service providers.

8. Process of SFD development

Field-based data collection, including surveys, KIIs and FGDs, was implemented between 27th June 2017 and 18th April 2018. A draft SFD graphic was produced, presented and discussed publicly on 27th June 2018 at the city hall of Cap-Haïtien in the presence of more than 80 representatives of public institutions (various ministries, departmental agencies, and municipalities), the private sector (*bayakous* and formal emptying companies), NGOs and local associations (SOIL, etc.), as well as technical and financial partners of the Republic of Haiti (IDB, AECID, USAID). Standard SFD-PI methodology and templates were used throughout the entire process. The overall trajectory that the vast majority of faecal sludge is being discharged to the environment without treatment is generally accepted, as no appropriate treatment plant for faecal sludge exists. But, consensus needed to be reached on the safety and scale of replacing pit latrines when full. In any case, during the workshop, a consensus was reached that the SFD graphic reflects the reality of sanitation in Cap-Haïtien.

9. List of data sources

- Adamson, James, and Javan Miner. 2018. Report III. "Well Inspection and Testing Report."
- Adamson, James, Javan Miner, and Sarah Lindholm. 2018. "Report IV Modeling of Groundwater Contamination Vulnerability Commune of Cap Haïtien, Haïti."
- Archambault, Aude, and Benjamin Biscan. 2018. "ANALYSE ENVIRONNEMENTALE ET SOCIALE (AES) (HA-L1135)."
- CNIGS. 2014. "Spatial Point Data of All Buildings in Cap-Haïtien."
- DINEPA. 2013. "DINEPA République d'Haïti Référentiel Technique National EPA."
- DINEPA, and République d'Haïti. 2014. "Document d'orientation Stratégique Pour L'assainissement En Haïti.
- Guillande, R. 2015. "Caractérisation et Cartographie Du Risque Inondation et de Submersion Marine Sur L'agglomération Du Cap-Haïtien.

- IBI, and DAA. 2012. "Plan Stratégique de Développement d'Haïti. Tome 1 Les Grands Chantiers Pour Le Relèvement et Le Développement d'Haïti."
- IDB. 2017. "Demographic Household Survey (N = 3090) Implemented by Inter-American Development Bank and OREPA Nord."
- IDB, and OREPA Nord. 2017. "Household Survey for Water, Sanitation and Hygiene Indicators (N = 1518)."
- IHSI. 2015. "L'Institut Haïtien de Statistique et d'Informatique (IHSI) 'Population Totale, de 18 Ans et Plus - Ménages et Densités Estimés En 2015.'."
- Ingénierie, BRL, and BRGM et PC. 2011. "Etude de Faisabilité Pour La Réhabilitation, L'extension Du Système AEP, La Réalisation Du Système d'assainissement Des Rejets Liquides et La Supervision de Travaux de La Ville de Cap Haïtien. Rapport Final d'étude. Composante 1: Volet Eau et Assainisseme."
- Lozano Gracia, Nancy, and Marisa Garcia Lozano. 2017. "Haitian cities: Actions for today with an eye on tomorrow." 122880. The World Bank.
- MTPTC, MSPP, and MDE. 2015. "Protocole d'accord Entre Le Ministère Des Travaux Publics, Transports et Communication ; Le Ministère de La Santé Publique et de La Population ; Le Ministère de L'Environnement ; Portant Promotion de L'assainissement, de L'hygiène et Du Cadre de Vie."
- République d'Haïti. 2009. "Loi Cadre Portant Organisation Du Secteur de L'eau Potable et de L'assainissement. Le Moniteur, (29), p. 1-12."

Table Of Contents

List of Tables

List of Figures

Abbreviations

AECID	Spanish Agency for International Development Cooperation
AFD	Agence Française de Développement
AI	Informal settlement
ANARHY	National Water Resources Agency (Agence Nationale des Ressources Hydriques)
CBS	CBS. Container-based sanitation
CIAT	CIAT. Interministerial Committee of Regional Development
DINEPA	DINEPA. National Directorate of Drinking Water and Sanitation (Direction Nationale de l'Eau Potable et de l'Assainissement)
FGD	Focus Group Discussion
FS	Faecal Sludge
FSM	Faecal Sludge Management
HTG	Haitian Gourde
IDB	Inter-American Development Bank
KASAV	Social Action Committee for Sanitation in the City (Konbit Aksyon Sosyal pou Asenisman Vil yo)
KII	Key Informant Interview
MARNDR	Ministry of Agriculture, Natural Resources, and Rural Development
MDE	Ministry of the Environment
MENFP	Ministry of National Education and Vocational Training
MDG	Millennium Development Goal
MICT	Ministry of the Interior and Regional Communities
MoU	Memorandum of Understanding
MPCE	Ministry of Planning and Foreign Cooperation
MSPP	Ministry of Public Health and Population
MTPTC	Ministry of Public Works, Transportation, and Communication

OD	Open Defecation
OREPA	The Regional Office for Drinking Water and Sanitation (L'Office Régionale de l'Eau potable et de l'Assainissement)
PU	Peri-urban
PVC	Polyvinyl chloride
SDG	Sustainable Development Goal
SFD	Shit-Flow-Diagram
SFD-PI	Shit Flow Diagram Promotion Initiative
SOIL	Sustainable Organic Integrated Livelihoods
SPU-MTPTC	Urban Planning Service
TEPAC	Drinking Water and Sanitation Technician for Communes (Technicien en Eau Potable et en Assainissement pour les Communes)
UR	Urban
USAID	United States Agency for International Development
USD	United States Dollar
VIP	Ventilated Improved Pit
WASH	Water, Sanitation and Hygiene

1. City Context

Cap-Haïtien is located in Haiti, in the Caribbean region. It is Haiti's second largest city after its capital, Port-au-Prince. The city of Cap-Haïtien is located within the commune of Cap-Haïtien, which is divided into three communal sections (sections communales), which are Haiti's smallest official administrative unit. These are (Figure 1):

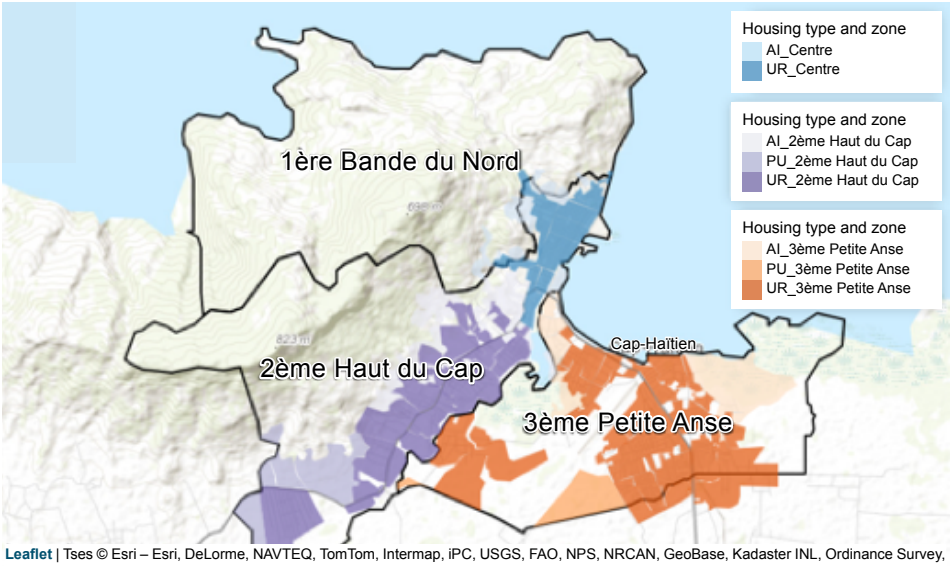
- 1ère Bande du Nord,
- 2ème Haut du Cap,
- 3ème Petite Anse.

The population of the city of Cap-Haïtien can be classified as living in urban, informal or peri-urban areas (IDB, 2017). No rural population is considered for the present study.

Criteria for the classification were density and type of urban plot. Informal settlements corresponded to the areas with the highest density and least urban regularity. Based on the analysis of household data, it is estimated that 70% of the population live in urban areas, 2% in peri-urban areas and 28% in informal settlements (IDB, 2017). The above analysis showed a total population of 404,766 (IDB, 2017), with 5.02 inhabitants per household.

Cap-Haïtien is a flood-prone city, which is dissected by the 'Rivière du Haut du Cap' (also called the Mapou River). This river creates a large, permanent water basin, the Bassin Rhodo, in the geographic centre of the town. For decades, people have settled unsafely along the river banks, in order to access work opportunities in the city centre and the municipal market. Between 2010 and 2015, there was

Figure 1. Administrative boundaries of the three communal sections of Cap-Haïtien commune. Colours further indicate a categorization by the IDB into three zones and three types of housing (IDB, 2017)

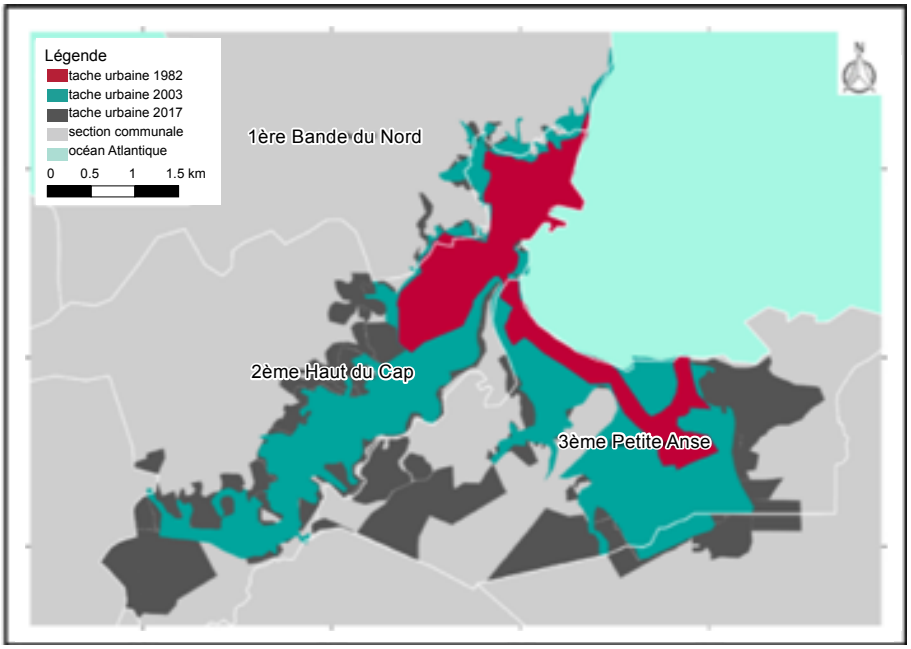


an estimated 32% increase in the number of roofs that are within a radius of 50 m around the Haut du Cap Bassin Rhodo (Lozano Gracia & Garcia Lozano, 2017, page 73, Figure 2).

Cap-Haïtien has grown rapidly since the 1980s. Uncontrolled and unplanned urban growth has occurred mainly along national highway #1, leading southwest from downtown and along national highway #6 in the southeast (Figure 2). This growth occurred in areas where there is plain terrain available, which is especially in the lower-lying parts of the city (< 100 m above sea level). It is easier to carry out construction activities in these areas as compared to the hilly northern and western parts of the city, with an altitude rising from 100 m to approximately 700 m above sea level.

A significant part of the city is at a high (zone 3), very high (zone 4) or extreme (zone 5) risk of flooding (see Figure 3). Guillande (2015) created this flooding vulnerability map using two digital data sources: LiDAR and ORTHOPHOTO.

Figure 2. Urban expansion map of Cap-Haïtien for the years of 1982, 2003 and 2017 (IDB, 2017)



According to the housing layer (CNIGS 2014), the number of households located in danger zones 3, 4 and 5 make up 6% of the total number of households[1]. However, given the uncontrolled urban growth since then, and the likely increase in flood risk caused by the continued denudation of the surrounding environment, it is likely that this figure is now higher than 6%.

Sanitation technologies in these areas are either permanently flooded or regularly overflow.

1 Results based on spatial analysis of percentage of houses located in three high-risk zones (CNIGS, 2014)

Figure 3. Map of flood and runoff risks in the greater Cap-Haïtien region (Guillande, 2015)

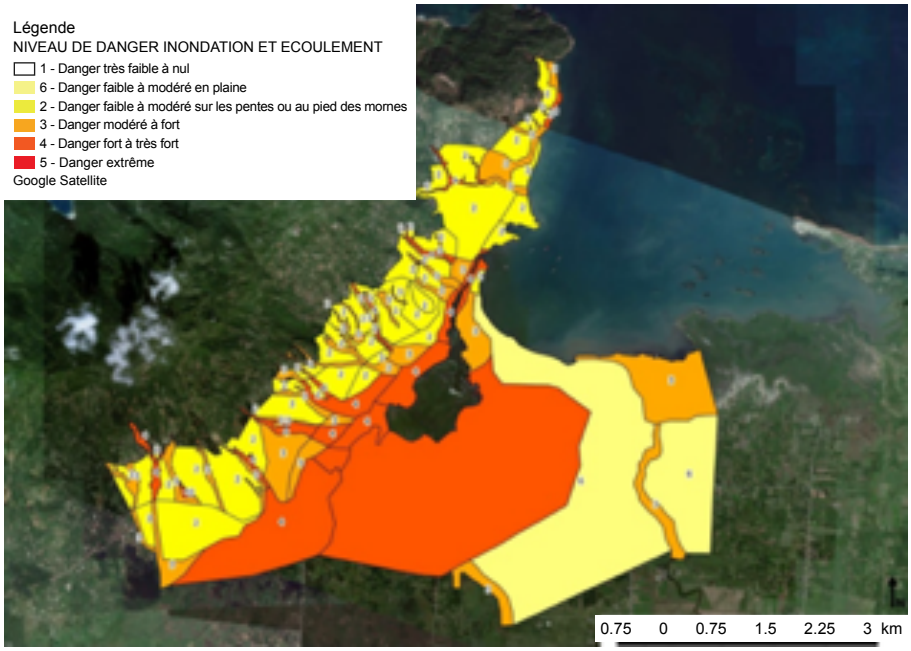


Figure 4 shows the population density for each of the eight zones of the city, and Figure 5 presents the total population per housing type and zone.

The climate in Cap-Haïtien is tropical, with significant rainfall in most months of the year, ranging from 46 mm in July, to 253 mm in November, and a total average of 1,595 mm per year. August is the warmest month, with an average temperature of 26.9 °C, and January, with 22.9 °C, has the lowest average monthly temperature. The annual average temperature is 25.3 °C[2].

2 Data accessed on 2019-05-28: https://en.climate-data.org/north-america/haiti/departement-du-nord/cap-haitien-3631/

Figure 4. Population density in eight zones of Cap-Haïtien

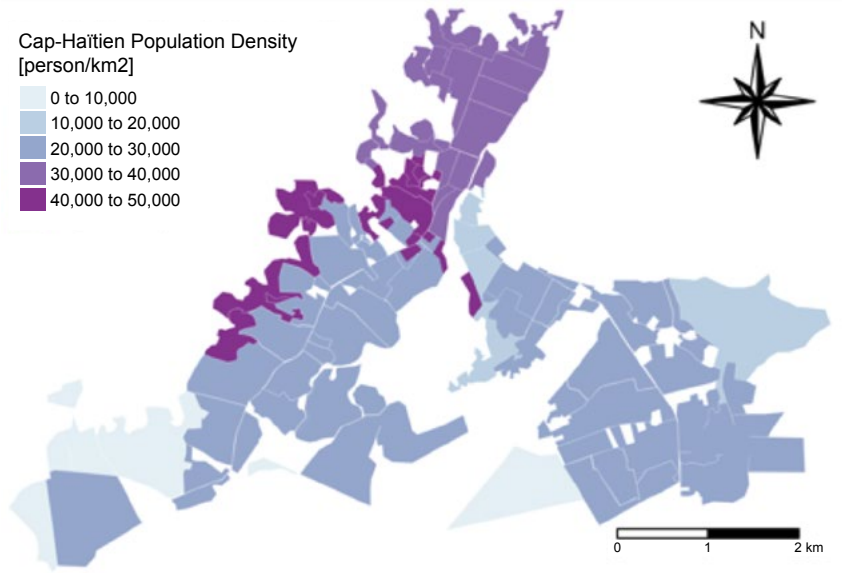
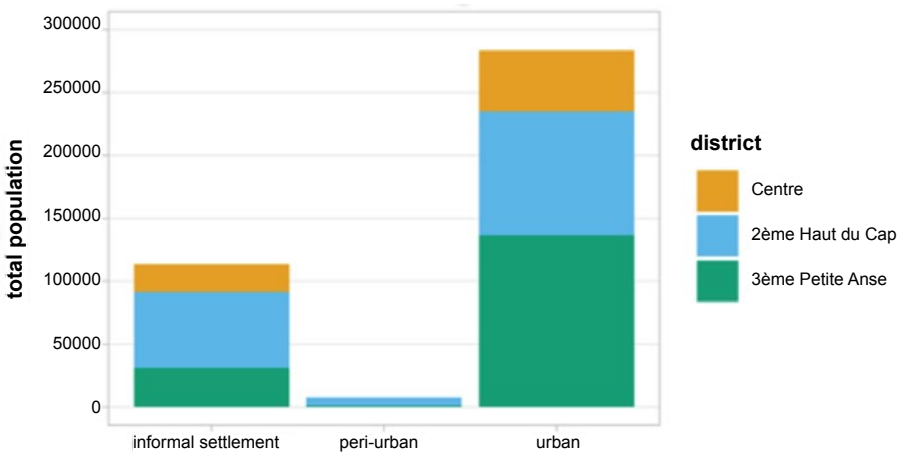


Figure 5. Total population of Cap-Haïtien by zone and housing type



2. Service Outcomes

2.1 Overview

This section presents the range of Faecal Sludge Management (FSM) infrastructure/technologies, methods and services designed to support the management of faecal sludge through the sanitation service chain in Cap-Haïtien. Refer to Section 2.2 for details on quantitative estimates for the resulting SFD matrix.

In 2017, The Regional Office for Drinking Water and Sanitation (OREPA) Nord, with support of the Inter-American Development Bank (IDB), implemented a household survey of 1,518 households in Cap-Haïtien (IDB and Nord, 2017). This survey was designed to be representative of the eight zones defined for the survey, and data were analysed to provide disaggregated results for septic tanks, pit latrines, container-based sanitation (CBS) toilets and open defecation (OD).

2.1.1 Containment

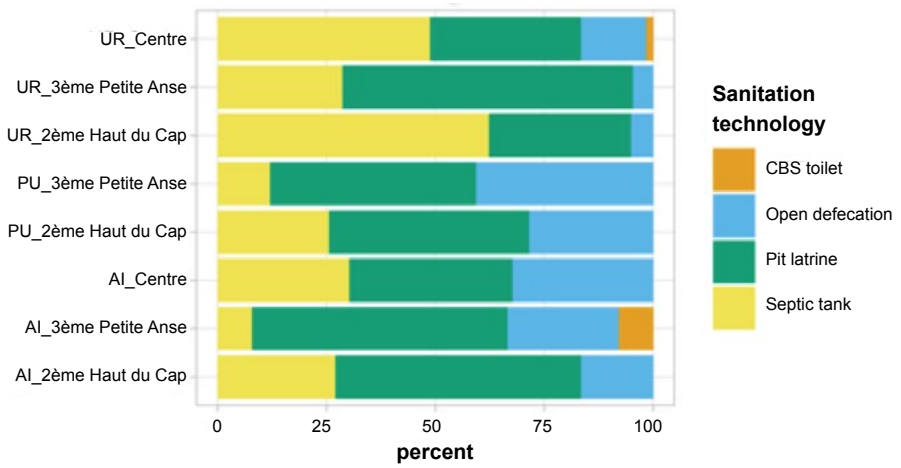
Table 1 shows the percentage of the population dependent on septic tanks and pit latrines. These are the most commonly used sanitation technologies in Cap-Haïtien, while a significant proportion of the population has no sanitation facility and practices OD. Cap-Haïtien is one of two locations in Haiti where a CBS system is being implemented as an alternative method for sanitation. The city has no sewer-based sanitation, although there is an extensive system of stormwater drainage in the town center, which likely has some illegal wastewater connections to it.

Table 1. Types of sanitation technologies in Cap-Haïtien and percentage of population with access (IDB and Nord 2017)

Sanitation technology	Percent
Pit latrine (several types)	51
Septic tank	37
Open defecation	11
CBS toilet	1

In Figure 6, sanitation technologies are shown disaggregated by eight zones. Results show that there are significant differences among zones. For example, OD in urban parts of communal section 3ème Petite Anse is estimated to be as low as 5%, while OD rates in peri-urban parts of the same communal section are estimated to be 41%. This disaggregation demonstrates the huge inequality in sanitation coverage in the city and highlights the risk of representing the problem of OD with a single statistic, i.e. 11%, for the whole city.

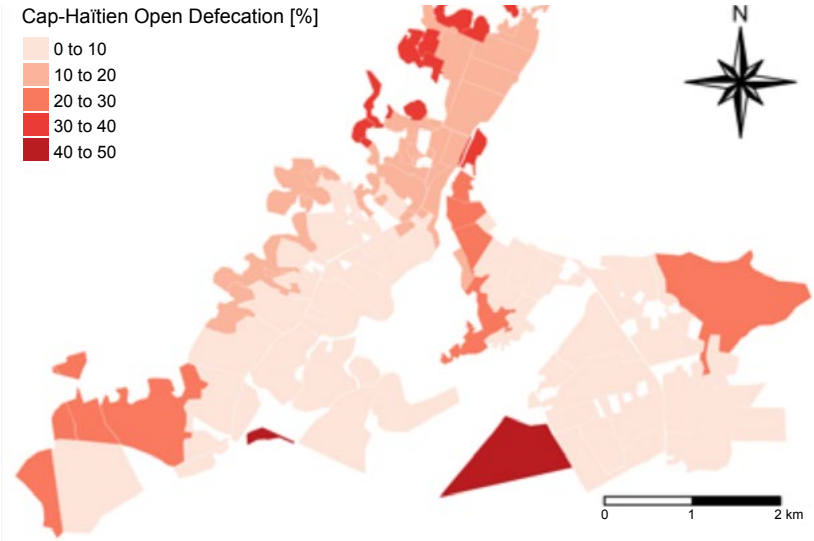
Figure 6. Types of sanitation technologies in Cap-Haïtien and percentage of population with access, disaggregated by eight different zones (IDB and Nord 2017)



Open defecation

OD is highly prevalent in Cap-Haïtien (Figure 7). While estimates for the entire city are relatively low, disaggregated data show that some zones experience between 30 to 50% of the zone's population have no sanitation facility. Based on key informant interviews, even these percentages are likely underestimated for some discrete habitations of the informal settlements of the city, where it is suggested that up to 11% of the total population practice OD.

Figure 7. Map of population percentages per zone practising open defecation in Cap-Haïtien (IDB and Nord, 2017)



Septic tanks

Households with flush toilets (twalèt kònfo modèn, in Creole) systematically refer to their containment technology as a septic tank. However, these are most commonly not a septic tank, but a two-compartment pit (Figure 8 and Figure 9), of which the first compartment is watertight and the second compartment serves as the soak pit, without an outlet or overflow). Size of containment and emptying frequency are unknown[3].

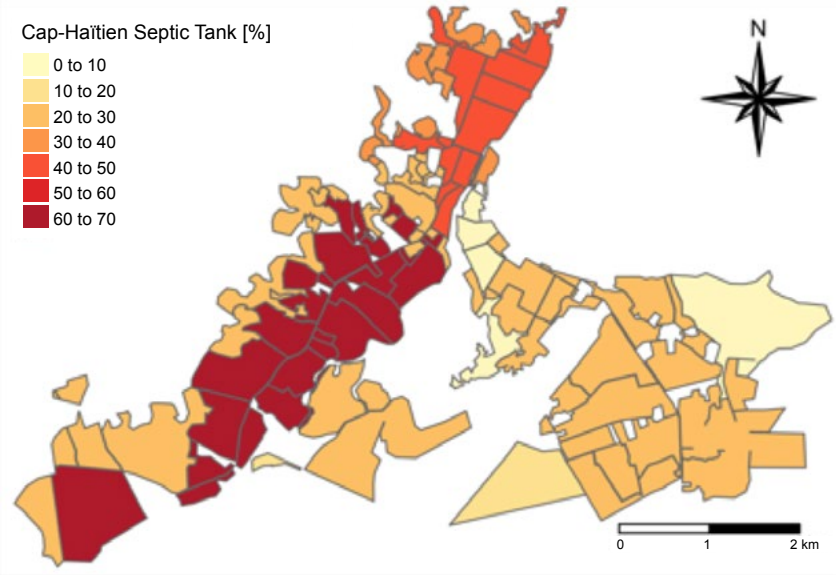
3 Range from two to 20 years collected during diagnostic.

Figure 8. Two-compartment pit, commonly referred to in Cap-Haïtien as a septic tank. Photo credit: Benjamin Biscan

Figure 9. New construction of two-compartment pit for a health clinic, commonly referred to as septic tank in Cap-Haïtien. Photo credit: Anthony Kilbride

Figure 10 shows that these technologies are most prevalent in urban housing areas and zone *Centre*. They are less prevalent in informal settlements, but still make up a relatively large proportion of the total.

Figure 10. Map of population percentages with septic tanks in Cap-Haïtien (IDB and Nord 2017)



Pit latrines

Pit latrines are the most commonly used sanitation technology in Cap-Haïtien (Figure 11). Containment can be unlined, brick-lined and with or without an open bottom, but such data on the integrity of the containment is not available and is typically very hard to establish. Based on the IDB and OREPA Nord (2017), the large majority of the latrines are installed with a slab and/or are ventilated improved pit (VIP) latrines, and could be considered a 'basic' sanitation solution according to Sustainable Development Goal (SDG) guidelines (or 'improved' according to the superseded Millennium Development Goal (MDG) guidelines).

On the other hand, the Key Informant Interviews (KIIs) and observations conducted as part of the production of the SFD graphic, show a greater presence of unimproved latrines but lack the same degree of representativity of the survey, so additional analysis on this subject should be conducted in the future.

Figure 11. Map of population percentages with pit latrines in Cap-Haïtien (IDB and Nord, 2017)

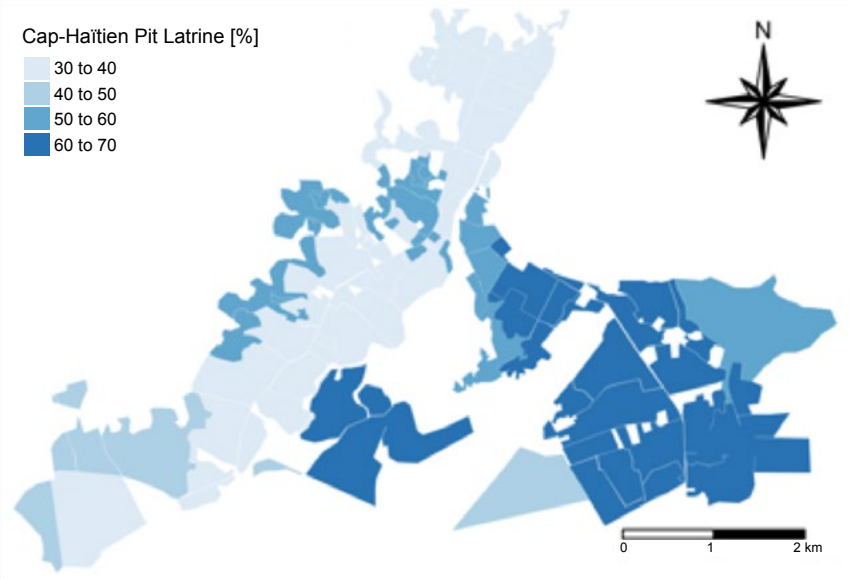


Figure 12 shows pit latrines with unlined and brick-lined containment. The size of containment is estimated at a surface area of 2 m^2 and a depth ranging from 1.8 to 4.5 m, depending on water-table elevation. Typical emptying frequency has been reported at two to four years, depending on pit depth.

Figure 12. Pit latrines with unlined and brick-lined containment and open bottom, commonly found in Cap-Haïtien

CBS toilets (*EkoLakay*)

CBS (Container-based Sanitation) is a system where toilets collect human excreta in sealable, removable containers (also called cartridges or buckets) that are transported to treatment facilities when full. In Haiti, this service is known as the EkoLakay Toilet service and is provided by Sustainable Organic Integrated Livelihoods (SOIL), a non-profit research and development organization[4].

The EkoLakay service is marketed to households in dense urban settlements. Households pay a monthly fee of 200 - 300 HTG[5] to rent a SOIL toilet and receive a carbon-based cover material to "flush" the toilet (Figure 13 and Figure 14). Full containers are collected on a weekly basis, exchanged for clean containers and waste is transported and treated at a composting facility (more details in Section 2.1.2 and Section 2.1.3). In Cap-Haïtien, approximately 1,000 households currently use this service, which has been implemented in two neighbourhoods of Petit Anse: Shada/Fort St. Michel and Aviasyon.

4 For more details, see: https://www.oursoil.org/who-we-are/about-soil/

5 2.04 to 3.06 USD (29th April 2020)

Figure 13. Construction of SOIL CBS toilets using locally available materials (concrete). Photo credit: SOIL

Figure 14. SOIL CBS toilet and cover material (sugarcane bagasse) on the right. Photo credit: SOIL

2.1.2 Emptying and transportation

Mechanical emptying and transport services

At the time of this SFD assessment, four trucks (two 'public' and two 'private') were actively operating in Cap-Haïtien:

- JEDCO: One truck of 3,000 gallons[6] (Figure 15)
- GOLSA: One truck of 5,000 gallons
- OREPA Nord: One truck of 1,000 gallons, for use only for public institutions (public toilets, schools and hospitals).
- Ministry of Public Health and Population (MSPP): One truck of 1,000 gallons, operated by the Cholera Treatment Center, which collects sludge from the hospital and sometimes from schools.

Note that, in addition to the active trucks based in Cap-Haïtien, both JEDCO and GOLSA can mobilize trucks from Port-au-Prince to drive to Cap-Haïtien for specific jobs. SANCO, who do not have a truck based permanently in Cap-Haïtien, also send a truck from Port-au-Prince periodically to service the prison under their contract with the Ministry of Justice. Therefore, Port-au-Prince-based companies and their fleets, if not considered 'active' in Cap-Haïtien, should at least be considered as potential resources for any FSM strategy development.

Costs for a single mechanical emptying, including truck voyage and discharge, range from 20,000 HTG to 25,000 HTG[7]. The cost is fixed 'per voyage', i.e. the cost applies regardless of whether the truck fills up completely. Mechanical emptying services are almost exclusively provided to households with septic tanks. Reasons include:

- ability to pump, due to liquid nature of FS (compared to pit latrines);
- ability to pump, due to lower solid waste content (compared to pit latrines); and
- accessibility of the containment technology (compared to pit latrines).

In terms of physical accessibility to septic tanks, results of a spatial analysis (IDB, 2017) have shown that 82% of households in urban areas and 50% of households in informal settlements could theoretically receive mechanical emptying services. The analysis was performed by adding a 10-metre buffer to the road network and calculating the percentage of houses in each housing area type that are located within 30 metres of a road, which can be used by a truck. Furthermore, service providers tend to refuse the emptying of pit latrines, as these contain a significant amount of solid waste (e.g. broken glass), which can damage the pump and hose pipes of vacuum trucks.

Figure 15. JEDCO truck turning off main road towards FS dump site. Photo credit: Anthony Kilbride

6 1 US gallon - 3.8 litres

7 203.72 USD to 254.65 USD (29th April 2020)

Manual emptying and transport services

Services of *bayakous* are provided at night and typically in groups. Simple tools such as buckets and spades are used to empty the pit or tank. *Bayakous* usually enter into the pits almost bare body, and without personal protective equipment.

Depending on the depth of the pit, costs for manual emptying service are in the range of 10,000 HTG[8] (110 USD) for pits of 4.5 m^3 of volume, to 20,000 HTG (220 USD) for pits of 9 m^3. In comparison, construction of a new toilet is higher (reported at 289 to 579 USD) and therefore, households are incentivized to empty a full latrine rather than build a new one. Furthermore, lack of available space does not allow for building new infrastructure and it is therefore assumed that the entire population of Cap-Haïtien empties a containment once full. The proportion of households that empty containments themselves, for example during flooding events, is unknown.

If sufficient bare land is available on the property, the house owner allows *bayakous* to bury emptied sludge onsite, by digging a hole specifically for this purpose. The detailed procedure is unknown and from interviews it can be assumed that burying is not done safely (Figure 16). More often in the urban environment there is no space available, and so sludge is transferred with buckets into 50-litre rice bags that are transported in wheelbarrows at a maximum distance of one to two kilometres. Without any dedicated location for disposal or treatment, bags are dumped into nearby streams, rivers or the sea.

More often in the urban environment there is no space available, and so sludge is transferred with buckets into 50-litre rice bags that are transported in wheelbarrows at a maximum distance of one to two kilometres. Without any dedicated location for disposal or treatment, bags are dumped into nearby streams, rivers or the sea.

8 "On 2019-05-16: 1 HTG ~ 0.011 USD"

Figure 16. Left: Image showing a latrine on left and the emptying site is located immediately to the right, on the slope in the middle of the picture. Right: 50-litre rice bags filled with faecal sludge. Photo credit: Anthony Kilbride

JEDCO reported sometimes using *bayakous* to empty latrines, if clients requested that service. Their cost is fixed at 30,000 HTG[9], i.e. more expensive than their mechanical emptying service. JEDCO provide 30 x 55 gallon drums (i.e. total volume of 1,650 gallons ~ 6 m^3) and a truck to take the drums away to a JEDCO disposal site (Figure 19).

In the past, there was an effort by the city hall to support *bayakous* with operating licenses, which would be provided for a fee. The goal was to recognize the existence and need for services provided by *bayakous* and to improve working conditions. Licensing stopped a few years ago, after little progress was made to address the demand of *bayakous* for support and provision of dedicated FS disposal locations.

A thorough mapping exercise of *bayakous* is a necessary, albeit difficult task, in order to advance Cap-Haïtien's FSM strategy. One group, 'SANITAS', who provide *bayakou* services to JEDCO, report that *bayakous* operate geographically, according to operational zones. Another group, 'KASAV' (Konbit Aksyon Sosyal pou Asenisman Vil yo), comprising some of the more senior *bayakous*, was organized in December 2018 under the guidance of the Limonade-based private company, Spiral Group.

CBS system

Households that use the EkoLakay service provided by SOIL are visited at least once each week to collect a full container, leave a clean empty container and provide a fresh supply of carbon cover material. The monthly fee for services ranges from 200 HTG[10] for mobile payments, to 250 HTG[11] for cash payments at the depot and 300 HTG[12] for payments in cash through door-to-door payment collections. The goal is to transition to 100% mobile payments. SOIL technicians are sent to customers in the even that toilet repair or maintenance is needed.

Containers are collected in modified wheelbarrows or three-wheeled motorcycles and transported to a neighbourhood depot for intermediate storage to optimize logistics (Figure 17). Currently, six vehicles are operated, with one additional vehicle available as a back-up. Containers are stored at the depot for approximately one day before they are transferred (three trips per week) with a flat-bed truck (capacity of 500 containers) to a treatment site, which is approximately 12 km outside of the city.

Figure 17. SOIL collection of containers used inside CBS toilets. Depending on the density of the neighbourhood, appropriate modes of transport are developed, such as modified wheelbarrows and three-wheeled motorcycles. Photo credit: SOIL

9 305.58 USD (29th April 2020)

10 2.04 USD (29th April 2020)

11 2.55 USD (29th April 2020)

12 3.06 USD (29th April 2020)

2.1.3 Treatment infrastructure

Four sites for disposal and/or treatment were documented as part of the SFD assessment. Figure 18 shows a map of Cap-Haïtien commune and the four neighbouring communes. Each site is identified with a blue marker. The "3 Baies" natural protected area is shown in a shade of green. Below, is a description of each individual site.

Figure 18. Map showing the commune of Cap-Haïtien and four neighbouring *communes*. Four disposal and/or treatment sites are indicated with blue markers

MSPP

This site is located on the grounds of Hôpital de la Convention Baptiste d'Haïti at the "Carrefour Lamò" intersection. FS collected by the truck of the Cholera Treatment Center is discharged here. The treatment consists of three steps: (1) chlorine disinfection, (2) dewatering and drying on two unplanted drying beds, (3) and final disposal through burying of dried sludge onsite. No liquid effluent treatment is provided. Daily quantities and effectiveness of treatment are unknown. As this site only concerns the Cholera Treatment Center, it was not included in the production of the SFD graphic.

JEDCO

This site is located outside of Cap-Haïtien in the commune of Quartier Morin. It is basically an unlined hole dug in the ground (surface area: 15 m x 15 m), with a low wall surrounding three sides of the hole (Figure 19). The hole is on private land and was commissioned by JEDCO approximately 10 years ago. JEDCO pay an annual fee to use the land; a fee is paid to the landowner, as well as to the mayor of Quartier Morin. However, the site is open to the public and used by many other groups, including GOLSA, SANITAS, and SANCO. A site observation in June 2019 revealed that solid waste and FS collected by *bayakous* is also dumped at this site, outside the brick walls that provide limited protection. Daily quantities discharged at this site are unknown.

Figure 19. JEDCO truck dumping FS into JEDCO site and images of solid waste, indicating disposal of FS collected by *bayakous*

DINEPA

The National Directorate of Drinking Water and Sanitation (DINEPA) site, now managed by OREPA Nord, was built to service the portable toilets for the national carnival of 2013 (Figure 20). The site was designed and constructed by Golder Associates, a private company based in the USA.

The site is composed of two reception basins and a single retention basin. The operating history of the site since 2013 is not documented, but the site has been non-functional for many years and is now closed. Approximately 60% of the site footprint, on the eastern side of the site, is inside the natural protected area of '3 Baies'.

Figure 20. DINEPA treatment site in Mouchinette, commune Limonade. The site is managed by OREPA Nord

SOIL composting site

SOIL's composting (waste treatment) site in Mouchinette is just across the road from the OREPA Nord-managed site. It was commissioned in 2012 and has increased its capacity gradually, in line with the waste it receives from the CBS toilets. The thermophilic composting operation uses batch processing; a single batch is the volume contained within a compost bin. The basic waste treatment unit is a compost bin (2m x 5m x 1.5m deep) and a series of three adjoining spaces to turn the compost (Figure 21).

The waste treatment process (from the compost bin to the first, second, and then, third, space) can take up to six months per batch. The compost bins and adjoining spaces are covered. An on-site laboratory verifies the safety of the composting process. After six months, compost is sieved and sold as a rich organic compost called 'Kopos Lakay'. The SOIL site is the only safe waste treatment site in Cap-Haïtien.

Figure 21. SOIL composting site. Transfer of container content to composting bins and disinfection of cleaned buckets with chlorine solution. Photo credit: SOIL (left) and Lars Schoebitz (right)

Uncontrolled site

A fifth site near *Carrefour Lamò* was mentioned but could not be visited. It would seem that this site is also more of an uncontrolled dumping site for private trucks.

2.1.4 End-use / Disposal

Only the SOIL composting site produces an end-use product, an organic compost called '*Kopos Lakay*' marketed as '*Eko Lakay*'. SOIL currently produce five tons of compost per month.

2.2 SFD Matrix

The following sections include a detailed explanation of all assumptions that were made to derive percentages for the final SFD graphic presented and discussed in Section 2.3. Figure 22 shows the SFD selection grid and Figure 23 depicts the SFD matrix.

Figure 22. SFD selection grid

List A: Where does de toilet discharge to? (i.e. what type of containment technology, if any?)	List B: What is the containment technology connected to? (i.e. where does the outlet or overflow discharge to, if anything?)									
	to centralised combined sewer	to centralised foul/separate sewer	to decentralised combined sewer	to decentralised foul/separate sewer	to soakpit	to open drain or storm sewer	to water body	to open ground	to "don't know where"	no outlet or overflow
No onsite container. Toilet discharges directly to destination given in List B					Significan risk of GW pollution Low risk of GW pollution					Not Applicable
Septic tank					Significan risk of GW pollution T1A2C5					
Fully lined tank (sealed)					T2A3C5 Low risk of GW pollution					T1A3C10
Lined tank with impermeable walls and open bottom	Significan risk of GW pollution Low risk of GW pollution	Significan risk of GW pollution Low risk of GW pollution	Significan risk of GW pollution Low risk of GW pollution	Significan risk of GW pollution Low risk of GW pollution	Significan risk of GW pollution Low risk of GW pollution					Significan risk of GW pollution Low risk of GW pollution
Lined pit with semi-permeable walls and open bottom	Not Applicable									T2A5C10 T1A5C10
Unlined pit										Significan risk of GW pollution Low risk of GW pollution
Pit (all types), never emptied but abandoned when full and covered with soil										Significan risk of GW pollution Low risk of GW pollution
Pit (all types), never emptied, abandoned when full but NOT covered with soil										
Toilet failed, damage, collapsed or flooded										
Containment (septic tank or tank or pit litrine) failed, damaged, collapsed or flooded										
No toilet. Open defecation	Not Applicable								T1B11 C7 TO C9	Not Applicable

Figure 23. SFD matrix

Cap-Haïtien, Department Nord, Haiti, 20 Sep 2019. SFD Level: 3 - Comprehensive SFD
Population: 404766
Proportion of tanks: septic tanks: 100%, fully lined tanks, 100%, lined, open bottom tanks: 100%

System label	Pop	F3	F4	F5
System description	Proportion of population using this type of system	Proportion of this type of system from which faecal sludge is emptied	Proportion of faecal sludge emptied, which is delivered to treatment plants	Proportion of faecal sludge delivered to treatment plants, which is treated
T1A2C5 Septic tank connected to soak pit	8.0	90.0	10.0	10.0
T1A3C10 Fully lined tank (sealed), no outlet or overflow	1.0	100.0	100.0	100.0
T1A5C10 Lined pit with semi-permeable walls and open bottom, no outlet or overflow	10.0	64.0	0.0	0.0
T1B11 C7 TO C9 Open defecation	11.0			
T2A3C5 Fully lined tank (sealed) connected to a soak pit, where there is a "significant risk" of groundwater pollution	29.0	90.0	10.0	10.0
T2A5C10 Lined pit with semi-permeable walls and open bottom, no outlet or overflow, where there is a "significant risk" of groundwater pollution	41.0	64.0	0.0	0.0

2.2.1 Step 1: Containment

The SFD-PI methodology uses a set of defined containment technologies to categorize sanitation technologies. For Cap-Haïtien, detailed information is not available about the underground construction of containment technologies. Therefore, assumptions need to be made to categorize available sanitation technologies.

Septic tanks were split into: 10% of septic tanks connected to a soak pit and 90% of fully-lined tanks (sealed) connected to a soak pit in order to reflect the reality that technologies referred to as septic tanks are mostly two-compartment pits. Pit latrines are categorized as lined pits with semi-permeable walls and open bottom, and CBS toilets as fully-lined tanks (sealed) with no outlet or overflow. Table 2 shows the SFD-PI methodology containment definitions for each of the sanitation technologies, with respective estimates for population numbers and percentages, which are rounded to the nearest integer.

Table 2. Sanitation technologies and corresponding containment according to the SFD-PI methodology, including total population numbers and percentages

Sanitation technology	Containment name according to the SFD-PI methodology	Population	Percent
CBS toilet	Fully-lined tank (sealed), no outlet or overflow	4,048	1
Open defecation	No toilet. Open defecation	44,524	11
Pit latrine	Lined pit with semi-permeable walls and open bottom	206,431	51
Septic tank	Fully-lined tank (sealed) connected to a soak pit	117,382	29
Septic tank	Septic tank connected to a soak pit	32,381	8
Total		**404,766**	**100**

2.2.2 Step 2: Groundwater pollution

An assessment of the potential for groundwater pollution was made for each of the eight zones (Figure 1). For each zone and containment technology, the consultant assessed the percentage of containment types with low and significant risk of groundwater pollution. The tool provided by the SFD-PI methodology was used for guidance[13]. Outcomes were discussed during KIIs and a final assessment was prepared.

Q1: Vulnerability of the aquifer

A large portion of Cap-Haïtien is underlain by the *Plain du Nord* alluvial aquifer, which is considered one of Haiti's largest aquifers, spanning over 270 square-kilometres. The aquifer is the primary water supply of Cap-Haïtien and communities in the *Plaine du Nord*. The aquifer also supports private residential, commercial, industrial and agricultural water demands and is considered a critical resource for the future water security of Cap-Haïtien. Aquifer contamination vulnerability is dependent on a variety of factors that include depth to groundwater, recharge dynamics, aquifer media, shallow soil media, topography and land use/sanitation practices. Adamson et al. (2018) analysed aquifer contamination vulnerability based on a model that incorporated these factors. Their study also presented bacteriological analyses of wells throughout the aquifer, demonstrating that large areas of the shallow aquifer exceed DINEPA standards for *E. coli* bacteria. The shallow nature of the aquifer's potentiometric surface, especially in the low-lying areas and plains with sandier soils and aquifer media, are especially vulnerable in areas of higher density development.

Result: The *Plaine du Nord* aquifer is a critical water supply that underlies much of Cap-Haïtien and has low to significant risk for groundwater contamination, influenced by a range of factors. Areas outside the aquifer limits and in the hills have a lower risk for groundwater contamination.

Q2: Lateral separation

A spatial analysis was performed to identify the percentage of sanitation facilities that are located <10m from groundwater sources. As data on the exact location of sanitation technologies are not available, houses were used as a proxy. The analysis has shown that approximately 25% of houses are located within 10m from groundwater sources. The analysis also

13 See here for details: https://sfd.susana.org/risk-groundwater

revealed that more than 25% of houses are located uphill of groundwater sources.

Result: Significant risk of groundwater pollution for Cap-Haïtien as a whole.

Q3 and Q4: Water supply and water production

Municipal water supply is from a series of production wells located in Balan. The wells function intermittently due to a variety of maintenance, management, operation and technical issues (Adamson and Miner, 2018). Water collected from springs in the hills are productive only during the rainy season and with really low water flows (Ingénierie and BRGM et PC, 2011).

The latest inventory identified more than 400 private wells and boreholes, which are largely unprotected. Water from wells for all domestic purposes is used by 60% of the population and as drinking water for 37% of the population (IDB and Nord 2017). Although 77% of drinking water originates from private stands where water is supposed to be treated, the water is also extracted from unprotected, underlying groundwater.

Result: Significant risk of groundwater pollution for Cap-Haïtien as a whole.

Overall risk

The overall risk of groundwater pollution in all urban areas is considered significant. It is only in some parts of the informal settlements of *Haut du Cap* and *Centre*, and the peri-urban areas of *Haut du Cap* where the risk is considered low. This is largely due to the fact that sanitation technologies are on hills with great enough of a distance from groundwater sources. Based on local knowledge of the contributing authors, low risk was estimated for:

- 20% of pit latrines in zone AI_centre.
- 20% of pit latrines in zone AI_2éme Haut du Cap.
- 20% of pit latrines in zone PU_2éme Haut du Cap.
- 10% of septic tanks in zone AI_centre.
- 10% of septic tanks in zone AI_2éme Haut du Cap.
- 20% of septic tanks in zone PU_2éme Haut du Cap.

Table 3 shows the resulting total percentages of sanitation technologies that are considered to be in areas of low and significant risk of groundwater pollution. In total, 3% of the population have sanitation technologies located in areas of low risk for groundwater pollution and are therefore considered as "FS contained", while for 97% of the population, the result is "FS not contained". Data can be disaggregated by zone, which would make it possible to produce eight SFD graphics. This disaggregation will be useful for the planning process to provide adequate solutions based on the specific characteristics of each zone.

Table 3. Sanitation technologies and corresponding containment according to the SFD-PI methodology, including percentages of population using the technology in areas of low and significant risk of groundwater pollution

Sanitation technology	Containment name according to the SFD-PI methodology	Significant risk [%] and system name	Low risk [%] and system name
Septic tank	Fully-lined tank (sealed) connected to a soak pit	29 (T2A3C5)	0
	Septic tank sealed connected to a soak pit	0	8 (T1A3C5)
Pit latrine	Lined pit with semi-permeable walls and open bottom	41 (T2A5C10)	10 (T1A5C10)
Open defecation	No toilet. Open defecation	11 (T1B11 C7 TO C9)	0
CBS toilet	Fully-lined tank (sealed), no outlet or overflow	1 (T1A3C10)	0
Total		**82**	**18**

The proportion of FS in septic tanks, fully-lined tanks and all types of pits were all set to 100%, as per the guidance given in the Frequently Asked Questions (FAQs) on the Sustainable Sanitation Alliance (SuSanA) website.

2.2.3 Step 3: Emptying

Seven different methods of FS emptying were identified for Cap-Haïtien:

1. "Flushing out" by removing bricks during heavy rain and flooding or connecting a PVC pipe to a nearby stream or drain.
2. Manual emptying by house owner or tenant, discharge locally.
3. Manual emptier (*bayakous*), discharge locally.
4. Manual emptier (*bayakous*), collection in 50-litre rice bags and limited transport (< 2 km).
5. Manual emptier (*bayakous*), collection in 55-gallon (208 litres) drums and motorized transport on trucks.
6. Manual collection of CBS toilet containers, transport on modified wheelbarrows, three-wheelers and trucks.
7. Mechanical emptying with vacuum trucks.

Detailed information on the scale of these methods is not available and would require a dedicated FS quantification survey to be conducted in order to make reasonable estimates. However, it is assumed that 20% of the population with pit latrines throughout Cap-Haïtien does not empty the containment when full, but covers the pit with soil to replace it with a new one. For the remaining population, it is assumed that one of the seven emptying methods is applied when the containment becomes full.

Despite the lack of data, emptying efficiency was assumed as 90% for tanks and 80% for pits as previously reported in other SFD reports with similar sanitation systems (Shrestha et al., 2020). Therefore, variable F3 = 80% x 0.8 = 64% for pits (systems T1A5C10 and T2A5C10) and variable F3 = 100% x 0.9 = 90% for tanks (systems T1A2C5 and T2A3C5). For system T1A3C10 (CBS system), F3 = 100% since the full container is collected, as explained in Section 2.1.2.

2.2.4 Step 4: Transport

Of the seven identified emptying methods, it is only those with motorized transport that can deliver FS to a treatment plant. Data for collection and transport of CBS toilet containers shows that 100% of all containers are also delivered to treatment (variable F4 set to 100% for system T1A3C10).

In the absence of data for the remaining emptying and transport methods, and based on the available truck fleet for the city, it is assumed that a maximum of 10% of FS from septic tanks collected by mechanical emptying with vacuum trucks in urban areas is delivered to treatment (variable F4 set to 10% for systems T1A2C5 and T2A3C5). All remaining FS is considered to not be delivered to treatment and is discharged either locally or to streams, rivers and the ocean (variable F4 for pits, i.e. systems T1A5C10 and T2A5C10 is set to 0%).

2.2.5 Step 5: Treatment

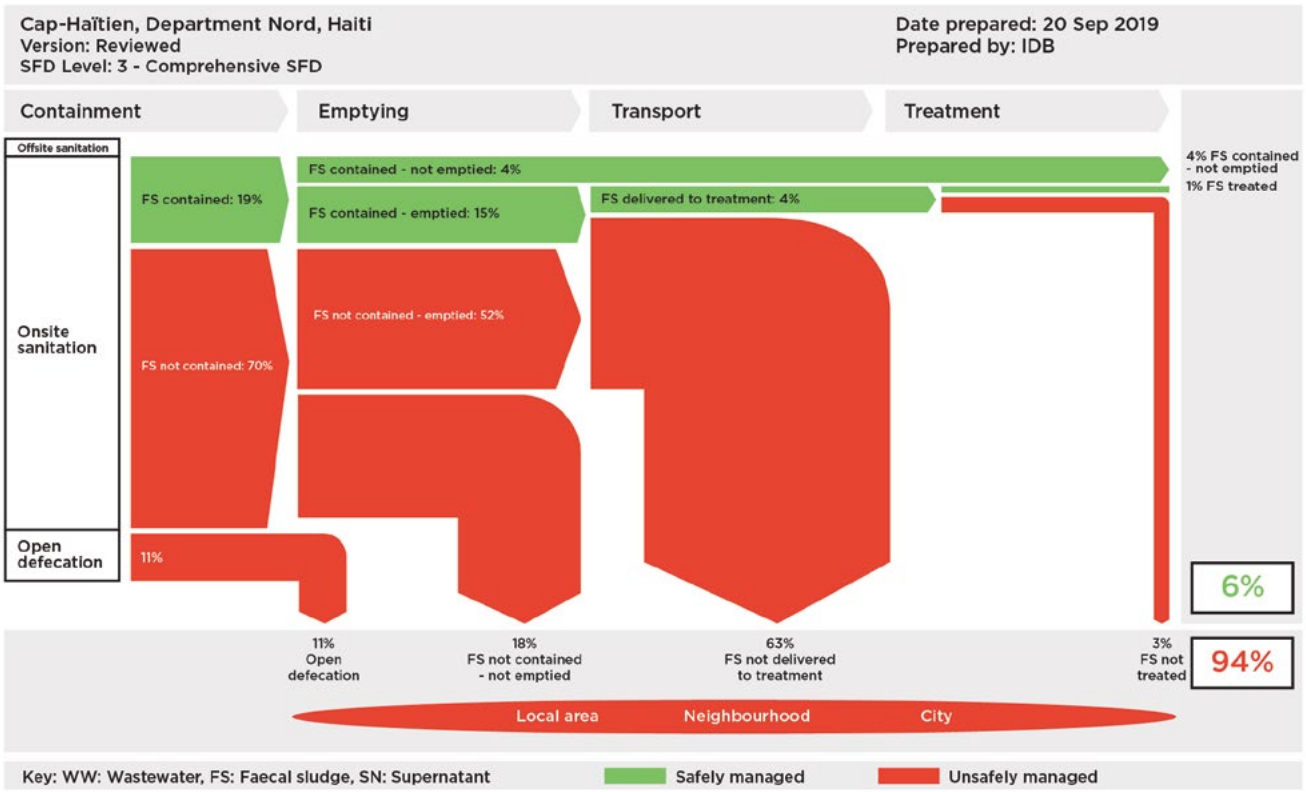
Of the FS that is delivered to treatment, it is only that of CBS toilet containers that is safely treated. Regular quality monitoring of the treatment product, compost, is practised and indicates that World Health Organization standards for safe treatment and re-use are met. Therefore, 100% is considered safely treated (variable F5 for system T1A3C10 set to 100%).

FS collected by mechanical emptying methods is considered to be delivered to the site commissioned by JEDCO. Considering these sites are earmarked for disposal, away from the habitat, although the sites are not appropriately designed treatment plants, it is considered that 10% of excreta reaching the sites is safely treated (variable F5 for systems T1A2C5 and T2A3C5 set to 10%). For pits (systems T1A5C10 and T2A5C10), variable F5 = 0% since no faecal sludge from pits reaches any disposal site, as stated in Section 2.2.4. For system T1A3C10 (CBS system), variable F5 = 100%, since all faecal sludge from this system is treated in the SOIL composting site, as stated in Section 2.1.3.

2.3 SFD graphic

Presented in Figure 24 is the resulting SFD graphic, based on the above data collection and assumptions.

Figure 24. Final SFD graphic for the city of Cap-Haïtien



Produced with support from the SFD Promotion Initiative with funding from the Bill & Melinda Gates Foundation.
The SFD Promotion Initiative recommends that this graphic is read in conjunction with the city's SFD Report which is available at: sfd.susana.org

The assessment shows that in total, 6% of FS is safely managed in Cap-Haïtien and 94% is not safely managed. This final 6% consists of FS from those households that have access to the CBS toilet service, FS from a small number of households with pit latrines that are in areas of low risk for groundwater pollution and cover the pit with soil to replace it with a new one when it is full, and by considering a small portion of FS treated off-site.

The 94% of FS not safely managed consists of: 3% of FS delivered to treatment but not treated; 63% of FS not delivered to treatment; 18% of FS not contained - not emptied and 11% of FS that originates from people practising open defecation.

An immediate action could be to commission a site for safe disposal of the 32% of FS that is not treated at the current (JEDCO site) discharge location. A safe discharge location would likely also result in a greater percentage of FS to be delivered to treatment that is currently not. This is because all formal service providers would prefer to discharge FS safely if they had the choice.

However, the greatest increase in safely managed sanitation could be achieved by a combination of technical solutions that should form an overall FSM strategy. These include:

1. Provision of a dedicated (emergency) treatment plant for FS from pit latrines and septic tanks.
2. Provision of transfer stations for intermittent storage of manually-collected FS by *bayakous*.
3. Provision of mechanical transport methods to deliver stored FS from transfer stations to a dedicated treatment plant.
4. Increase of CBS services, specifically in areas with significant risk of groundwater pollution.

In addition to technical solutions, there is a wide range of non-technical methods that can increase demand for safe emptying and transport of FS. These include:

1. Awareness-raising campaigns to inform the population about safe and unsafe methods for FSM.
2. Formal recognition and licensing of FS-emptying service provider as legal services.
3. Support in business development and marketing of FS-emptying services.
4. Financial incentive for discharge of FS at Limonade treatment site.

2.4 Quality / credibility of data sources

The provided "SFD Source Evaluation Tool"[14] (Appendix 1) was used to score the credibility of data sources. In total, 41 sources scored either medium or high if they were official, well-documented studies and conducted within the past few years.

Throughout the process of the production of the SFD graphic, one data source, the household survey, was used the most and will continue to be used in many different ways in the future. Therefore, it is important to discuss this data source and its data collection and analysis process in order to learn from it for more efficient implementation in the future.

The household survey that was implemented in 2017 collected data to compute 38 indicators. The questionnaire was part of a larger national survey, the "*inventaire national*", undertaken by DINEPA in all communes of Haiti to establish a solid baseline for planning and implementation of water, sanitation and hygiene programmes.

For Cap-Haïtien, this national survey was adapted by the IDB to include more detailed questions on sanitation, specifically for planning of FSM infrastructure. The original questionnaire was designed in French and then translated into Creole. The Fulcrum software package, which requires a professional licence obtained by paying a fee, was used for data collection and storage by the survey's main enumerators: the Drinking Water and Sanitation Technician for Communes (TEPACs). Raw data in the database were stored in Creole and then cleaned and interpreted by an IDB statistician to compute an indicator database in French. Another statistician has then used this French database, together with results of a second demographic survey, to establish summarized indicators for the entire population in each of the eight zones.

Learnings:

1. Questions in Creole are not well-formulated. This leads to misinterpretations by surveyors and households.
2. Interpretation of Creole raw data for computation of indicators is unclear and not reproducible.
3. Datasets are lacking metadata and codebooks that describe each variable and response values.

Recommendations:

1. Translated questionnaires need to be validated and field-tested with professionals who understand the language and have knowledge of the context of the survey.
2. Transformation and interpretation of raw data into a set of indicators should ideally be written in code, so that each step can be reproduced. If that is not feasible, then each interpretation and manipulation needs to be well-documented in a data analysis notebook, which forms part of the metadata and should always be shared, together with final indicators.
3. The minimum metadata that should be provided with raw datasets is a codebook that describes each variable (i.e. column in a dataframe) and response categories. This ensures that those who use the data fully understand the meaning of the information.

14 Access tool here: https://www.susana.org/_resources/documents/default/3-3525-7-1548074582.xlsm

3. Service Delivery Context Analysis

3.1 Policy, legislation and regulations

3.1.1 Policy

Sanitation is underfunded in the WASH sector in Haiti. The legal framework of the sector is outdated and scattered throughout several legislative texts pertaining to urban and rural development and hygiene. Responsibilities for sanitation are divided among municipalities and ministries, including the Ministry of Public Works, Transportation, and Communication (MTPTC), Ministry of the Environment (MDE) and Ministry of Public Health and Population (MSPP). A memorandum of understanding (MoU) on the promotion of sanitation, hygiene, and the living environment, which was signed by these three ministries (MTPTC, MSPP, and MDE 2015) in January 2016, represents a first step in organizing the sector. However, it is not known if this MoU has resulted in any actions or follow-up at a local level.

3.1.2 Institutional roles

The framework law of 2009 on the organization of the water and sanitation sector incorporates sanitation into the responsibilities of the National Directorate of Drinking Water and Sanitation (DINEPA), under the guidance of the MTPTC, particularly in defining a sanitation policy (République d'Haïti, 2009). However, the framework law makes very little mention of sanitation in general, and no mention of individual household sanitation. Specifically, DINEPA's mandate has three main parts:

- development of the WASH sector nationally;
- regulation of the sector;
- monitoring of the actors.

A "Strategic Guidance Document for Sanitation in Haiti" was produced, but has not translated into policy or local action (DINEPA and République d'Haïti, 2014). It has set a goal of reaching national sanitation coverage of 90% by 2022.

Concerning the powers of each of the two other ministries involved, their main mandates in connection with sanitation are:

- Ministry of the Environment – Department of the Living Environment and Sanitation: Draw up and enforce rules, standards, and recommendations for procedures related to excreta and wastewater.

- Ministry of Public Health and Population: Draw up and oversee the enforcement of technical and sanitation standards related to public hygiene.

Other ministries are involved in the sanitation sector (DINEPA and République d'Haïti, 2014):

- The Ministry of National Education and Vocational Training (MENFP), in connection with sanitation in the schools and environmental education, ensures compliance with environmental standards in schools and introduction of hygiene principles in basic education curricula.

- The Ministry of the Interior and Regional Communities (MICT), through the municipalities, the Ministry of Planning and Foreign Cooperation (MPCE), the Interministerial Committee of Regional Development (CIAT), the Urban Planning Service (SPU-MTPTC) and the Ministry of Agriculture, Natural Resources, and Rural Development (MARNDR), respectively, is responsible for enforcing local laws, regional development, management of catchment areas for the potential reuse of treated effluent, if applicable.

Finally, at the national level, a bill was voted on in 2017 for the creation of an autonomous body (ANARHY: *Agence Nationale des Ressources Hydriques*) charged with implementing the government policy on regulating the water and sanitation sector without specifying its sanitation mandate. The coordination between this new entity and DINEPA does not yet seem clearly defined for the moment.

The framework law of 2009 also created the OREPAs (*L'Office Régionale de l'Eau potable et de l'Assainissement*) in charge of compliance with the standards and directives developed by DINEPA. At

the regional level and, more specifically, for the city of Cap-Haïtien, sanitation is the shared responsibility of OREPA Nord, the Health Department of Nord (MSPP) and the municipality of Cap-Haïtien.

3.1.3 Service provision

While DINEPA, in its sector strategy (DINEPA and République d'Haïti, 2014), encourages the diversification of service management models, service provision in FSM is essentially private or, in a few cases, provided by NGOs, without private-public partnership.

Households rely on private companies for de-sludging service. The vast majority of Cap-Haïtien uses manual emptying and transport services when their latrines become full. In Haiti, these service providers are referred to as *bayakous*. The number of individuals who operate in Cap-Haïtien cannot be reliably estimated.

In Cap-Haïtien, four private companies were identified that use mechanical methods (i.e. vacuum trucks) for emptying and transportation of faecal sludge (FS): JEDCO, GOLSA, Cap Sanitation Services and Clean X. These companies provide services in Cap-Haïtien, but JEDCO and GOLSA have a larger presence in Port-au-Prince.

Each treatment site is operated by the owner of the site (private company or public agency).

In Cap-Haïtien, an "*EkoLakay Toilet*" service is provided by Sustainable Organic Integrated Livelihoods (SOIL), a non-profit research and development organization[15].

3.1.4 Service standards

In 2013, DINEPA published the technical reference for the Drinking Water and Sanitation sector[16]. The general technical requirements apply to operations to be carried out in Haiti and fall within the scope of competence of DINEPA.

However, there is no effluent discharge standard for wastewater and sewage.

3.2 Planning

3.2.1 Service targets

While documents exist at the regional Interministerial Regional Planning Committee (IBI and DAA, 2012) and municipal levels, no comprehensive diagnostic and no planning document exist for the sector at the city level.

At the national level, the sector goal is to achieve 90% sanitation coverage by 2022, through: i) the installation of about 20 sanitation services in the four OREPAs, in collaboration with the MSPP Hygiene Department; ii) encouraging families to build 500,000 new sanitary facilities and improve 700,000 existing toilets; and iii) the use of 12,000 public sanitary facilities, with the full involvement of the responsible state authorities, the formalization of 20 emptying services and the commissioning of 20 treatment plants, in collaboration with the Ministry of the Environment (DINEPA and République d'Haïti, 2014).

3.2.2 Investments

The total amount of planned investments in the water and sanitation sector over the next five years for the city of Cap-Haïtien is estimated at USD 50 million. The main contributors are IDB and the Spanish Agency for International Development Cooperation (AECID), with some limited additional support from the United States Agency for International Development (USAID). Most of the investments will be dedicated to the improvement of the drinking water supply to jump from the present 900 clients to more than 16,000. The radical improvement in access to safe drinking water is expected to have a major impact on the use and type of sanitation facilities in the coming years, as well as the dependence on household wells for water supply.

15 For more details, see: https://www.oursoil.org/who-we-are/about-soil/

16 For more details, see: https://dinepa.gouv.ht/lereferentieltechnique/index.html

Based on the above and on the SFD graphic results, a flexible scheme is proposed for the improvement of sanitation in the city. This scheme includes several actions: i) semi-collective type condominial sanitation solutions for the city centre and slums; ii) increasing the CBS (Container-based Sanitation) client base; iii) rehabilitation of the faecal sludge treatment plant; iv) improved management of sludge from both mechanical and manual emptying, including the construction of transfer stations; and v) the inclusion of a sanitation levy in the water bill, to cover sanitation operational expenses for sanitation infrastructure.

3.3 Equity

3.3.1 Current choice of services for the urban poor

The sanitation sector is almost exclusively private. There is no technical or financial assistance for households or owners wishing to install sanitation technologies and there is currently no ongoing public financing for excreta collection or treatment. The market is underdeveloped, unorganized and provides no financially affordable or technically appropriate solutions for the majority of households.

In floodplains in the city, compliance with technical specifications for "conventional" solutions, such as watertight or above-ground pits, has proven to be technically difficult and expensive (DINEPA, 2013). Therefore, the dwellers of this inhospitable environment, the poorest of the poor, must pay the highest construction costs for a safely-contained toilet, or must resort to open defecation.

3.3.2 Plans and measures to reduce inequity

EkoLakay toilets offer a promising 'zero-construction' alternative. It is an inexpensive service for households to the extent that the payment is on a monthly basis (amounting to a maximum of 3,600 HTG per year; 42 USD). Importantly, signing up for the service does not require large lump investments in infrastructure or pit-emptying. As such, this service is more accessible to low-income households and the vulnerable segment of the population.

3.4 Output

3.4.1 Capacity to meet service needs, demands and targets

Sanitation in Haiti is essentially self-sustaining and entirely at the expense of the inhabitants. Between 1990 and 2015, and despite the investment made since the cholera outbreak in 2010, access to improved sanitation has decreased by three percentage points for the poorest 40% in urban areas (World Bank, 2018). Therefore, it is unlikely that the current capacity of the sector will be adequate to meet service needs, demands and objectives.

The *EkoLakay* service is only available to a limited number of customers at present, and would require financial support to be extended.

3.4.2 Monitoring and reporting access to services

At the national level, DINEPA undertakes activities aimed at a better knowledge of the different private operators working in the sector and a better understanding of the system, in accordance with and through the systems established by the National Observatory of DINEPA (DINEPA and République d'Haïti, 2014). However, only a small amount of data is available for the sector (and nothing for urban sanitation). Most of the available information comes from international agencies, in particular the Joint Monitoring Program (OMS and UNICEF).

There is no regular monitoring and reporting on access to services at the municipal level. The most up-to-date information is based on the Demographic Household Survey, implemented by Inter-American Development Bank and OREPA Nord in 2017.

3.5 Expansion

In urban areas, such as Cap-Haïtien, there are currently no plans to stimulate demand for services or strengthen the public and private sectors.

4. Stakeholder Engagement

The proposed tools of the SFD-PI methodology were used for stakeholder engagement and data collection. All planning and execution of engagement activities was carried out jointly with OREPA Nord.

Key information interviews

Between 27th June 2017 and 18th April 2018, KIIs were performed with approximately 20 representatives at the national, regional and municipal levels. Another set of KIIs was performed in June 2019 to fill some remaining gaps of the initial SFD graphic.

Focus group discussions

Twelve FGDs were organised, which approximately 150 people attended.

- Ten FGDs with households. These FGDs were distributed throughout 10 neighbourhoods of the city to get a representative picture of the different typologies of neighbourhoods.
- One FGD with sanitation officers (DSN-MSPP).
- One FGD with manual emptying service providers (*bayakous*).

Observations

A wide range of observations have supported the triangulation of quantitative and qualitative data.

Local SFD event

The results of the SFD graphic were presented and discussed publicly on 27th June 2018 at the city hall of Cap-Haïtien in the presence of more than 80 representatives of public institutions (various ministries, departmental agencies and municipalities), the private sector (*bayakous* and formal emptying companies), NGOs and local associations (SOIL, etc.), as well as technical and financial partners of the Republic of Haiti (IDB, AECID, USAID).

During the workshop, the SFD graphic was widely discussed in its most important aspects and a consensus was reached.

5. Acknowledgements

The authors are grateful to everyone who participated in the discussions and the development of this SFD report. They include: Guito Edouard (General Director – DINEPA), Edwige Petit (Director - Sanitation Division DINEPA), Poisson Bernardin (Director – OREPA NORD), Durant Leroy Edniss (TEPAC), Jean-Claude Mondésir (Principal Mayor of Cap-Haïtien), Frantzy Jean (Director of the City Hall of Cap-Haïtien), Maria Rodríguez Vera (IDB); as well as Franciot Wanelus, assistant consultant, for their involvement in this project.

6. References

Adamson, James, and Javan Miner. 2018. "Hydrogeological characterization of the aquifer and existing wells at Balan, Cap-Haïtien, Haiti. Report III. Well inspection and testing report."

Adamson, James, Javan Miner, and Sarah Lindholm. 2018. "Hydrogeological studies and planning Cap-Haïtien and Gonaïves. Report IV modeling of groundwater contamination vulnerability commune of Cap Haïtien, Haïti."

Archambault, Aude, and Benjamin Biscan. 2018. "ANALYSE ENVIRONNEMENTALE ET SOCIALE (AES) DU PROJET EAU, ASSAINISSEMENT ET HYGIENE A CAP HAITIEN, DEPARTEMENT DU NORD, HAITI. PROGRAMME EAU, ASSAINISSEMENT ET HYGIENE DANS LES ZONES URBAINES, PERIURBAINES ET RURALES DE LA REGION NORD DHAITI (HA-L1135)."

Banque Mondiale. 2018. Regarder Au-Delà de la Provision par le Gouvernement des Services en Eau et Assainissement : Les Choix et Pratiques des Plus Vulnérables en Haïti. Banque mondiale, Washington, D.C.

CNIGS. 2014. "Centre National d'Informations Géospatiales (CNIGS) (2014). Spatial Point Data of All Buildings in Cap-Haïtien."

DINEPA. 2013. "DINEPA République d'Haïti Référentiel Technique National EPA."

DINEPA, and République d'Haïti. 2014. "Document d'orientation Stratégique Pour L'assainissement En Haïti." Disponible Sur : https://www.dinepa.gouv.ht/strategie-nationale-de-lassainissement/.

Guillande, R. 2015. "Caractérisation et Cartographie Du Risque Inondation et de Submersion Marine Sur L'agglomération Du Cap-Haïtien." Disponible Sur: http://ciat.gouv.ht/sites/default/files/docs/Rep-FINAL-CIATLIDAR-04.15.001V3.pdf%09.

IBI and DAA. 2012. "Plan Stratégique de Développement d'Haïti. Tome 1 Les Grands Chantiers Pour Le Relèvement et Le Développement d'Haïti."

IDB. 2017. "Demographic Household Survey (N = 3090) Implemented by Inter-American Development Bank and OREPA Nord."

IDB, and OREPA Nord. 2017. "Household Survey for Water, Sanitation and Hygiene Indicators (N = 1518)."

IHSI. 2015. "L'Institut Haïtien de Statistique et d'Informatique (IHSI) 'Population Totale, de 18 Ans et Plus - Ménages et Densités Estimés En 2015.'."

Ingénierie, BRL, and BRGM et PC. 2011. "Etude de Faisabilité Pour La Réhabilitation, L'extension Du Système AEP, La Réalisation Du Système d'assainissement Des Rejets Liquides et La Supervision de Travaux de La Ville de Cap Haïtien. Rapport Final d'étude. Composante 1 : Volet Eau et Assainissement."

Lozano Gracia, Nancy, and Marisa Garcia Lozano. 2017. "Haitian cities: Actions for today with an eye on tomorrow." 122880. The World Bank.

MTPTC, MSPP, and MDE. 2015. "Protocole d'accord Entre Le Ministère Des Travaux Publics, Transports et Communication ; Le Ministère de La Santé Publique et de La Population ; Le Ministère de L'Environnement ; Portant Promotion de L'assainissement, de L'hygiène et Du Cadre de Vie."

République d'Haïti. 2009. "Loi Cadre Portant Organisation Du Secteur de L'eau Potable et de L'assainissement." *Le Moniteur*, (29), p. 1-12.

Shrestha, J. et al. (2020). SFD report for Waling (Nepal). SuSanA Promotion Initiative website.

7. Appendix

7.1 Appendix 1: SFD Source Evaluation

Name of the source	Type of source	Representativenes	Depth of data or Scal	Confidenc	Documentati	Sum of Value	Credibility
Programme des Nations Unies pour le Développement. 1990. "Cadre Hydrogéologique d'Haïti 1/250000."	Documented studies	1	0	3	1	5	MEDIUM
ONU-Habitat. 2012. "Haïti : Profil Urbain Du Cap-Haïtien."	Documented studies	1	0	3	1	5	MEDIUM
LOKAL+. 2014. "Plan de Financement Des Services Publics Communaux (PFC)."	Documented studies	2	0	3	1	6	MEDIUM
L'Institut Haïtien de Statistique et d'Informatique (IHSI) "Population Totale, de 18 Ans et plus - Ménages et Densités Estimés En 2015."	Documented studies	2	0	2	2	6	MEDIUM
L'Institut Haïtien de Statistique et d'Informatique (IHSI) "Population Totale, de 18 Ans et plus - Ménages et Densités Estimés En 2012."	Documented studies	1	0	2	2	5	MEDIUM
L'Institut Haïtien de Statistique et d'Informatique (IHSI) "Population Totale, de 18 Ans et plus - Ménages et Densités Estimés En 2009."	Documented studies	1	0	2	2	5	MEDIUM
IBI DAA. 2012. "Plan Stratégique de Développement d'Haïti. Tome 1 Les Grands Chantiers Pour Le Relèvement et Le Développement d'Haïti."	Documented studies	1	0	3	1	5	MEDIUM
Comite Interministerial d'Amenagement du Territoire (CIAT). 2012. "Plan d'aménagement Du Nord/Nord-Est."	Documented studies	1	0	3	1	5	MEDIUM
BRL Ingéniarie, BRGM, and PC. 2011. "Etude de Faisabilité Pour La Réhabilitation, l'extension Du Système AEP, La Réalisation Du Système d'assainissement Des Rejets Liquides et La Supervision de Travaux de La Ville de Cap Haïtien"	Documented studies	1	0	3	2	6	MEDIUM
Caractérisation et Cartographie Du Risque Inondation et de Submersion Marine Sur l'agglomération Du Cap-Haïtien	Documented studies	3	0	3	3	9	HIGH
focus group Hab - Slum 1	Interviews and FGDs	2	3	2	3	10	MEDIUM
focus group Hab - Slum 2	Interviews and FGDs	2	3	2	3	10	MEDIUM
focus group Hab - Slum 3	Interviews and FGDs	2	3	2	3	10	MEDIUM
focus group Hab - Slum 4	Interviews and FGDs	2	3	2	3	10	MEDIUM
focus group Hab - Urbain 1	Interviews and FGDs	2	3	2	3	10	MEDIUM
focus group Hab - Urbain 2	Interviews and FGDs	2	3	2	3	10	MEDIUM
focus group Hab - Urbain 3	Interviews and FGDs	2	3	2	3	10	MEDIUM
focus group Hab - Urbain 4	Interviews and FGDs	2	3	2	3	10	MEDIUM
focus group Hab - Péri-urbain 1	Interviews and FGDs	3	3	2	3	11	HIGH
focus group Hab - Péri-urbain 2	Interviews and FGDs	2	3	2	3	10	MEDIUM
focus group Bayakou	Interviews and FGDs	3	3	3	3	12	HIGH
focus group Officiers Sanitaires	Interviews and FGDs	3	2	3	3	11	HIGH
Entretien avec	Interviews and FGDs	3	3	3	3	12	HIGH
Entretien avec	Interviews and FGDs	3	3	3	3	12	HIGH
Entretien avec	Interviews and FGDs	3	3	3	3	12	HIGH
Entretien avec	Interviews and FGDs	3	3	3	3	12	HIGH
Entretien avec	Interviews and FGDs	3	3	3	3	12	HIGH
Entretien avec	Interviews and FGDs	3	3	3	3	12	HIGH
Entretien avec	Interviews and FGDs	3	3	3	3	12	HIGH
Entretien avec	Interviews and FGDs	3	3	3	3	12	HIGH
Rodriguez, Maria, and Sergio Perez. 2017. "Desigualdades En Materia de Agua, Saneamiento e Higiene En La Ciudad de Cabo Haitiano, Haiti - Version Provisoire."	Municipal, utility or private local service provider records	3	0	2	3	8	HIGH
SOIL. 2018. "Kat Sèvis EkoLakay Okap."	Municipal, utility or private local service provider records	3	0	2	3	8	HIGH
OXFAM. 2016. "Plan d'action Contre Le Choléra de La Ville Du Cap Haïtien."	Municipal, utility or private local service provider records	3	0	1	1	5	MEDIUM
DINEPA Republic of Haiti. 2014. "Document d'orientation Stratégique Pour l'assainissement En Haïti."	Municipal, utility or private local service provider records	2	0	1	3	6	MEDIUM
République d'Haïti. 2009. "Loi Cadre Portant Organisation Du Secteur de l'eau Potable et de l'assainissement."	Municipal, utility or private local service provider records	1	0	3	3	7	MEDIUM
Observation toilette publique	Observation	3	3	2	3	11	HIGH
Observation Site de Dépotage	Observation	3	3	2	3	11	HIGH
Observation fosse "septique" en construction	Observation	3	1	3	3	10	MEDIUM
Observation Prison	Observation	3	3	2	3	11	HIGH
Observation Ecoles	Observation	3	3	2	3	11	HIGH

SFD Promotion Initiative