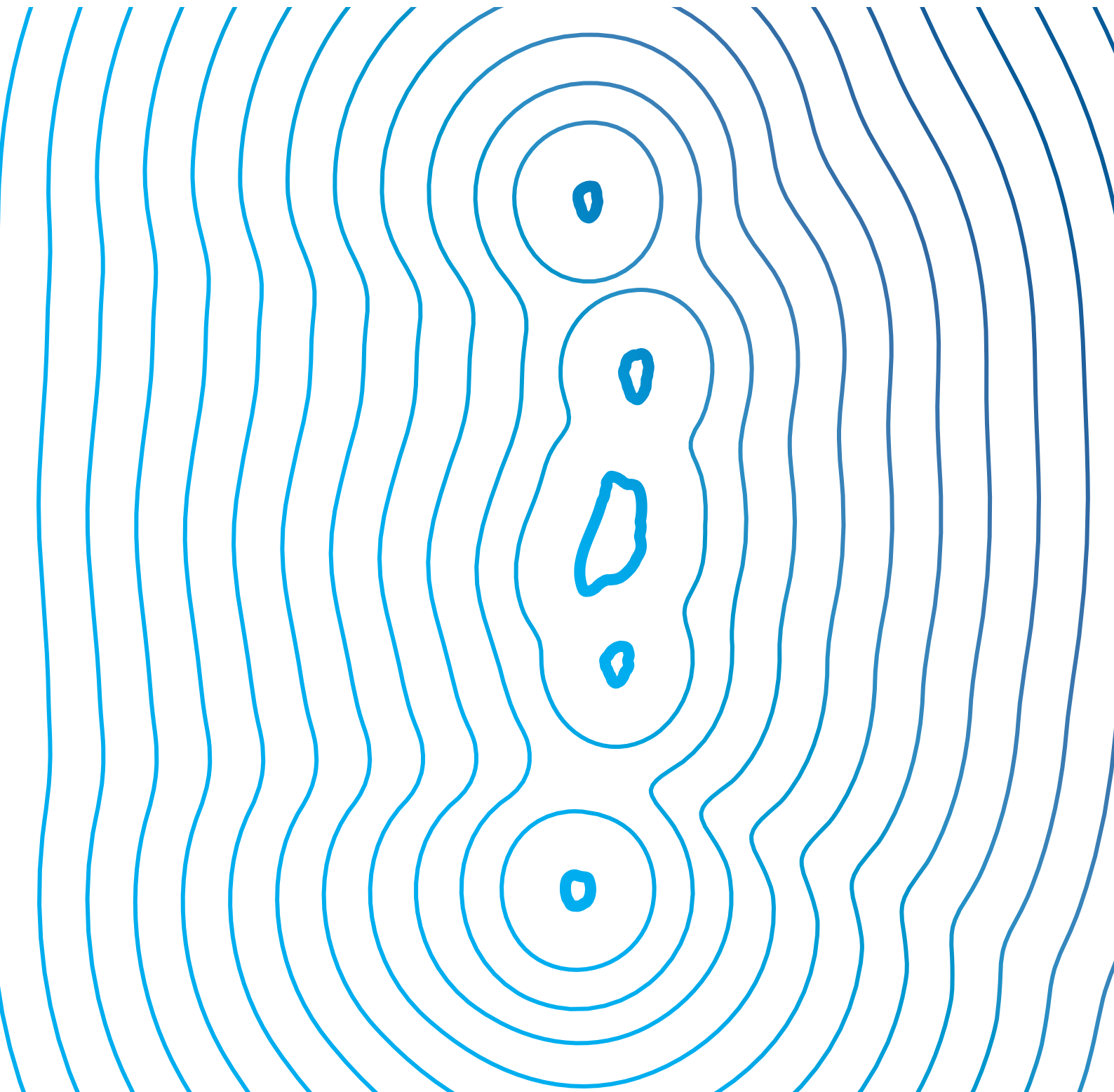


Water Security in Barbados and 11 Countries of the Eastern Caribbean



Water Security in Barbados and 11 countries of the Eastern Caribbean

Editor CAF

Executive Presidency
Sergio Díaz-Granados

Corporate Vice Presidency, Strategic Programming
Christian Asinelli

Sustainable Territorial Development Management
Julián Suárez Migliozi

Direction of Analysis and Technical Evaluation of Water and Sanitation
Franz Rojas

Regional Management Caribbean
Stacy Richards-Kennedy

Direction of Strategic Communication
Editorial management

Document based on the report by: Stephan Quash, Senior Consultant

Technical supervision:
Raúl Caldevilla, DAETAS
Luis Burbano, DAETAS
Jorge Escurra, DAETAS

Technical edition:
Agustin Alonso, DAETAS
Carlos Orellana, DAETAS

Logistical Support:
Florencia Pietrafesa, DAETAS

Graphic design
Estudio Bilder / Buenos Aires

This and other publications are available at scioteca.caf.com

© CAF-development bank of Latin America and the Caribbean- 2024

The ideas and statements contained in this publication are the sole responsibility of the authors and do not represent the official position of CAF. The terminology used and the presentation of data in this publication do not imply any endorsement by CAF regarding the legal status of countries, territories, cities, regions, or their respective authorities, borders, or boundaries.

Licensed under the Creative Commons Attribution-NonCommercial-NoDerivs 4.0 International License (CC-BY-NC-ND 4.0). To view a copy of this license, visit <https://creativecommons.org/licenses/by-nc-nd/4.0/>



Content

Acronyms — 6

1

Introduction — 8

2

Regional context of the Eastern Caribbean — 10

Geography, Demography & Political landscape — 11

Socio Economic characteristics of the Eastern Caribbean — 14

Weather, climate change and Water Resources in the Eastern Caribbean — 16

3

Water Security - Regional Diagnosis & Gap Analysis (Eastern Caribbean) — 18

Legal, Institutional & Regulatory Landscape — 19

Water Resources Management — 21

Existing Infrastructure (water supply & sanitation, irrigation & drainage) — 24

Vulnerability to Extreme Weather Events - Adaptation & Mitigation — 32

Status of Hydrometeorological and Climate Monitoring Systems — 33

Emergency Response Plans and Disaster Preparedness — 35

Asset Planning & Development — 37

Historical Investments by Subsector — 38

Governance Frameworks and Institutional Performance — 40

4

Roadmap — 42

General — 43

Watershed Management improvement — 45

Water Supply Improvement — 48

Sanitation and Sewerage Improvement — 55

Drought management and flood control — 61

5

Water Security - Island Case Studies — 64

Barbados — 65

Dominica — 74

Grenada — 81

Guadeloupe — 90

Martinique — 105

Saint Lucia — 115

Saint Vincent and the Grenadines — 121

Figure Index

Figure 2.1 Caribbean Region	12
Figure 2.2 OECS States in the Caribbean	13
Figure 3.1 Level of Development of the Governance Framework versus Performance of State-Owned Water and Sanitation Enterprises in the English-Speaking Caribbean	30
Figure 3.2 Water Tariffs in the Caribbean Region (IDB - 2017)	31
Figure 3.3 Spiral of Decline (PUB Singapore & Rouse 2013)	31
Figure 5.1 Existing and Expanded NAWASA Service Area - Southern St. George Water Expansion Project	89
Figure 5.2 Water Service Providers Guadeloupe (2020)	91
Figure 5.3 Sewerage Service Providers Guadeloupe (2020)	92
Figure 5.4 Household Sanitation Service Providers Guadeloupe (2020)	93
Figure 5.5 NRW levels (%) in various parts of Guadeloupe (2020)	98
Figure 5.6 Repartition of PAP Funds per Sub-Sector in Guadeloupe - 2020	102
Figure 5.7 Spatial Distribution of PAP Funds in Guadeloupe - 2020	103
Figure 5.8 Progress Achieved under the PAP as of September 2022 in Guadeloupe	104
Figure 5.9 Natural Risk Prevention Plan – PPRN - Example of Interactive Maps	112
Figure 5.10 Works Implementation under Plan EAU DOM Martinique in Million € (Grants)	114
Figure 5.11 Investment Portfolio (Plan Eau DOM Martinique) per Sub-Sector	115

Table Index

Table 2.1 Socio Economic Characteristics of the Eastern Caribbean States (OECS & Barbados)	14
Table 2.2 Water Resources in the Eastern Caribbean States (OECS and Barbados)	17
Table 3.1 Water Sector Legislation in the OECS & Barbados	20
Table 3.2 Water Resources Management in the OECS & Barbados	23
Table 3.3 Characteristics of Water Supply Systems in the OECS & Barbados	26
Table 3.4 Sewerage and Sanitation in the OECS and Barbados	27
Table 3.5 Hydrometeorological & Climate Monitoring in the OECS & Barbados	34
Table 3.6 Emergency Response Plan and Disaster Preparedness in the OECS & Barbados	36
Table 3.7 Major Ongoing Projects - Water Supply & Sanitation Subsector - in the OECS & Barbados	39
Table 4.1 Preliminary Assessment of Investment Needs in Watershed Management Improvement in countries of the OECS & Barbados	47
Table 4.2 Preliminary Assessment of Investment Needs in Water Supply Improvement in countries of the OECS & Barbados	54
Table 4.3 Preliminary Assessment of Investment Needs in Sanitation & Sewerage Improvement in countries of the OECS & Barbados	60
Table 5.1 Responsibility of Main Agencies in Grenada's Water Sector	81
Table 5.2 Priority Actions to Strengthen Grenada's Disaster Risk Management	85
Table 5.3 Declaration of National Disasters in Grenada – Responsibility Allocation Schedule	87
Table 5.4 Repartition of PSEP Investments - Guadeloupe	102

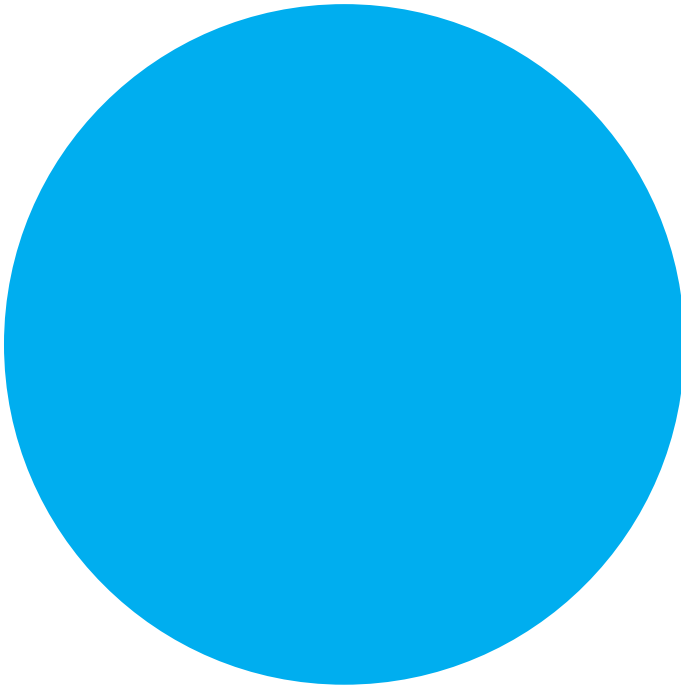
Acronyms

ABMS	Antigua and Barbuda Meteorological Service
ACP	African, Caribbean and Pacific Group of States
ADEME	Agency for the Environment and Energy Conservation (Guadeloupe & Martinique)
APUA	Antigua Public Utilities Authority
ANSI	American National Standards Institute
BMS	Barbados Meteorological Services
BADMC	Barbados Agricultural Development and Marketing Corporation
BOT	Build Operate Transfer
BOOT	Build Operate Own Transfer
BS	British Standards
BVI	British Virgin Islands
BWA	Barbados Water Authority
BWS	Belize Water Services Limited
CAF	Development Bank of Latin America and the Caribbean
CAPEX	Capital Expenditure
CARICOM	Caribbean Community
CARIFORUM	Caribbean Forum
CEC	Certificate of Environmental Clearance
CDEMA	Caribbean Disaster Emergency Management Agency
CIMH	Caribbean Institute for Meteorology and Hydrology
CWSA	Central Water and Sewerage Authority (Saint Vincent & the Grenadines)
DDM	Department of Disaster Management (BVI)
DMA	District Metering Areas
DMCA	Disaster Management Coordination Agency (Montserrat)
DMS	Dominica Meteorological Service
DMZ	District Metering Zone
DOM	Département d'Outre Mer (Overseas Department)
DOWASCO	Dominica Water and Sewerage Company
EBITDA	Earnings Before Interest Taxation Depreciation and Amortization
EH	Equivalent Habitant
EMA	Environmental Management Authority
EN	European Norms
EPCI	Etablissement Public de Coopération Intercommunale (Intercommunal Communities or Syndicates – Martinique & Guadeloupe)
EU	European Union
FAO	Food and Agriculture Organization
FTC	Fair Trading Commission (Barbados)
GBV	Gross Book Value
GEF	Global Environment Facility
GWI	Guyana Water Incorporated
ICAO	the International Civil Aviation Organisation
IDB	InterAmerican Development Bank
iMGD	Imperial Millions of Gallons per Day
ISO	International Standards Organization
IWRM	Integrated Water Resources Management
KPI	Key Performance Indicators
MUL	Montserrat Utilities Limited

NaDMA	National Disaster Management Agency (Grenada)
NAWASA	National Water and Sewerage Authority (Grenada)
NDERT	National Disaster Emergency Response Team (Barbados)
NEEC	National Emergency Executive Committee (Saint Vincent & the Grenadines)
NEOC	National Emergency Operations Centre (Barbados)
NEMO	The National Emergency Management Office (Saint Lucia)
NEPO	National Emergency Planning Organization (Dominica)
NHC	National Hurricane Centre (USA)
NURC	National Utility Regulatory Commission (Saint Lucia)
NRW	Non Revenue Water
NWC	National Water Commission (Jamaica)
NWRIS	National Water Resources Information System
ODE	Office De L'Eau (Water Resources Agency in Martinique & Guadeloupe)
ODM	Office of Disaster Management (Dominica)
OECS	Organisation of Eastern Caribbean States
OPEX	Operational Expenditure
OSH	Occupational Health and Safety
PBC	Performance Based Contract
PPP	Public Private Partnership
PTP	Personal Tank Programme
PURC	Public Utility regulatory Commission (Grenada)
PVO	Private Voluntary Organizations (Dominica)
SCADA	Supervisory Control And Data Acquisition
SCHAPI	Central Service for Hydrometeorology and Support for Flood Forecasting (Guadeloupe and Martinique)
SOP	Standard Operating Procedure
SVGMO	St. Vincent & the Grenadines Meteorological Office
UNDESA	United Nations Department of Economic and Social Affairs
WASA	Water and Sewerage Authority (Trinidad y Tobago)
WASCO	Water and Sewerage Company Incorporated (Saint Lucia)
WCA	Water Corporation of Anguilla
WHO	World Health Organization
WLR	Water Loss Reduction
WRMA	Water Resources Management Agency
WSC	Water and Sewerage Corporation (Bahamas)
WSD	Water Services Department (St Kitts & Nevis)
WTP	Water Treatment Plant
WWTP	Waste Water Treatment Plant



Introduction



Caribbean countries are highly vulnerable to natural disasters. Extreme weather events are common, the region experienced three Category 5 hurricanes between 2017 and 2019. When a hurricane hits, it can wipe out the entire annual GDP of a small island and it is often the poorest who suffer the most. Major hurricanes, including Irma and Maria, in 2017, and Dorian in 2019 were stark reminders of this reality.

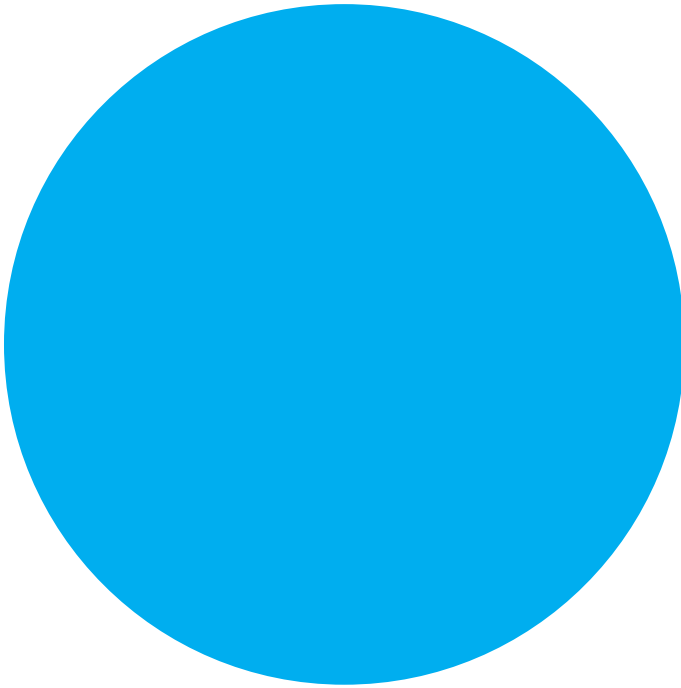
This vulnerability includes challenges to water security, including water scarcity, water stress and drought, pollution, watershed degradation, saline intrusion, and flooding. Climate change is worsening the severity of these challenges, and response capacities are often curtailed by a lack of financial resources, poor coordination between institutions and less than optimal governance structures & procedures.

CAF, Development Bank of Latin America and the Caribbean, is a multilateral financial institution whose mission is to support the sustainable development of its shareholder countries, regional integration and resilience to natural disasters and climate change. CAF serves the public and private sectors, supplying multiple products and services to a broad portfolio of clients from its shareholder countries, private companies, and financial institutions. CAF recently joined the Barbados coalition to develop resilient infrastructure and to drive new social and nature capital investments building on its Resilience and Sustainable facility at the IMF.



2

Regional context of the Eastern Caribbean



Geography, Demography & Political landscape

The Caribbean archipelago covers about 2.6 million km² and includes about 700 islands that make up 30 political entities. The total area of the islands covers about 235,667 km² (Cuba, the Dominican Republic and Haiti making up 79% of the total). In 2019, the total population was 43.5 million inhabitants (Cuba, Dominican Republic and Haiti making up 75% of the total) of which 74.3% (32.3 million) lived in urban areas. The average population density was close to 184 inhabitants/km².

This Eastern Caribbean Water Security Study focuses on 12 countries in the Eastern Caribbean Region, the 11 OECS countries plus Barbados.

The Organisation of Eastern Caribbean States (OECS), a sub-group of islands in the Eastern Caribbean established in 1981, comprises of 11 states (7 member states and 4 associate states), covers about 5,910 km², with a total 2017 population of 1.434 million and an average population density of 216 hab/km². The OECS include member states Antigua and Barbuda, Dominica, Grenada, Saint Kitts and Nevis, Saint Lucia, Saint Vincent and the Grenadines, Montserrat, and associate states Anguilla, the British Virgin Islands, Guadeloupe and Martinique.

Barbados, also located in the Eastern Caribbean, covers 439 km², with an estimated 2023 population of 303,000 of which 34% live in urban areas. The average population density was close to 690 inhabitants/km².

The OECS is an inter-governmental organisation dedicated to economic harmonisation and integration, protection of human and legal rights, and the encouragement of good governance between countries and territories in the Eastern Caribbean. It also performs the role of spreading responsibility and liability in the event of natural disaster. The administrative body of the OECS is the Commission, which is based in Castries, the capital of Saint Lucia.

OECS operates an economic union within the larger CARICOM economic union. Eight members operate as a currency union – the Eastern Caribbean Currency Union, using the Eastern Caribbean dollar.

The figure below illustrates the Caribbean Region and the OECS states.

Figure 2.1
Caribbean Region



Figure 2.2
OECS States in the Caribbean



Geographically situated in the Caribbean, the OECS and Barbados share a common history and have similar cultural and linguistic ties. The region's legacy is marked by the influence of European powers, including the British and French, whose impact is evident in the languages spoken, legal systems, and cultural practices. The majority of the OECS states gained their independence in the latter half of the 20th century, with some opting to remain

within the British Commonwealth. Guadeloupe and Martinique are French Overseas Departments.

One of the key factors driving regional integration within the OECS and Barbados is the recognition of shared challenges that transcend national borders. Climate change poses a significant threat to the low-lying islands of the Caribbean, and the OECS states are particularly vulnerable to rising sea levels, extreme weather events,

and other climate-related impacts. The devastation caused by hurricanes, such as Hurricanes Irma and Maria in 2017, highlighted the urgent need for collective action to address climate resilience and disaster preparedness.

In terms of governance, the OECS and Barbados operate on the principles of democracy, rule of law, and respect for human rights. Each member state has its own government, headed by an elected leader, and the political systems reflect a mix of parliamentary and constitutional monarchy structures. The governments

of the OECS member states work collectively through the OECS Secretariat, the executive body responsible for coordinating regional initiatives and facilitating communication among member states.

Martinique's and Guadeloupe's governance structure aligns with the French model, featuring a locally elected government and representation in the French National Assembly. The population is largely French-speaking, and the legal and governance systems are integrated with those of France.

Socio Economic characteristics of the Eastern Caribbean

The following table summarizes the main socio-economic characteristics of the OECS and Barbados.

Table 2.1
Socio Economic Characteristics of the Eastern Caribbean States (OECS & Barbados)

Country	Size km ²	Population		GDP (Official Exchange Rate in \$US)		GDP/Capita (\$US/capita)		Urban Population % total population		Source
		Number	Year	GDP	Year	GDP/c	Year	% of Total	Year	
Anguilla	91	19,079	2023	\$175 million	2009	\$12,200	2008	100%	2023	CIA FactbookWorld Bank
Antigua & Barbuda	443	101,489	2023	\$1.52 billion	2017	\$19,100	2021	24.3%	2023	CIA FactbookWorld Bank
Barbados	430	303,431	2023	\$4.99 billion	2017	\$17,430	2017	31.4%	2023	CIA FactbookWorld Bank
British Virgin Islands	151	39,369	2023	\$1.38 billion	2018	\$34,200	2017	49.7%	2023	CIA FactbookWorld Bank
Dominica	751	74,656	2023	\$520 million	2017	\$7,274	2017	72%	2023	CIA Factbook, World Bank
Grenada	344	114,299	2023	\$1.12 billion	2017	\$13,700	2017	37.1%	2023	CIA FactbookWorld Bank
Guadeloupe	1,628	396,017	2023	\$9.56 billion	2018	\$24,150	2018	NA	NA	Worldometer
Martinique	1,128	366,782	2023	\$10.86 billion	2000	\$27,570	2021	80%	2000	Worldometer
Montserrat	102	5,440	2023	\$167 million	2011	\$34,000	2011	9.3%	2023	CIA FactbookWorld Bank
Saint Kitts & Nevis	261	54,817	2023	\$964 million	2017	\$26,500	2021	31.1%	2023	CIA FactbookWorld Bank
Saint Lucia	616	167,591	2023	\$1.82 billion	2017	\$6,560	2017	19.2%	2023	CIA Factbook, World Bank
Saint Vincent & the Grenadines	389	100,804	2023	\$785 million	2017	\$13,700	2021	54.3%	2023	CIA FactbookWorld Bank

The table calls for the following comments:

1. Martinique and Guadeloupe are the largest countries (respectively 1,628 km² and 1,128 km²) followed by Dominica (751 km²) and Saint Lucia (616 km²). The smallest country is Anguilla (91 km²);
2. Guadeloupe & Martinique are the most populated countries (respectively 396,017 hab. and 366,782 hab.) followed by Barbados (303,431 hab.) and Saint Lucia (167,591 hab.). The least populated country is Montserrat with only 5,440 hab;
3. BVI and Montserrat have the highest GDP per capita (respectively \$US 34,200 and \$US 34,000) followed by Martinique (\$US 27,570) and Saint Kitts & Nevis (\$US 26,500). The country with the lowest GDP per capita is Saint Lucia with \$US 6,560;
4. Anguilla and Martinique have the highest percentage of urban population (respectively 100% and 80%) followed by Saint Vincent & the Grenadines (54.3%) and BVI (49.7%). The least urbanized country is Montserrat (9.3%).

Economically, the OECS face both opportunities and challenges. The region's economies are largely dependent on tourism, agriculture, and services. The picturesque landscapes, pristine beaches, and vibrant cultures make the OECS a popular destination for international tourists. However, this heavy reliance on tourism makes the economies vulnerable to external shocks, such as natural disasters or global economic downturns. Agriculture, though historically significant, has faced challenges due to factors such as limited arable land, vulnerability to natural disasters, and competition from cheaper imported goods.

Despite these challenges, the OECS has made strides in regional integration to enhance their collective strength. The Eastern Caribbean Currency Union, for example, underscores their commitment to economic cooperation, with a common currency—the Eastern Caribbean Dollar (XCD)—facilitating trade and economic stability. Additionally, the Eastern Caribbean Supreme Court serves as a unified judicial system for OECS member states, promoting legal harmonization.

Barbados exhibits distinctive socio-economic characteristics. The economy is diversified, with sectors such as tourism, international business and finance, and manufacturing playing crucial roles. Barbados has positioned itself as a regional financial centre, attracting international businesses and investors.

Tourism is a key driver of Barbados' economy, with its pristine beaches and cultural attractions drawing visitors. However, the country has been working to diversify its economy to reduce vulnerability to external shocks. The government has implemented policies to promote renewable energy and foster innovation in sectors like technology and healthcare.

Barbados boasts a high standard of living and a well-developed social infrastructure, including a robust healthcare and education system. The literacy rate is high, contributing to a skilled workforce. The country places a strong emphasis on cultural preservation, and the Bajan culture reflects a blend of African, British, and indigenous influences.

Both Martinique and Guadeloupe, as French overseas departments, share commonalities in economic diversification, dependence on agriculture and tourism, and integration into the French political and legal frameworks. Tourism is a vital economic driver for Martinique, attracting visitors with its natural beauty and cultural richness. Agriculture, while facing challenges, contributes to the island's cultural identity and includes crops such as bananas and sugarcane.

The islands' socio-economic characteristics are influenced by their historical ties to France. The islands boast a high standard of living, reflecting France's influence, and residents benefit from social services such as healthcare and education.

Weather, climate change and Water Resources in the Eastern Caribbean

The climate of the Caribbean region is humid tropical, with an average temperature between 18 and 22 °C in the winter and 26 to 35 °C in the summer.

Caribbean countries are highly vulnerable to climate change and natural disasters to such an extent that the United Nations considers the Caribbean to be "Ground Zero" in the global climate emergency.

Extreme weather events are common: the region experienced three Category 5 hurricanes between 2017 and 2019¹. When a hurricane hits, it can wipe out the entire annual GDP of a small island and it is often the poorest who suffer the most. Climate damages in the Caribbean are projected to increase from 5% of GDP in 2025 to 20% of GDP in 2100² in the absence of meaningful adaptation & mitigation measures.

Infrastructure networks are being affected by the physical impacts of climate variability and change but can also play an essential role in building resilience to those impacts.

Climate-resilient infrastructure, including nature-based solutions, has the potential to reduce direct and indirect losses, improve the reliability of service provision, increase asset life and protect asset returns.

The table below summarizes the hydrological characteristics of OECS and Barbados.

According to the UN³, an area is experiencing water stress when annual water supplies drop below 1,700 m³ per person. When annual water supplies drop below 1,000 m³ per person, the population faces water scarcity, and below 500 cubic metres "absolute scarcity".

Of the countries included in the table, Antigua & Barbuda, Saint Vincent & the Grenadines can be considered as

facing water scarcity, Barbados, Saint Kitts & Nevis as facing absolute scarcity.

Though Annual Renewable Water Resources⁴ data is not available for several OECS countries, it is likely that based on their geographic location and relief:

1. Anguilla, BVI and Montserrat can be considered as facing water scarcity;
2. Martinique and Guadeloupe can be considered as above the water stress threshold.

The above situation is however evolving with climate change.

For example, according to a recent hydro-economic study commissioned by the Water Resource Agency of Martinique (ODE)⁵, 2055 simulations using climate change models predicted the following (for Martinique):

1. Yearly rainfall is expected to decline by -10% to -15% overall;
2. The annual renewable water resources that can be withdrawn from Martinique's rivers would be -31% lower than those of today in a wet year and up to -75% in a dry year.

In the absence of an adaptation strategy:

1. The tension between respecting ecological baseflows in waterways and satisfying uses will be increasingly exacerbated;
2. Water supply disruptions & rationing will increase;

1 Including hurricanes Irma and Maria, in 2017, and Dorian in 2019 which wreaked havoc in the Caribbean.

2 Climate Analytics 2020

3 <https://www.un.org/waterforlifedecade/scarcity.shtml>

4 TARWR = Total Annual Renewable Water Resources

5 <https://www.observatoire-eau-martinique.fr/actualites/831-modele-de-gestion-de-la-ressource>

3. Water supply and sanitation tariffs will need to increase to compensate for revenue declines associated with population migration and/or decline. In this context, affordability of water tariffs will become an issue and the rate of water poverty will be higher;
 4. It will not be possible to serve all uses (drinking water, agriculture, industry) and water rationing will become the norm.
- On the basis of the above findings, the ODE report recommends the following:
1. A strategy for adapting to climate change and demographic change with concrete and anticipated measures;
 2. A concerted approach between all the water sector actors (urban/municipal, industry, agriculture) that breaks with the dynamics of historical compartmentalization;
 3. Changes in uses to maintain their satisfaction while respecting the ecological baseflows in watercourses.

Table 2.2

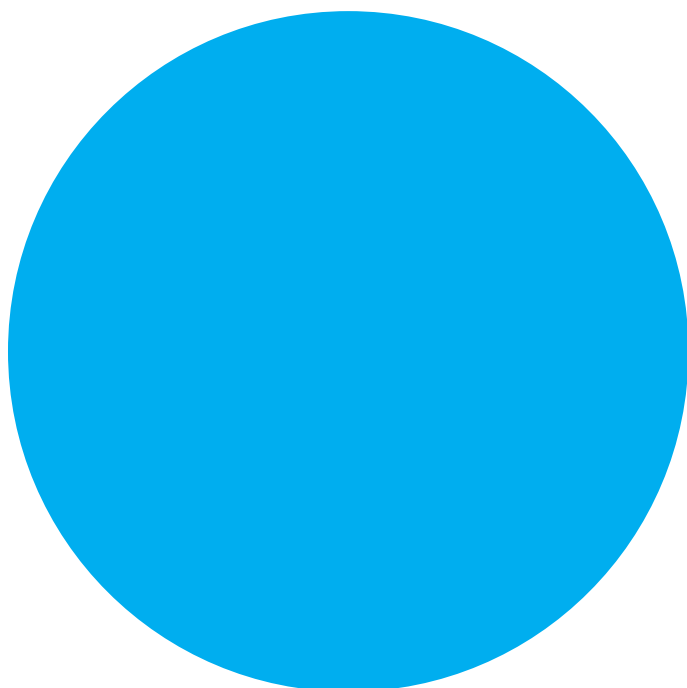
Water Resources in the Eastern Caribbean States (OECS and Barbados)

Country	Size km ²	Average Annual Rainfall (mm)	Renewable Water Resources		Withdrawals			Wetlands Ramsar Site	Source
			Total	Per Capita	Domestic	Agriculture	Industry		
Anguilla	91	1,000 mm							
Antigua & Barbuda	443	1,030 mm	52 million m ³ /year	578 m ³ /c/year	63%	15%	22%	3,600 ha	FAO Aquastat
Barbados	430	1,200 mm to 1,400 mm	80 million m ³ /year	281 m ³ /c/year	25%	67%	8%	33 ha	FAO Aquastat
British Virgin Islands	151	1,000 mm to 1,200 mm							
Dominica	751	1,500 mm to 3,700 mm	200 million m ³ /year	2,778 m ³ /c/year	95%	5%			FAO Aquastat
Grenada	344	2,350 mm	200 million m ³ /year	1,887 m ³ /c/year	85%	15%		518 ha	FAO Aquastat
Guadeloupe	1,628	1,600 mm			83%	14%	3%	30 ha	ODE - Wikipedia
Martinique	1,128	1,200 mm to 4,000 mm			73	25%	2%	207 ha	ODE - Wikipedia
Montserrat	102	1,600 mm							
Saint Kitts & Nevis	261	1,427 mm	24 million m ³ /year	444 m ³ /c/year	99%	1%			FAO Aquastat
Saint Lucia	616	2,100 mm	300 million m ³ /year	1,648 m ³ /c/year	29%	71%		85 ha	FAO Aquastat
Saint Vincent & the Grenadines	389	1,583 mm	100 million m ³ /year	917 m ³ /c/year	99.97%	0.03%			FAO Aquastat



3

Water Security - Regional Diagnosis & Gap Analysis (Eastern Caribbean)



Legal, Institutional & Regulatory Landscape

All countries included the study have legislation and regulations governing water supply, sanitation, and water resources (refer to Table 3.1). Most of this primary and secondary legislation is post 1990 or post 2000 with the notable exception of Barbados (1980 Act), Antigua and Barbuda (1945 Act last amended in 1953), Saint Kitts & Nevis (1956 Act). In some of the more recent legislative measures, effective governance of the water and sanitation subsector (e.g., autonomy, transparency, and accountability of governing bodies) is insufficiently addressed and can be aligned with ISO 37000 standards. Moreover, when they do exist, State Enterprise Performance Manuals fail to adequately fill this gap⁶.

In several countries included in the study, the management of water resources is entrusted to the entity responsible for water supply and sanitation (Barbados, Dominica, Grenada, Saint Vincent & the Grenadines). In other countries, management of water resources lies with a separate entity, either under the Ministry responsible for the environment (Anguilla, Antigua & Barbuda, BVI, Montserrat, Saint Kitts & Nevis) or an independent Water Resources Agency (Martinique, Guadeloupe, Saint Lucia). In the latter countries, Integrated Water Resources Management (IWRM) is enshrined in both policy and legislation and implemented via independent institutions. The other countries have usually established overarching environmental policies (which at times include IWRM) but whenever they do exist,

⁶ ISO 37000:2021: Governance of organizations – Guidance

these IWRM policies have yet to be translated into effective legislation, regulations and institutions.

The responsibility for economic regulation of water supply and sanitation usually lies with the line Ministry of the entity responsible for providing the service with the exception of several countries where economic regulation is performed by an independent regulator (FTC in Barbados, PURC in Grenada & NURC in Saint Lucia). The regulation of water quality and sanitation usually lies with the Ministry of Health. In a number of countries, the regulation of effluent discharge to the environment falls under the responsibility of the Ministry which portfolio includes the environment.

Responsibility for drainage usually lies with the Ministries responsible for roads and transport, with the notable exception of Guadeloupe and Martinique where the responsibility for drainage has recently been vested with the municipal entities responsible for water supply and sewerage (EPCI).

In most of the countries included in the study, the Ministry responsible for agriculture oversees policy development and management of agricultural practices including irrigation.

Table 3.1
Water Sector Legislation in the OECS & Barbados

Country	Water Sector Legislation / Year	Political Status
Anguilla	Water Corporation Act 2008	British Overseas Territory
Antigua and Barbuda	Watercourses and Waterworks Ordinances - Amended 1953 Disaster Management Act 2002	Independent Parliamentary Democracy within the Commonwealth
Barbados	Barbados Water Authority Act 1980	Republic within the Commonwealth
British Virgin Islands	Water and Sewerage Authority Act 2021 Disaster Management Act, 2003	British Overseas Territory
Dominica	Water and Sewerage Act 1991 Water Resources Policy 2011	Independent Parliamentary Democracy
Grenada	National Water and Sewerage Authority Act - Amended 2008 Water Quality Act 2005	Independent Parliamentary Democracy within the Commonwealth
Guadeloupe	Water Act 2006 (transposition into French law of the European Water Framework Directive 2000/60/CE) NOTRe Law 2015	Overseas Department of France
Martinique	Water Act 2006 (transposition into French law of the European Water Framework Directive 2000/60/CE) NOTRe Law 2015	Overseas Department of France
Montserrat	Montserrat Utilities Limited (MUL) Act 2008 Conservation and Environmental Management Act (CEMA) 2014	British Overseas Territory
St Kitts & Nevis	Watercourses and Waterworks Ordinance 1956 National Conservation and Environment Protection Act (1987) National Disaster Management Act 2020	Independent Parliamentary Democracy within the Commonwealth
Saint Lucia	Water and Sewerage Act 2004 National Utilities Regulatory Commission Act 2016 Disaster Management Act 2006	Independent Parliamentary Democracy within the Commonwealth
Saint Vincent & the Grenadines	Central Water and Sewerage Authority Act 1991 National Emergency Disaster Management Act 2006	Independent Parliamentary Democracy within the Commonwealth

Meteorological services have been established in the larger countries, under the Ministries responsible for transport and aviation, where they monitor a number of meteorological stations. The smaller countries Anguilla, BVI, Montserrat rely on meteorological services provided by their larger neighbour Antigua & Barbuda. The Caribbean Institute for Meteorology and Hydrology (CIMH) and the National Hurricane Centre (NHC) in the USA also provide weather forecasts and services for the region. In Martinique and Guadeloupe, local branches of Météo France, the national meteorological agency, provides weather forecasts and services.

Given their high exposure to natural disasters and climate change, virtually all countries included in the study have adopted robust disaster preparedness and recovery policies, legislation, plans and have established the entities to execute them (e.g. National Emergency Management Agency or Office, Offices of Disaster Management, etc.).

It is noteworthy mentioning that in 1991, the Caribbean took ownership of Disaster Management in the region through the formation of CDERA, which has since been renamed the Caribbean Disaster Emergency Management Agency (CDEMA). That same year, four sub-regional focal points were established – Antigua and Barbuda, Jamaica, Barbados and Trinidad and Tobago.

Water Resources Management

An issue in many of the islands understudy, as in many SIDS, is the absence of comprehensive national water sector and water resources policy instruments and legislation, which leads to institutional fragmentation of the water sector as well as gaps in water sector functions. For example, delineation between rivers and drains (whether earthen or constructed) is often unclear leading to silo type management.

Also, as shown in Table 2.2, several of the countries included in the study, more specifically Barbados and those situated to the northern part of the island chain, face water scarcity or absolute scarcity as a result of average rainfall, small landmass and relative high population densities and water demand (exacerbated by seasonal influx of tourists).

Water resources in the countries understudy display the following characteristics:

1. Modest size of catchments and limited capacity of freshwater bodies (rivers, lakes and aquifers);
2. Low retention times & self-cleaning capacities of freshwater bodies and limited aquifer recharge as water usually flows from top of the catchment to the sea in less than one day. This is exacerbated in countries with high relief and declivity (e.g. Grenada,

Dominica, Saint Vincent & the Grenadines, Saint Lucia, Martinique, Guadeloupe);

3. High vulnerability of freshwater bodies to over abstraction and pollution;
4. Limited management of freshwater resources which impedes the sustainable balancing of uses versus ecological flows;

Despite classification of a number of wetlands in the region as Ramsar sites (refer to Table 2.2), there are still challenges to align policy and practice, resulting in freshwater resources being undervalued, overexploited, to the detriment of the invaluable ecological services they provide (biodiversity, climate regulation, protection against extreme weather events, etc).

Effective water resources management, aligned with IWRM principles and practices, is therefore an imperative, moreso when the current and projected effects of population and demand growth, climate variability and climate change are considered. These IWRM principles and practices need to be aligned with the objectives set forth by the UN's 2023 Water Conference, the first in half a century where the Freshwater Challenge was launched, with the aim of

restoring 30 percent of degraded rivers and wetlands by 2030⁷.

As previously mentioned, in the countries under study, the management of water resources lies either with the water and sewerage utility, or with the Ministry responsible for the environment and natural resources or with independent entities (Martinique, Guadeloupe, Saint Lucia). Refer to the summary in Table 3.2.

In the first case, the utility is regulating itself, thus encouraging over abstraction and less focus on NRW management and reduction. As a case in point, Barbados and Dominica had NRW of 45% and 46% respectively in 2018⁸.

In the second case, water resources management by the Ministry responsible for the environment and natural resources is a progress compared to the first group of countries (where that responsibility lies with the water utility), it is still premature to ensure that the principles that the principles of IWRM are embedded or applied by these Ministries, which usually have broad and diversified responsibilities and management portfolios, especially in the smaller islands.

In the third case, IWRM principles and practices have been embraced by the independent entities entrusted with water resources management in Martinique (ODE), Guadeloupe (ODE) and Saint Lucia (WRMA). There is however still scope for improvement as the cases of Guadeloupe and Saint Lucia illustrate:

1. In Saint Lucia, the WRMA manages water abstraction but not effluent discharge (treated, partially or untreated) to the freshwater bodies. The latter responsibility lies with another entity. This segmented approach to water resources management where quantity is managed by one entity and quality by another does not follow IWRM best practice and is certainly not adapted to the Eastern Caribbean context where freshwater bodies display low dilution & self-cleaning capabilities;
2. In Guadeloupe, though the ODE is a well-established independent entity with water resources management powers and resources, mismanagement and overconsumption by the water & sewerage utilities

(each municipality was previously responsible for these services) have led to dubious investment decisions, excessive NRW levels and severe water rationing. The situation is gradually being addressed with the help of the French Authorities as described in Section 5.4.2, and water demand sobriety, operational efficiency, targeted investments in grey and green infrastructure and water resources restoration projects are currently being actively pursued as part of an ambitious investment plan (Plan Eau DOM).

Whatever water resources management model applied, effective enforcement of water resources and effluent discharge licenses and regulations is deemed key towards efficient performance of the sector. However, enforcement needs to be improved in many of the countries under consideration, and the establishment of an effective environmental police unit, attached to the National Police, is seen as the most effective option. This is presently the case in Martinique and Guadeloupe where the Police Force under the Regional Government (DEAL) is responsible for water resources policing.

It is noteworthy mentioning that in some of the smaller islands facing water scarcity (in the north of the island chain), water resources are scarce and generally limited to aquifers with limited capacity. Water demand is high (upper income levels and tourism) and as a result, desalination is the norm. In those cases, it can be argued that the direct and indirect benefits associated with the establishment of an independent entity for the management of water resources should be weighed against the costs and red tape involved.

However, in the larger islands such as Barbados, Dominica and Saint Vincent and the Grenadines (and also Grenada), should be advisable to explore the possibility for the establishment of an independent water resources management entity following IWRM principles and practice. For recollection, the four pillars of IWRM are:

1. Establishment of an independent entity (WRMA for example) for the management of water resources following IWRM principles and practice and in accordance with the provisions of the water resources master plan (see below);

7 Over the past 5 decades, one third of wetlands have disappeared and freshwater species populations have plummeted by 83 percent on average (high cost of cheap water – WWF – 2023)

8 The Caribbean Water Study – IDB – Oct 2021

2. Establishment of a National Water Resources Information System (NWRIS) where all water resources and relevant water sector data/information is regularly collected, analysed, archived and diffused freely⁹ to stakeholders and the general public via a WebGIS type application¹⁰. The NWRIS is managed by the WRMA;
3. Establishment of a Water Forum, a consultative body (sort of Water Parliament) where all stakeholders meet (e.g. quarterly or twice a year) to determine water allocations, abstraction and discharge tariffs and approve water resources master plans. The WRMA acts as the secretariat to the Water Forum which can be seen as the application of the "participatory principle" in IWRM;
4. Establishment of a water sector trust fund, managed by the WRMA, which is credited with the part of the proceeds of raw water abstraction and effluent discharge fees (municipal, industry and agriculture),

various levies on water and sewerage bills and if required, government subsidies. This trust fund is used for targeted loans/grants to water sector projects which have positive impacts on water resources (quality & quantity) such as WWTPs, restoration of wetlands etc. The remaining monies collected help meet the running costs of the WRMA. The objective is that the sector becomes gradually financially self-sufficient in application of the principle "water pays for water".

Finally, the adoption of primary and secondary legislation for the establishment of an independent entity, entrusted with the management of water resources following IWRM principles and practices, should be preceded by the adoption of relevant water sector/water resources policies, or the revision of existing water sector and/or environmental policies as laws not aligned with existing policies are bound to be challenged in the courts.

Table 3.2

Water Resources Management in the OECS & Barbados

Country	Entity Responsible for Water Resources Management	Comments
Anguilla	Water Corporation of Anguilla (WCA)	Limited freshwater resources
Antigua and Barbuda	Antigua Public Utilities Authority (APUA)	Limited freshwater resources
Barbados	Barbados Water Authority (BWA)	Limited freshwater resources Proposed legislation for a separate WRA has been shelved
British Virgin Islands	Ministry of Natural Resources, Labour, and Immigration	Limited freshwater resources
Dominica	Dominica Water and Sewerage Company (DOWASCO)	Water Resources Policy 2011 (including IWRM) never formally adopted nor implemented
Grenada	National Water and Sewerage Authority (NAWASA)	Legislation to establish a WRMU (under PURC) before Parliament
Guadeloupe	ODE (Water Resources Agency)	Independent entity following IWRM policies and practices
Martinique	ODE (Water Resources Agency)	Independent entity following IWRM policies and practices
Montserrat	Department of Environment (DOE), under the Ministry of Agriculture	Limited freshwater resources
St Kitts & Nevis	Water Services Department (WSD)	Good groundwater resources.
Saint Lucia	Water Resources Management Agency (WRMA)	Independent entity under Min. of Agriculture. Improvements required to fully align with IWRM principles & practices
Saint Vincent & the Grenadines	Central Water and Sewerage Authority (CWSA) via WRMU	

⁹ Some specific specialized services can however be billed to stakeholders/customers.

¹⁰ A good example is the Martinique Water Observatory (a comprehensive Water Resources Data Base) managed by ODE Martinique with comprehensive water sector data sets and interactive WebGIS maps: <https://www.observatoire-eau-martinique.fr/>

Existing Infrastructure (water supply & sanitation, irrigation & drainage)

General

Water resources, water supply and sanitation are indeed essential underpinnings for the societies and economies of the Eastern Caribbean region which depends heavily on the services sector including tourism, and only secondarily on agriculture and industry. Water resources management in the countries under study has been described in the preceding section where the need for a more effective and systematic implementation of IWRM policies and practices has been highlighted, especially in the light of growing demand, dwindling water resources and the need to restore and maintain ecological flows in the freshwater bodies (including wetlands which provide invaluable ecological services to society and the economy). The prevailing situation as regards water supply and sanitation is described more in detail in Sections 3.3.2 to 3.3.4 included.

It can be argued that except for several islands (Saint Lucia, Barbados and Martinique), irrigation currently represents a small fraction of total water withdrawals, thus attesting to the limited expansion of agriculture and/or the limited use of irrigation in agricultural practices in the islands under study. Subsistence agriculture is practiced in many of the islands though in some of the larger islands (Saint Lucia, Barbados and Martinique) export crops (e.g. bananas, sugar cane) account for a non-negligible percentage of local GDP. In the Eastern Caribbean, over the last decades, the sector has been in slow decline due to a combination of limited economies of scale, land exhaustion, lack of technological progress, higher environmental standards and emphasis on the service sector including tourism and financial services. Climate change/variability and an increase in the frequency & intensity of extreme weather events has exacerbated this trend.

However, as a result of the combined effects of the Covid 19 pandemic and the war in Ukraine there has been a 46% increase in moderate to severe food insecurity between Feb.

and Aug. 2022 leaving 57% of the population struggling to put food on the table¹¹. In this context, there is a growing regional trend towards increasing food security and securing local and regional food chains. In that respect, recent initiatives worth mentioning are 1) the establishment of two regional logistics hubs, both based in Barbados, for the distribution of food and disaster relief items to CARICOM member states and 2) signing of agreements between Barbados and Caricom members Guyana and Suriname for increased interaction in various sectors with an emphasis on joint agricultural projects and an increase in food imports from the continent.

Drainage and flood alleviation/mitigation have also come to the fore of regional concern as a result of the increase in the frequency and intensity of extreme weather events brought about by climate variability/change. This has resulted in significant and at times catastrophic flood events which have caused loss of life, impacted buildings and infrastructure, caused hillside erosion and landslides, affected crops and livestock and resulted in general loss of productivity and economic output. Ineffective water sector governance, institutional fragmentation, poor land planning and management, lack of integrated water resources management have exacerbated the effects of flooding and drought spells. The traditional response of governments and entities responsible for drainage in the region has indeed been the implementation of more grey drainage infrastructure and insufficient investments in green infrastructure/nature based solutions (e.g. hillside reforestation and terracing, restoration of wetlands and other freshwater bodies, sponge cities, etc.) and non-structural solutions (establish drainage action plans, enhanced land planning, management and enforcement, breaking institutional silos and building institutional bridges agencies, institutional reform to embed IWRM, enhancing drainage design guidelines and SOPs, etc.). Green infrastructure and non-structural measures are usually highly cost effective and sustainable when compared to grey infrastructure.

¹¹ <https://www.forbes.com/sites/daphneewingchow/2022/10/30/barbados-based-logistics-hubs-to-support-caribbean-food-security/>

Description

Water Supply

Summary of water supply system characteristics in the countries under study are reported in Table 3.3.

In the countries under study, raw water is abstracted from surface water and/or groundwater and/or brackish or sea water (desalination), the weighting of each source (as a % of total abstraction) depending on the specific characteristics of the countries including the level of water demand, and the availability of renewable water resources. In some countries (those experiencing water scarcity), desalination, rainwater harvesting and wastewater reuse account for a non-negligible percentage of overall supply, though there can be quality issues with the two latter sources.

Some islands such as Saint Lucia, Dominica, Montserrat & Saint Vincent & the Grenadines depend almost exclusively on surface water sources and gravity supply whilst others depend on surface water and accessorially on groundwater (Martinique, Guadeloupe, Grenada), others on desalination & groundwater (Antigua & Barbuda, Barbados, St Kitts & Nevis) and others on a combination of desalination, wells, wastewater reuse and rainwater harvesting (Anguilla, BVI).

Most countries are experiencing an increase in water demand (driven by population growth, climate change, a resurgent tourism sector). In the absence of effective demand management (reduction of leakage on the public network and wastage at customer premises) and faced with dwindling available water resources, many countries are considering desalination to bridge the water supply gap. Desalination is however expensive (CAPEX & OPEX) and should be considered as a last resort or as a means to increase system resilience in the face of climate/variability/change and in the event of extreme weather events.

Though pipe borne water supply coverage throughout the countries under study is high (see following section) and the capacities of WTPs are generally considered as adequate, there is need for investments in WTP rehabilitation/upgrade/expansion to compensate for the historical under-investments in plant maintenance and the deterioration of raw water quality of surface water bodies because of

increased pollution, erosion & runoff. Also, WTPs are rarely automated leading to non-optimal O&M procedures, costs, and treated water quality outputs.

There is generally insufficient communal storage capacity (less than 6h) to cater for water supply disruptions and emergency situations. To compensate, in most countries, household storage is the norm, especially in countries experiencing rationed water supply. Note that there is virtually no household storage in Martinique and Guadeloupe because of water quality/sanitary considerations.

Water supply networks are generally well sized and extend to the entire service area of utilities which in most cases also include a significant part of the rural areas. The main issues usually lie with the advanced age of the network and the historical lack of investments in maintenance and renewal which, together with sub-optimal O&M practices, lead to high levels of NRW (refer to Section 3.3.4 below). At times, lack of quality of materials and workmanship are also factors which increase NRW levels.

Effective sectorization of water distribution networks (in DMZs and DMAs) is rarely a reality thus impeding network management, pressure management¹², water balances, NRW management and the optimal allocation of limited operational and financial resources.

There is a general lack of distribution network automation and SCADA, thus leading to lack of real time knowledge of network pressures and flows, longer reaction times, sub-par customer information and satisfaction.

Whilst universal metering is a reality in many islands (including Barbados, Grenada, Martinique, Guadeloupe & Saint Lucia), and most islands meter their largest customers (industrial, commercial, institutional) others have yet to systematically meter all their customers (including domestic customers). Universal metering is a key component of water demand management which includes management/reduction of both leakage on utility networks and wastage at customer premises.

¹² Sectorization and pressure management are especially relevant in countries with high declivity (e.g. Martinique, Guadeloupe, Grenada, Dominica, St. Lucia, St Vincent & the Grenadines).

Table 3.3

Characteristics of Water Supply Systems in the OECS & Barbados

Country	Pop.	Utility	Production					Storage (m³)	Network (km)	Coverage %		Supply 24/7 %	Water Quality (WHO)	Comments
			Surface %	Ground %	Desal %	Other %	Total m³/day			Network	Improved Water Services			
Anguilla	19,000	WCA	0%	0%	80%	20%	3,700							Relies heavily on imported desalinated water and wastewater reuse (via purchasing agreements). Rainwater harvesting practised by population
Antigua and Barbuda	101,000	APUA	25%	5%	70%		10,000				94%			APUA staff operates 5 desal plant and 2 WTPs
Barbados	303,000	BWA	0%	77%	23%		100,000		2,500	100%		100%	94%	Reliance on desalination to increase in future (salinity of coastal aquifer increasing). BOOT desal. plant. Rainwater harvesting being introduced (GCF)
British Virgin Islands	39,000	WSD	0%	0%	100%		12,500							3 desal. plants operated by private operators. Rainwater harvesting practised by population
Dominica	75,000	DOWSACO	100%	0%	0%		31,800			95%				42 surface water prod. facilities vulnerable to natural hazards
Grenada	114,000	NAWASA	95%	5%	0%	0%	36,400	22,700			98%			Rainwater harvesting (RWH) by population in the North. RWH in Carriacou and Petite Martinique + 2 private package desal. plants
Guadeloupe	396,000	EPCI	92%	8%	0%	0%	157,000	111,000	3,000	95%		75%	97%	52 WTPs, 149 communal water storage tanks
Martinique	367,000	EPCI	95%	5%	0%	0%	107,000	180,000	3,500	100%		100%	>95%	27 WTPs. 290 communal water storage tanks
Montserrat	5,500	MUL	100%	0%	0%	0%		8,300						6 springs. 13 communal reservoirs
St Kitts & Nevis	55,000	WSD												
Saint Lucia	168,000	WASCO	99.5%	0%	0.5%	0%				100%			83%	30 surface water intakes. JC Dam. 3 package desal. plants (hotels) in the north. Desalination to increase in future (hotels)
Saint Vincent & the Grenadines	101,000	CWSA	100%	0%	0%	0%	24,000			90%				23 surface water intakes. Rainwater harvesting by population in the Grenadines (where desal. plants are planned in future)

Sanitation

Whilst access to improved sanitation is high throughout the countries under study (refer to Section 3.3.3 and Table 3.4 below), sewerage coverage is usually well below that of urbanisation¹³. Indeed, with a few exceptions, there has been historical under-investments in sewerage facilities in the countries under study.

This sewerage gap is currently met by a combination of package plants (for large housing developments and large customers such as industries and hotels) and household

sanitation (for domestic customers). This situation is far from ideal as:

1. There are often operational issues associated with privately run package plants (lack of specialized personnel for O&M, lack of funds etc.);
2. Household sanitation does not always include filters which can lead to aquifer contamination, requires a value chain for septage handling and treatment (which is often lacking) and is less feasible & cost effective in an urban environment.

¹³ Average regional sewerage coverage is 11% – Governance Position Paper Caribbean Water Sector – IDB – Dec 2019

Also, public sewerage networks are often plagued with several operational issues such as:

1. Grease plugs in the sewerage networks (an indication of absence and/or non-functioning grease traps at customer premises, especially commercial properties);
2. High levels of clear water infiltration (Infiltration & Inflow¹⁴) in the sewerage networks which result in hydraulic overloading of the system and flushing effects in the WWTPs;
3. Long rising mains which lead to H₂S emissions, an HSE hazard which is also detrimental to operations and to the longevity of sewerage assets (pump stations, networks, WWTPs).

Table 3.4

Sewerage and Sanitation in the OECS and Barbados

Country	Pop.	Utility	% Urbanisation	% Sewerage	Sewerage Gap %	Comments Sewerage Systems	Comments Household Sanitation Systems
Anguilla	19,000	WCA	100%	0%	100%	No recorded significant sewerage system nor WWTP on the island	Household sanitation widespread. Package WWTP in some hotels. Limited freshwater resources
Antigua and Barbuda	101,000	APUA	24%	5%	19%	Absence of sewerage systems in densely populated areas	85% use septic tanks and 10% pit latrines poorly maintained leading to ground water pollution
Barbados	303,000	BWA	31%	8%	23%	2 sewerage systems and WWTPs (Bridgetown and South Coast). Primary treatment only at Bridgetown WWTP. Urgent upgrades required. BWA planning to expand decentralized sewerage systems + WWTPs in the vicinity of its wellfields	Household sanitation = septic tanks + soakaways. Many hotels equipped with package WWTPs with WW reuse for non-potable uses
British Virgin Islands	39,000	WSD	50%				Household sanitation = septic tanks + soakaways. Many hotels equipped with package WWTPs
Dominica	75,000	DOWSACO	72%	20%	52%	Sewerage systems cover capital Roseau and neighbouring areas. WWTP located in Baytown (pre-treatment only + outfall to the sea)	80% of the population relies on household sanitation (septic tank + soakaways or pit latrines)
Grenada	114,000	NAWASA	37%	5%	32%	2 sewerage systems in St George (capital) and Van Norman Dam areas. Partially treated effluents discharged to sea via outfalls	Household sanitation = septic tanks + soakaways or pit latrines. Many hotels equipped with package WWTPs
Guadeloupe	396,000	EPCI	80% ¹⁵	44%	36%	125 WWTPs with total capacity = 282,115 EH. Upgrades required as 28% only of large plants in conformity with discharge standards. Constructed wetlands WWTPs introduced successfully.	Household sanitation in non-sewered areas. Filters with coconut chip media used after septic tanks.
Martinique	367,000	EPCI	80%	42%	38%	112 WWTPs with total capacity = 337,000 EH. Upgrades required as 43% only of plants in conformity with discharge standards. Widespread use of decentralized constructed wetlands WWTPs	Household sanitation in non-sewered areas. Filters with coconut chip media used after septic tanks.
Montserrat	5,500	MUL	9%			1 WWTP with 2 branches of the sewerage network in Davy Hill and Lookout	Household sanitation in non-sewered areas
St Kitts & Nevis	55,000	WSD	31%				
Saint Lucia	168,000	WASCO	19%	7%	12%	4 sewerage systems + 3 WWTPs operated by WASCO. Castries has an outfall but no WWTP. Pilot decentralized constructed wetland system in Vieux Fort (CARIBSAN project)	Household sanitation in non-sewered areas. Hotels equipped with package WWTPs
Saint Vincent & the Grenadines	101,000	CWSA	54%	4% ¹⁶	50%	Sewerage networks in capital Kingstown and small section of Arnos Vale (340 connections in total). 1 WWTP in Arnos Vale. No WWTP in Kingstown, raw sewage discharged to sea via outfall	Household sanitation in non-sewered areas. Hotels equipped with package WWTPs

¹⁴ Infiltration & Inflow is commonly referred to as I&I

¹⁵ Estimate

¹⁶ Estimate

Pursuant to the above, some countries (e.g. Martinique, Guadeloupe, Saint Lucia, Dominica) have started experimenting with low cost, low maintenance and nature based decentralized WWTPs such as constructed wetlands (with lead to shorter sewerage networks and less sewerage pump stations & force mains). Preliminary results are very positive as they lead to higher resilience and lower CAPEX and OPEX requirements including lower negative environmental and social impacts. Replication throughout the region could be considered (including in the countries with high declivity such as Grenada and St. Vincent & the Grenadines).

Centralized WWTPs in the countries understudy entail either preliminary/primary treatment with outfalls (e.g.

Barbados South Coast, Baytown in Dominica) or waste stabilization ponds (e.g. Bridgetown Barbados, Rodney Bay Saint Lucia). In some instances, sewerage networks spew untreated sewage directly to the sea via short outfalls (e.g. St George in Grenada, Castries in St Lucia, Kingstown in Saint Vincent & the Grenadines). Plants in Martinique and Guadeloupe usually entail secondary treatment though plant output does not always meet discharge standards, as mentioned in Section 3.3.3 below.

This situation is obviously far from ideal and some countries are planning and/or implementing sewerage system upgrades (Barbados, Saint Lucia, Grenada).

Coverage & Quality of Service

Water Supply

In the countries understudy, piped borne water supply coverage is usually above 70% (regional average 76%) and accessibility to improved water coverage is usually high (>92%)¹⁷.

Adherence to water quality standards (WHO standards in most countries) is also usually > 85%¹⁸ and is contingent not only upon water quality at WTP outlet but also upon realization of 24/7 supply and adherence to operational standards and SOPs during leak repairs and flushing of mains.

There is a lack of reliable data on continuity of service though interviews have revealed that Martinique enjoys 24/7 service, whilst there is rationed water supply in Guadeloupe, Barbados and Saint Lucia. It is not unreasonable to infer that rationed supply is the norm throughout the countries under study. 2019 regional average is 21/7.¹⁹

There is also a lack of reliable data on customer satisfaction though the referenced 2019 IDB report mentions 39 complaints per 1,000 customers per year in Dominica and 11 in Saint Lucia, the 2019 regional average being 54.

Sanitation

Access to improved sanitation coverage in the countries understudy is usually higher than 88%, the regional average being 90%, and is loosely correlated with the country's income²⁰.

Sewerage coverage on the other hand is low (regional average is 11%)²¹, though Martinique and Guadeloupe have higher sewerage coverage (respectively 42% and 44% respectively) compared to the other OECS islands and Barbados.

17 Governance Position Paper Caribbean Water Sector – IDB – Dec 2019

18 Governance Position Paper Caribbean Water Sector – IDB – Dec 2019

19 Governance Position Paper Caribbean Water Sector – IDB – Dec 2019

20 Governance Position Paper Caribbean Water Sector – IDB – Dec 2019

21 Governance Position Paper Caribbean Water Sector – IDB – Dec 2019

In Martinique and Guadeloupe, despite higher sewerage coverage ratios, there are persistent challenges and only 28% of the plants (with capacity > 2,000 EH) are declared in conformity with discharge standards in Guadeloupe and 43% in Martinique. These challenges stem from:

A persistent sewerage gap in both islands as urbanisation levels are high (e.g. 80% in Martinique refer to Table 2.1);

1. Ageing WWTP facilities and insufficient levels of O&M lead to the underperformance of WWTPs with only 28% of the plants (with capacity > 2,000 EH) declared in conformity with discharge standards in Guadeloupe and 43% in Martinique;
2. Slack environmental and water policing by some municipalities which is detrimental to the identification of non-conformities and the implementation of corrective actions.

3. High density of sewage pump stations (due to natural declivity of catchments), long force mains with high retention times which leads to H₂S production and hazards/inconveniences in the vicinity of pump stations and at WWTPs.

Also, as previously mentioned, in some countries, sewerage networks spew untreated sewage directly to the sea via short outfalls (e.g. Castries in St Lucia, Kingstown in Saint Vincent & the Grenadines, St George in Grenada) or after primary treatment (South Coast in Barbados). This is far from ideal as dilution does not equate treatment and climate change/variability results in rising sea levels and variable ocean currents.

Operational Efficiency and Financial Performance

Operational Efficiency

Whenever data was available^{22 23}, operational efficiency of utilities in the countries under study have been measured via a number of indicators (KPIs) namely:

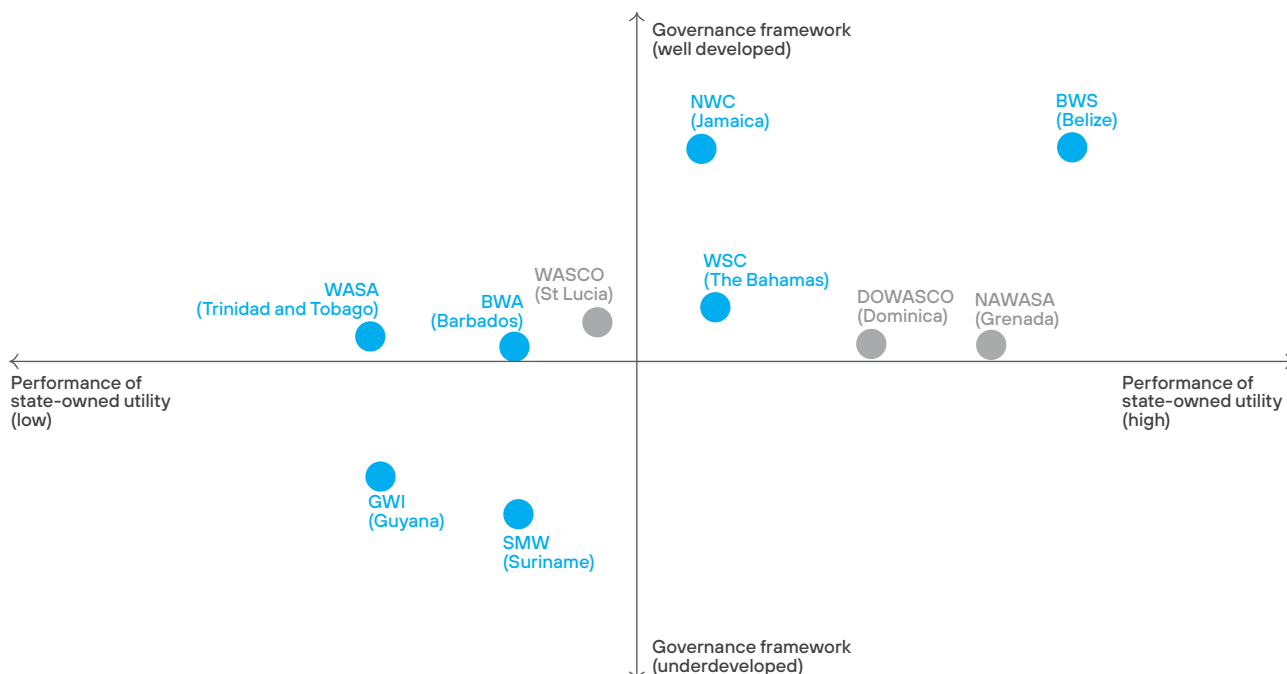
1. NRW varies from 26% (Grenada), 44% (Martinique), 45 % (Barbados), 53% (Dominica), 56% (Saint Lucia) to 60% (Guadeloupe), the regional average being 45%;
2. Staff productivity varies from 5.3 staff per 1,000 connections (Grenada), 6.1 (Saint Lucia) to 6.7 (Barbados & Dominica), the regional average being 6.8 staff per 1,000;
3. Electricity cost varies from 3.9% of OPEX (Grenada), 12% (Dominica), 13% (Barbados) to 23% (Saint Lucia), the regional average being 22%;
4. Gross accounts receivable days (indicators of a utility's ability to collect from its customers) varies from 46 days (Grenada), 110 days (Guadeloupe), 113 days (Saint Lucia), 145 days (Dominica) to 208 days (Barbados), the regional average being 201 days;
5. Residential Monthly Water Bill (for 15 M³) varies from 16.33 USD (Saint Lucia), 19.11 (Dominica), 20.77 USD (Barbados) to 21.32 (Grenada), the regional average being 23.87 USD (for 15 m³).

22 Governance Position Paper Caribbean Water Sector – IDB – Dec 2019

23 The Caribbean Water Study – IDB – Oct 2021

Figure 3.1

Level of Development of the Governance Framework versus Performance of State-Owned Water and Sanitation Enterprises in the English-Speaking Caribbean



The preceding figures seem to indicate that among the benchmarked utilities, NAWASA (Grenada) is one of the most efficient.

The referenced 2019 IDB study shows that there is a close relationship between the quality of the governance framework and the performance of water and sanitation utilities in the English-speaking Caribbean, as shown in the figure below. For example, BWS (Belize), an English-speaking Caribbean company with the best operational performance, has a good governance framework characterized by water policies and a robust and developed legal and regulatory framework. Otherwise, SWM (Suriname) and GWI (Guyana), companies with low operational performance, have weak governance framework with underdeveloped water policies and legal and regulatory framework.

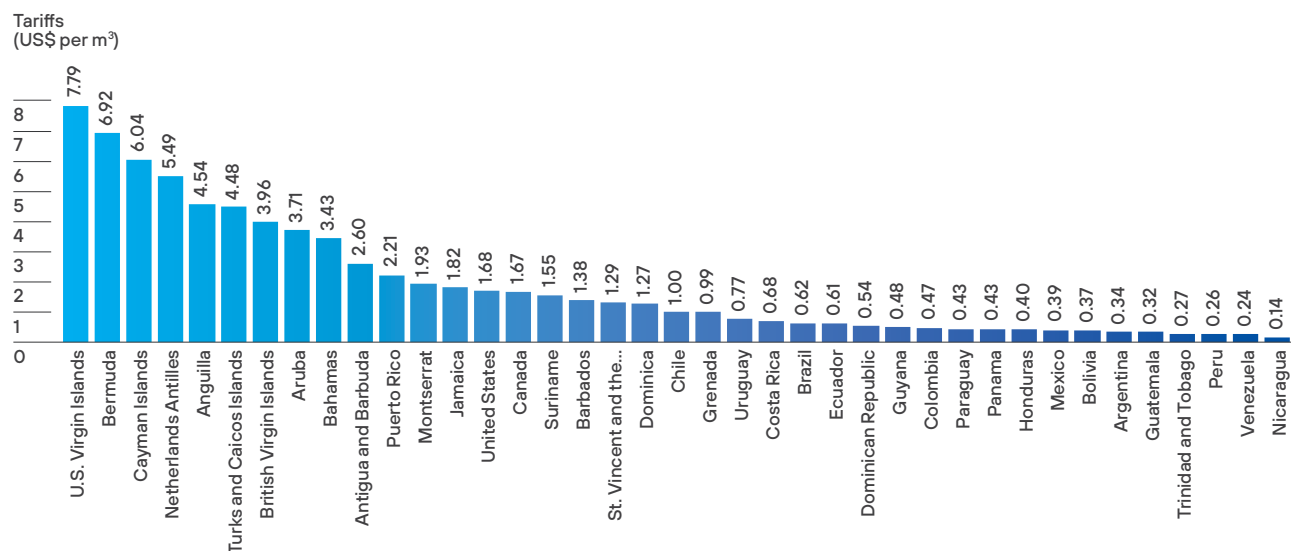
Financial Performance

Regional tariffs (IDB – 2019) are variable as shown in the figure below and for the countries understudy range between 4.54 \$US/m³ (Anguilla) and 0.99 \$US/m³ (Grenada). Water tariffs below 1 \$US/m³ are considered as incompatible with partial OPEX cost recovery, even in the absence of desalination.

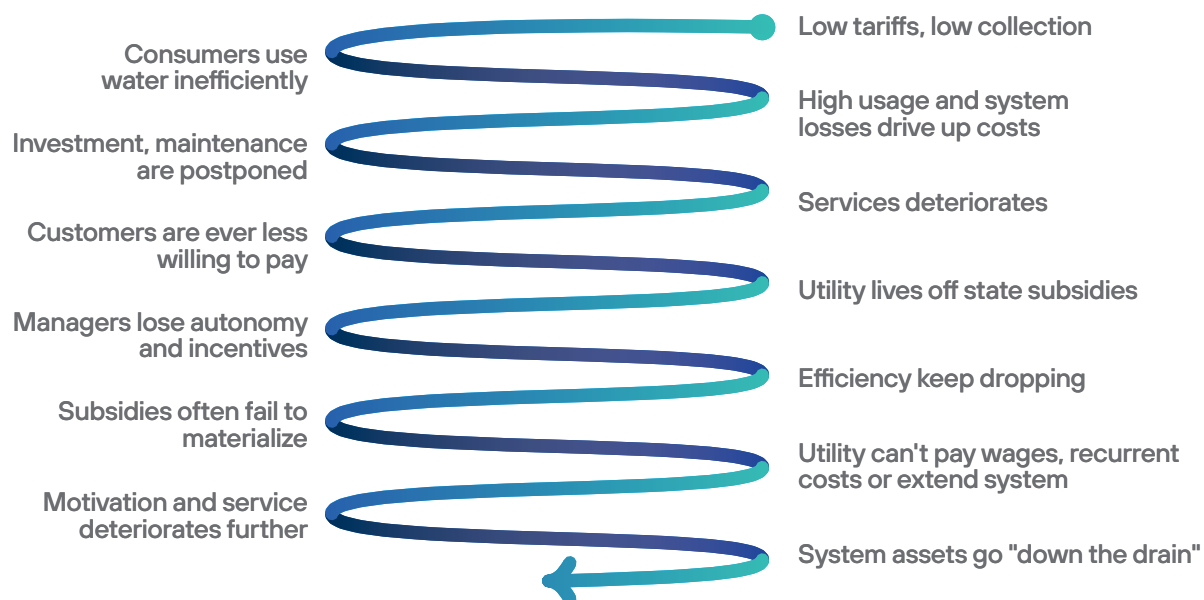
It is interesting to note that low tariffs are usually the trigger for the well documented spiral of decline as shown in the following figure.

Figure 3.2

Water Tariffs in the Caribbean Region (IDB - 2017)

**Figure 3.3**

Spiral of Decline (PUB Singapore & Rouse 2013)



Whenever data was available^{24 25}, financial performance of utilities in the countries under study have been measured via a number of indicators (KPIs) namely:

1. EBITDA margin varies from 7% (Barbados), 19% (Grenada), 22% (Saint Lucia), to 25% (Dominica);
2. Operating cost coverage varies from 0.9 (Dominica), 1.08 (Barbados), 1.2 (Saint Lucia) to 1.4 (Grenada);
3. Profitability (after interest, taxes, depreciation/amortization) varies from -11% (Dominica), -2% (Barbados), 8% (Saint Lucia) to 22% (Grenada);
4. Return on assets varies from -1% (Dominica), -0.4% (Barbados), 5% (Saint Lucia) to 7% (Grenada), the calculated regional average being 2%;
5. Current ratio (measure of liquidity = current assets/current liabilities) varies from 1.4 (Barbados Dominica and Saint Lucia) to 2.1 (Grenada), the calculated regional average being 1.3;
6. Debt service coverage ratio (measure of solvency = EBITDA/reimbursement principal + interests) varies from -0.19 (Dominica), 1.2 (Barbados) to 6.4 (Saint Lucia), the calculated regional average being 0.9;
7. Debt to equity ratio (measure of financial leverage) varies from 0.03 (Grenada), 0.5 (Saint Lucia), 0.7 Barbados to 0.79 (Dominica).

The preceding figures seem to indicate that among the benchmarked utilities, as it is the case for operational efficiency, NAWASA (Grenada) also displays the best financial performance.

To summarize, the main challenges faced by water and sanitation companies in the Caribbean, including the countries under study are linked to poor performance (operational & financial) and underdeveloped governance frameworks.

Vulnerability to Extreme Weather Events - Adaptation & Mitigation

Like many other island nations in the Caribbean, the countries of the OECS and Barbados are highly susceptible to the impacts of extreme weather events, climate variability and climate change. Its geographical location in the hurricane-prone Atlantic Basin, coupled with factors such as topography, population density, and socio-economic conditions, make it particularly vulnerable to hurricanes, tropical storms, and other climate-related disasters. The United Nations considers the Caribbean to be "Ground Zero" in the global climate emergency.

In recent decades, climate change/variability has led the region facing rising sea levels, extreme weather events, coastal erosion, warmer temperatures, and changing precipitation patterns. There has also been an increase in the frequency and intensity of hurricanes, the region

experiencing three Category 5 hurricanes between 2017 and 2019. When a hurricane hits, it can wipe out the entire annual GDP of a small island and it is often the poorest who suffer the most.

Periodically, volcanic activity is also a serious natural hazard in several islands of the region as evidenced by the eruption of the Soufrière Hills in Montserrat in 1995. It was a catastrophic event that marked the beginning of a prolonged period of volcanic activity on the Caribbean Island. The eruption forced the evacuation of the capital, Plymouth, as well as other nearby settlements, displacing thousands of residents, and the island's landscape underwent profound changes as a result of the volcanic activity, leaving a lasting impact on Montserrat's residents and environment.

²⁴ The Caribbean Water Study - IDB - Oct 2021

²⁵ Governance Position Paper Caribbean Water Sector – IDB – Dec 2019

Regional climate change predictions ²⁶ indicating a decrease in the extents of water-related ecosystems is observable in all OECS Member States (except Grenada) that report information on SDG 6 achievements. In terms of water scarcity, the most critical situation is currently observed in Barbados & St. Kitts and Nevis.

The rest of the islands are not under critical water stress, although the current situation can change drastically with the impacts of climate change mainly affecting water resources. There is still a lack of information concerning the impacts of climate change on water resources in OECS Member States, as well as on the identification of possible conflicts of use that may occur in the future if climate change further affects water resource systems resulting in increased scarcity.

Nevertheless, some of the Eastern Caribbean islands are already water-stressed for at least part of the year. Some of them currently rely heavily on desalinization or unsustainable abstraction of groundwater resources, especially to serve the tourism industry. Changes in temperature, rainfall and extreme events will inevitably lead to reductions in water availability and quality, as a result both of damage to service infrastructure and reduced water quality through siltation of streams and rivers via landslides and destructive floods.

Climate damages in the Caribbean is projected to increase from 5% of GDP in 2025 to 20% of GDP in 2100 in the absence of meaningful adaptation & mitigation measures²⁷. Infrastructure networks are being affected by the physical impacts of climate variability and change but can also play an essential role in building resilience to those impacts.

Climate-resilient infrastructure, including a renewed emphasis on green or nature-based infrastructure, has the potential to reduce direct and indirect losses, improve the reliability of service provision, increase asset life and protect asset returns.

Historically, because of their exposure to extreme weather events, most countries in the region have had some degree of emergency response plans and disaster preparedness systems in place. Faced with the increase in intensity and frequency of hurricanes and tropical storms over the last decade, most countries have made significant efforts to bolster their disaster preparedness and emergency response plans. They have also established regional emergency response and disaster preparedness mechanisms, logistical hubs and increased regional cooperation all of which have, to some degree, helped minimize the extent of damage and facilitate a swift response to the aftermath of hurricanes and tropical storms.

Status of Hydrometeorological and Climate Monitoring Systems

Meteorological services have been established in the larger countries, under the Ministries responsible for transport and aviation (refer to Table 3.5). In Martinique and Guadeloupe, local branches of Météo France, the national meteorological agency, provide weather forecasts and services.

The smaller countries of the northern island chain (Anguilla, BVI, Montserrat) rely on meteorological forecasts and services from regional and international meteorological services such as:

1. The Antigua and Barbuda Meteorological Service (ABMS) which provides forecasts for Anguilla on a daily basis;
2. The Caribbean Institute for Meteorology and Hydrology (CIMH) is one of the regional organizations that provides weather forecasts for the Caribbean;
3. The United States National Hurricane Centre (NHC) is a key international organization that monitors and provides forecasts for tropical weather systems, including hurricanes that may impact the Caribbean region.

²⁶ <https://rcc.cimh.edu.bb/files/>

²⁷ Climate Analytics 2020

Table 3.5

Hydrometeorological & Climate Monitoring in the OECS & Barbados

Country	Entity Responsible for Hydrometeorological & Climate Monitoring	Comments
Anguilla	Antigua and Barbuda Meteorological Service (ABMS)	Anguilla relies on services provided by ABMS
Antigua and Barbuda	Antigua and Barbuda Meteorological Service (ABMS)	Monitors 9 automatic weather stations and 6 rain gauges. An additional 10 automatic weather stations underway.
Barbados	Barbados Meteorological Services (BMS)	Operates a synoptic weather station and an automatic weather station at the GAIA, as well as rain gauges across the island
British Virgin Islands	Antigua and Barbuda Meteorological Service (ABMS)	BVI relies on services provided by ABMS Discussions underway to establish a National Meteorological Service in the Territory
Dominica	Dominica Meteorological Service (DMS)	Operates two meteorological stations, one at the Canefield Airport and the other at the Douglas-Charles Airport. There are also approximately 9 non-airport automatic stations that are not under the jurisdiction of the DMS but to which they have access
Grenada	Grenada Meteorological Service (GMS)	
Guadeloupe	Météo France Guadeloupe	Local Branch of Météo France (France Meteorology)
Martinique	Météo France Martinique	Local Branch of Météo France (France Meteorology)
Montserrat	Antigua and Barbuda Meteorological Service (ABMS)	Montserrat relies on services provided by ABMS. Note: Robust seismic monitoring network in Montserrat
St Kitts & Nevis	St Kitts Meteorological Department of SCASPA (St. Christopher Air & Sea Ports Authority)	An Automatic Weather Observing Station (AWS) was installed at the Robert L. Bradshaw International Airport in 2012
Saint Lucia	St Lucia Meteorological Services	Operates two weather stations located at the two airports on the island. These are namely, the GFL Charles Airport and the Hewanorra Airport
Saint Vincent & the Grenadines	Saint Vincent and the Grenadines Meteorological Office (SVGMO)	Operates the weather station located at the ET Joshua Airport and monitors the rainfall of at least 7 locations on the island of St. Vincent
Regional Entities	Caribbean Institute for Meteorology and Hydrology (CIMH) located in Husbands Barbados National Hurricane Centre (NHC) in the United States	The CIMH operates an automatic weather station as well as a fully equipped manual climatological station The NHC is located in Florida and its mission is to save lives, mitigate property loss, and improve economic efficiency by issuing the best watches, warnings, forecasts, and analyses of hazardous tropical weather and by increasing understanding of these hazards

Meteorological forecast and services, including information provided on the websites of the local branches of Météo France in Guadeloupe and Martinique are quite.

As of 2023, the Government of the BVI is reportedly engaged in discussions for the introduction of a National Meteorological Service in the Territory.

Montserrat has a robust seismic monitoring network (seismic stations, seismometers, Real Time Monitoring, etc.) managed by various entities including the Seismic Department of the University of the West Indies (based in St Augustine, Trinidad).

Some of the recommendations to improve climate services in the countries under study include:

1. Policy-maker buy-in;
2. Procurement of new equipment, as well as funding for maintenance and routine replacement of equipment;
3. Training and capacity building of new and existing staff to develop new products, to produce long-range forecasts and to conduct climate impact assessments;
4. Establishment of dedicated staff assigned for product development and refinement;

5. Establishment of dedicated research units with a clear long term research strategy and strong links to established research institutions;

6. Improvement to the Met Service websites, including interactive WebGIS maps and services; and

7. Increased opportunities for routine interaction with climate information users.

For more country specific information on the status of hydrometeorological and climate monitoring systems.

Emergency Response Plans and Disaster Preparedness

Given their high exposure to natural disasters and climate change, virtually all countries included in the study have adopted robust disaster preparedness and recovery policies, legislation, plans and have established the entities to execute them (e.g. National Emergency Management Agency or Office, Offices of Disaster Management, etc.). Refer to Table 3.6 for summary details.

In 1991, the Caribbean took ownership of Disaster Management in the region through the formation of CDERA, which has since been renamed the Caribbean Disaster Emergency Management Agency (CDEMA). That same year, four sub-regional focal points were established – Antigua and Barbuda, Jamaica, Barbados and Trinidad and Tobago.

Antigua and Barbuda has focal point responsibility for Anguilla, the British Virgin Islands, Montserrat and St Kitts/Nevis.

Other focal points and their assigned islands are:

1. Barbados: Dominica, St Lucia, St Vincent;
2. Trinidad: Tobago, Guyana, Grenada, Suriname;
3. Jamaica: Belize, Bahamas, Turks and Caicos and Haiti.

In Guadeloupe and Martinique, Natural Risk Prevention Plans (PPRN in French) are documents produced by the State that regulate the use of land at the municipal level, according to the risks to which it is subject. It makes it possible to consider natural risks in development, to control the urbanization of the territory by avoiding increasing the

stakes in high-risk areas and by reducing the vulnerability of the existing ones. These regulations range from a ban on building to the possibility of building under certain conditions.

The respective PPRNs for Guadeloupe²⁸ and Martinique²⁹ are available online and the web sites includes useful interactive maps with colour coding of risks and land use regulations.

Despite some challenges, Guadeloupe and Martinique have fairly robust disaster preparedness framework, response plan and adequate resources. They also provide assistance to its OECS neighbours struck by natural disasters (e.g. St. Lucia, Haiti, Dominica), mobilizing at times European funds dedicated to Caribbean solidarity.

Areas for improvement include:

1. The systematic provision of generators for the numerous sewerage pump stations as power interruptions often lead to the development of septic conditions within system (wet wells, force mains and WWTPs) which in turn result in occupational and environmental hazards as well as operational challenges;
2. Increase water storage to attain the objective of minimum 2 days of water supply and allow gravity feed in the event of power outages. This increases the resilience of the systems.

²⁸ <https://pprn971guadeloupe.fr/>

²⁹ <https://www.observatoire-eau-martinique.fr/politique-de-l-eau/plans-d-action/plan-de-prevention-des-risques-naturels>

Table 3.6

Emergency Response Plan and Disaster Preparedness in the OECS & Barbados

Country	Entity Responsible ERP and Disaster Preparedness	Comments
Anguilla	Department of Disaster Management (DDM) National Emergency Operations Centre (NEOC)	Coordinates general policy, administration, ensures implementation of policies and strategies (ERP&DP) Functions as HQ of activities undertaken in response to a disaster emergency
Antigua and Barbuda	National Office of Disaster Services (NODS) National Emergency Operations Centre (NEOC)	Established in 1984 as a division in the Ministry of Health and Home Affairs Activated during the passage of Hurricanes & Tropical Storms. Provided support for Montserrat when the volcano Soufriere erupted in 1995
Barbados	Department of Emergency Management (DEM) National Emergency Operations Centre (NEOC)	Responsible for the coordination of ERP & DP stakeholders and activities Centralised location from which the mobilisation and coordination of responses and resources is carried out in the event of a major incident, emergency or disaster
British Virgin Islands	Department of Disaster Management (DDM)	Coordination and integration of comprehensive disaster management with a special emphasis on disaster prevention, mitigation, preparedness, response and recovery
Dominica	Office of Disaster Management (ODM) National Emergency Operations Centre (NEOC) Climate Resilience Execution Agency for Dominica (CREAD)	Coordinates the implementation of Comprehensive Disaster Management (CDM) Functions as HQ of activities undertaken in response to a disaster emergency Established in 2018 with the assistance of UK funds as a temporary institute to mainstream adaptation in Dominica
Grenada	National Disaster Management Agency (NaDMA)	Established in 1985 and is responsible for coordinating all disaster management activities throughout Grenada, Carriacou & Petite Martinique
Guadeloupe	Prefecture of Guadeloupe Departmental Fire and Rescue Service (SIDS) Local Government Entities	Plays a significant role in coordinating and overseeing disaster management efforts on the island Plays a crucial role in disaster response and often collaborates closely with the Prefecture Have their own roles and responsibilities in disaster preparedness and response
Martinique	Prefecture of Martinique Departmental Fire and Rescue Service (SIDS) Local Government Entities	Plays a significant role in coordinating and overseeing disaster management efforts on the island Plays a crucial role in disaster response and often collaborates closely with the Prefecture Have their own roles and responsibilities in disaster preparedness and response
Montserrat	Disaster Management Coordination Agency (DMCA)	Lead agency on Montserrat responsible for emergency and comprehensive disaster management through prevention, mitigation, planning, preparedness, response and recovery
St Kitts & Nevis	National Emergency Management Agency (NEMA) National Emergency Operation Centre (NEOC)	NEMA is responsible for coordinating efforts related to disaster management, including preparedness, mitigation, response, and recovery Functions as HQ of activities undertaken in response to a disaster emergency
Saint Lucia	National Emergency Management Office (NEMO)	Responsible for coordinating efforts related to disaster management, including preparedness, mitigation, response, and recovery
Saint Vincent & the Grenadines	National Emergency Management Organisation (NEMO) National Emergency Operation Centre (NEOC)	Responsible for coordinating efforts related to disaster management, including preparedness, mitigation, response, and recovery Activated during an emergency
Regional Entities	Caribbean Disaster Emergency Management Agency (CDEMA)	Four sub-regional focal points were established in 1991 – Antigua and Barbuda, Jamaica, Barbados and Trinidad and Tobago

Asset Planning & Development

In most of the countries under study, the water utilities, under the aegis of their line Ministries, are responsible for asset planning and development in the water supply and sewerage sub-sectors.

Few of the countries under study have updated and comprehensive Water Sector Strategic Plans and Water Supply and Sewerage Master Plans. Whenever these documents do exist, resource and demand projections do not always capture the uncertainty linked with various climate change/variability scenarios nor the anticipated effects of various demand management scenarios, which should be grounded in hard data obtained from Pilot Area surveys/measurements.

Also, Strategic Plans and Master Plans should be living documents, providing strategic sector stewardship and investment guidelines, and should be regularly updated (every 5 years for the former and 10 years for the latter). Investment focus should not only be on traditional grey infrastructure but also on green infrastructure and nature-based solutions (especially in the water resource and sanitation sub-sectors), as they are usually highly cost effective and have invaluable direct and indirect benefits (for societies, economies and the environment).

If improved water supply coverage in the region is above 95%, water networks are old and there is insufficient renewal of ageing water supply assets, the required minimum percentage being 2%/year for assets with a 50-year life cycle and higher yearly percentages are required for assets with a lower life cycle.

There is therefore generally need for significant investments in water supply system renewal/upgrades. In Barbados for example, BWA has estimated the required investments in network renewal at 950 MUSD to which must be added investments in the upgrade/expansion of WTPs and storage tanks. Throughout the region, a number of projects are underway, but there is need to accelerate efforts to achieve the water security objectives.

In the countries under study, as previously mentioned, there is generally a significant gap in sewerage coverage as the % of population sewered is much lower than the % of urbanized population (and sewerage is generally cost effective in urban areas). Significant investments are thus

required to close the sewerage gap and feasibility studies are being considered in several countries (e.g. Barbados and Saint Lucia). Technical solutions of interest include:

1. The use of trenchless technologies to minimize traffic disruptions and negative economic impacts during construction in densely populated islands (e.g. Barbados);
2. The construction of condominium type sewerage systems which are adapted to specific situations (e.g. high water table, rocky subsoil, low income areas) and which require significantly less CAPEX as compared with traditional sewerage systems;
3. The construction of decentralized nature based WWTPs such as constructed wetlands with low CAPEX and OPEX requirements and which have been successfully implemented in Martinique and Guadeloupe and are being considered in Saint Lucia on a pilot basis.

To address the water sector disparities between Metropolitan France and French overseas departments (DOM in French), including those of Martinique and Guadeloupe, the French State, in partnership with its relevant agencies and Local Government entities in the DOM initiated the Plan Eau DOM in 2016.

The Plan Eau DOM aims to take specific action in the overseas departments to improve drinking water supply and sanitation infrastructure. It is a 10-year plan which is implemented over two (2) 5-year periods. The plan is assessed and reviewed after the first 5-year period.

In Martinique, the Plan Eau DOM constitutes an investment tool and facility with access to grant and concessionary loans (100 M€ over the first 5 years) for the implementation of water sector projects in Martinique. It was signed by the three (3) EPCI responsible for water supply, sanitation and drainage in Martinique between 2018 and 2020.

In Guadeloupe, several urgent non-regret projects were initiated prior to the signing of the Plan Eau DOM and were geared towards the reduction of NRW. This was followed by the Priority Action Plan which was launched in 2018 and includes 38 projects for a total investment of 71.4 M€.

Historical Investments by Subsector

Historically, in the countries understudy, there has been systematic under-investments in maintenance & renewal of ageing assets in the water supply, sanitation, irrigation and drainage subsectors. As a result, both performance and residual value of water sector assets have been gradually declining over time and significant investments are now required in asset renewal & reinforcement (and expansion), together with capacity building in asset management tools and methods.

Also, if historically there has been significant investments in new water supply facilities, the same cannot be said of sewerage facilities, one of the main reasons behind the important sewerage gap observed in the region.

Major ongoing projects in the water and sanitation subsector are summarized in Table 3.7 below.

The private sector has been insufficiently leveraged. With the exception of several BOT or BOOT type desalination projects, there have been few projects where private sector capital and/or know how have been harnessed via PBC or PPP type contracts to address the operational and financial challenges in the water sector (in close collaboration with public utilities).

Climate change/variability and its impact on water resources availability, water demand and allocation has brought to the forefront the importance of implementing adaptation and mitigation measures to avoid water chaos and ensure a water secure future in the region.

These measures include (non-exhaustive list): demand management (reduction of leakage and wastage), increased storage capacity, rainwater harvesting, wastewater reuse, aquifer recharge, restoration of wetlands, nature based WWTP solutions such as constructed wetlands, enhanced household sanitation and reuse etc.

These solutions have been largely overlooked in past investment programs though there is a growing trend towards their mainstreaming. An interesting example is the Water Sector Resilience Nexus For Sustainability project in Barbados, funded by the GCF (27.6 MUSD) with counterpart funding from the GoB (17.6 MUSD). The project is 60% completed and its objectives include:

1. Build greater resilience to extreme storm events and drought conditions by utilizing cleaner energy sources, decentralising water storage, promote rainwater harvesting at the household and community level, and improve the efficiency with which rainwater runoff replenish aquifers in Barbados;
2. Further advance adaptation and mitigation initiatives in the water sector of Barbados by redirecting and mobilising local funds through a revolving adaptation fund;
3. Reduce the greenhouse gas emissions intensity of water provision by integrating renewable energy with back-up natural gas turbines and sustainable Water Loss Reduction (WLR) initiatives;
4. Contribute to capacity building via knowledge sharing and lessons learnt platforms within communities, educational organizations, private sector, civil society, BWA and the Government of Barbados to manage and monitor water resources;
5. Support the review and development of a legislative framework to supports climate smart development and water sector resilience.
6. Collate and disseminate lessons learnt for use in developing further adaptation and mitigation initiatives and raising public awareness about climate change, water conservation, recycle and reuse, the revolving adaptation fund, Green Climate Fund and in general this project.

Table 3.7

Major Ongoing Projects - Water Supply & Sanitation Subsector - in the OECS & Barbados

Country	Beneficiary	Project Designation	Duration	Focus	Financing
Anguilla	NA	NA	NA	NA	NA
Antigua and Barbuda	NA	NA	NA	NA	NA
Barbados	BWA	Barbados Water Supply Network Upgrade Project (WatSNUP)	2016 – 2020 (Delays - 46% complete as of Nov. 2023)	Increase efficiency of operations, through investments in areas that impact service, delivery and efficiency	35 MUSD (CDB) + 8.4 MUSD (GoB)
	BWA	Barbados Water Infrastructure Rehabilitation Project (BWIRP)	2020 – 2025 (Delays - 15% complete as of Nov. 2023)	Reduce non-revenue water, enhance and update operational infrastructure & Implement water resource sustainability projects	12 MUSD (CAF + EIB) 6.1 MUSD (GoB)
	BWA	Water Sector Resilience Nexus for Sustainability in Barbados	2019 – 2024 (60% complete as of Nov. 2023)	Resilience to storms & drought, revolving adaptation fund, renewable energy, NRW reduction, capacity building, strengthen legislative framework, raise public awareness	27.6 MUSD (GCF) 17.6 MUSD (GoB)
British Virgin Islands	NA	NA	NA	NA	NA
Dominica	DOWASCO	Third Water Supply Project (Area 1 Water Network Upgrade)	90% completed as of March 2024	Capital city and surroundings. New WTP, network replacement & extensions, Technical Assistance	11 MUSD (CDB)
	DOWASCO	Water Sector Strategic Development Plan	90% completed as of March 2024	Execute urgent repairs to the impacted water supply and sanitation systems, reinstate service and increase system resilience in the aftermath of Hurricane Maria (2018)	9.26 MUSD (UK)
Grenada	NAWASA	Grenada Climate Resilience Water Sector Project (G-CREWS)	2019 – 2024 80% completed as of March 2024	Climate resilient water governance, Raw water impoundments, rehab. WTPs, expansion communal storage, network rehab. & extension, bulk metering, SCADA, Contributions NDC, regional learning & replication	42 M€ (GCF / BMUB Germany / GoG)
	NAWASA	Southern St. George Water Expansion Project	2024 – 2026 2% completed	St George (capital city) and surroundings. Improve water services to St George (capital city) + surroundings and tourism developments in the south	20 MUSD (UKCIF + CDB)
Guadeloupe	DEAL	Water Supply Security Plan (PSEP)	50% completed as of 2020	68 projects in total to enhance water supply security in Guadeloupe	93.7 M€ (AFD/ CdD/Other State Agencies)
	EPCI	Priority Action Plan (PAP) part of the Plan Eau Dom Guadeloupe	2018 – 2028 Approximately 70% complete as of Sept. 2022	38 projects in total to manage & reduce NRW, increase sanitation coverage & service levels, increase system resilience to extreme weather events	71.4 M€ (AFD/ CdD/Other State Agencies)
Martinique	EPCI	Plan Eau DOM Martinique	2019 – 2029 Delays due to Covid	79 projects in total to improve drinking water supply and sanitation infrastructure	90.4 M€ (AFD/ CdD/Other State Agencies)
Montserrat	NA	NA	NA	NA	NA
St Kitts & Nevis	NA	NA	NA	NA	NA

Continued on the next page →

Country	Beneficiary	Project Designation	Duration	Focus	Financing
Saint Lucia	WASCO	Castries Sewer Expansion	Designs underway	Castries Sewer Expansion	3 MUSD
	WASCO	Replace John Compton Dam raw water main	Designs underway	Replace 5km DN600	10 MUSD
	WASCO	Micoud Water Supply Project	To be tendered	Design and construction of an intake + pump station + package WTP + storage tanks + distribution mains	< 1 MUSD (Caricom Development Fund)
	WASCO	Water Network Extension in the North	To be tendered	2 km of DN 500mm water main in the North	< 1 MUSD (Financing Agency?)
Saint Vincent & the Grenadines	CWSA	Annual Asset Expansion and Renewal (CAPEX)	Annual	Renewal and expansion of water supply assets (WTP, storage tanks, PS and networks)	1.5 MUSD (Financing Agency?)
	CWSA	Water Supply of the Grenadines	In preparation	Package desalination plants + networks in 4 islands of the Grenadines	16 MUSD (in discussion with financing partners)

Governance Frameworks and Institutional Performance

In most of the countries understudy, with a few exceptions, limited institutional capacity and weak governance frameworks are the major impediments to provide efficient potable water and sanitation services, as well as to manage adverse hydrometeorological and climate events in an efficient and timely manner.

Limited institutional capacity stems from several factors among which can be mentioned the small size of the countries understudy, the relative youth of the regional democracies.

Also, as mentioned in Section 3.3.4, studies have revealed that the main challenges faced by water and sanitation utilities in the Caribbean are linked to performance challenges (operational & financial) and weak governance frameworks:

Though most of the legislation governing the water and sanitation sector is post 1990 or post 2000, some countries have notably outdated pieces of legislation which are in dire need of revision/replacement: Barbados (1980 Act), Antigua and Barbuda (1945 Act last amended in 1953), Saint Kitts & Nevis (1956 Act).

In the other countries with more recent legislation, good governance principles aligned with ISO 37000 standards including autonomy, transparency and accountability are rarely embedded in the primary and secondary legislation and whenever they do exist, State Enterprise Performance Manuals do not adequately fill the gap.

As a result, utility reporting and disclosure levels are low as evidenced by the absence of or difficulty in obtaining Utility related data such as annual reports, strategic plans, performance standards, customer satisfaction data.

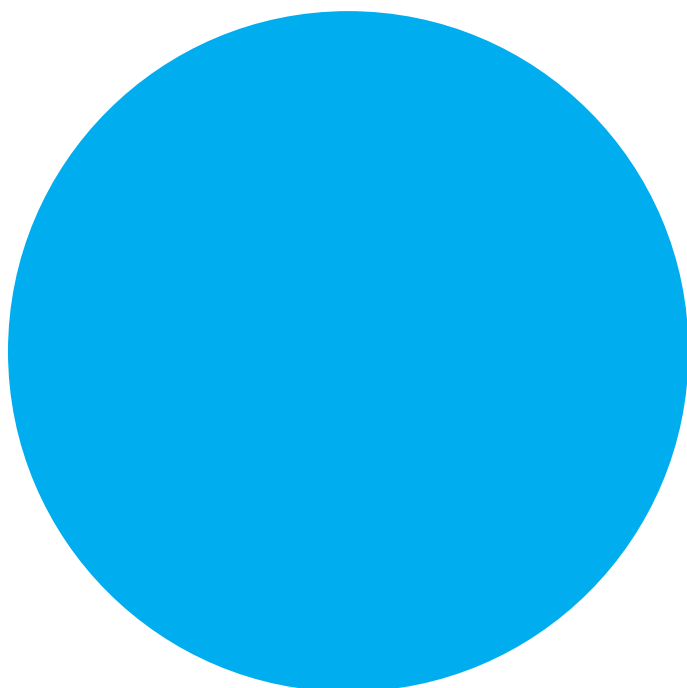
Regionalisation and the establishment of regional institutions has been one of the initiatives aimed at mitigating/compensating local institutional weaknesses. For example, in 1991, the Caribbean took ownership of Disaster Management in the region through the formation of CDERA, which has since been renamed the Caribbean Disaster Emergency Management Agency (CDEMA). That same year, four sub-regional focal points were established – Antigua and Barbuda, Jamaica, Barbados and Trinidad and Tobago. Also, recently (2023), there has been the establishment of two regional logistics hubs, both based in Barbados, for the distribution of food and disaster relief items to CARICOM member states.

Also noteworthy mentioning is the establishment in 1967 of the Caribbean Institute for Meteorology and Hydrology (CIMH) as one of the regional organizations providing weather forecasts and services for the Caribbean.

There is strong evidence that this regionalisation has brought about tangible benefits though distribution of responsibilities between local and regional entities has not come without its challenges.



Roadmap



General

This section entitled Roadmap follows the Eastern Caribbean water security diagnosis and gap analysis, which was described in Section 3, and is further informed by water sector data collated/analyzed by the Consultant as well as interviews with water sector managers in various islands of the OECS and Barbados³⁰.

The Roadmap was developed using the following guiding principles:

1. The main objective is to improve water security in the Eastern Caribbean;
2. Short to Mid Term measures (5-year horizon) are proposed. Given the starting point (existing situation)

described in the rapid diagnosis which is characterized by the relatively high vulnerability of existing systems to natural hazards and climate change/variability, and given the limited CAF funds available, short-term and mid-term measures should be focused on specific countries/goals/outcomes with regular assessments to realign programme outputs with stated objectives. These measures can then be extended/replicated as longer-term measures which will be required to attain the overall water sector security objectives in the various OECS countries;

3. Measures proposed should combine structural and non-structural measures, the leverage effect and cost effectiveness of the latter being usually very high;

³⁰ Five interviews held by Consultant to date with water and sanitation professionals in Martinique, Guadeloupe, Barbados Saint Lucia & Dominica.

4. There should be a flexible and adaptive approach to infrastructure development including the adoption of the participatory approach (of key stakeholders) and decision making under uncertainty (uncertainties linked to climate change/variation and demands);
5. Whenever possible, combination of traditional (grey) infrastructure) and nature-based (green) infrastructure are proposed. Nature based solutions are indeed highly sustainable, cost effective and aligned with many SDG goals and objectives. Also, the direct economic value derived from freshwater systems (lakes, rivers, aquifers, wetlands) are often underestimated leading to ripple negative effects (on climate, biodiversity, protection against extreme weather events, sustainability) and ultimately water chaos;
6. Proposed watershed management improvement should be focused on the operationalization of IWRM principles and practices (including setting up effective independent and accountable institutions and not only on the development of IWRM policies which are seldom or partially implemented) as well as the development of data/tools underpinning IWRM including a National Water Resources Information System (with Web GIS capabilities), hydrometeorological and climatic networks (including streamflow & rain gauges, traditional and mini met stations etc.);
7. Proposed water supply measures should be focused on improving system resilience as well as quality & continuity of service and overall customer satisfaction. Measures should take into account climate change/variability (which negatively impacts water resources) and increasing water demand (as a result of population growth and economic development);
8. Proposed sanitation/sewerage measures should be focused on improving performance of existing systems as well as expanding sewerage coverage in urban areas. Household sanitation should be improved to address existing issues in the faecal sludge value chain, avoid negative environmental and social impacts including aquifer contamination;
9. Protection against drought and floods calls not only for the implementation of structural and non-structural measures (the former including restoration of wetlands and floodplains) but also a more effective management of the watersheds including the reduction of hillside degradation (as a result of slash & burn agriculture, housing developments and quarrying), better spatial planning and more effective enforcement of updated physical development plans;
10. Poor governance, is often at the heart of the underperformance of the water sector in many countries, and the countries of the Eastern Caribbean are no exception to this reality, as the rapid diagnosis has revealed. Thus, improving the governance of public institutions in alignment with the principles of ISO 37000³¹ is deemed a key objective towards ensuring the effectiveness of the proposed measures for enhanced water security in the Eastern Caribbean and more so for their sustainability;
11. With the possible exception of Jamaica and the Dominican Republic, the private sector has been historically insufficiently leveraged in the Caribbean as a means to improve public infrastructure development and service delivery. The private sector should not only be seen as a source of alternative financing (such as in BOT or BOOT type contracts) but also as a provider of efficient management solutions and systems (such as in PBC and PPP type contracts. Necessary prerequisites to effective private sector involvement are an enabling legal and regulatory environment³² and the optimal distribution of risks between Parties in the PPP contract.

31 ISO 37000:2021: Governance of organizations – Guidance

32 Including PPP policy and legal instruments

Watershed Management improvement

Adopt & Operationalize Integrated Water Resources Management Policies & Practices

As stated in the rapid diagnosis (refer to Section 3), most countries have adopted environmental policies which often include IWRM policies, but few have effectively operationalized these IWRM principles. In the Eastern Caribbean, Guadeloupe, Martinique and to a lesser extent St Lucia stand out as countries with the most advanced IWRM ecosystems which can be emulated elsewhere in the region.

The IWRM policies, laws and regulations in the Eastern Caribbean Countries should be systematically reviewed to determine their alignment with international good practices as well as implementation bottlenecks/gaps, the objective being to facilitate their operationalization.

In the larger islands such as Barbados, Dominica and Saint Vincent and the Grenadines (and possibly Grenada), there is also a strong case for the establishment of an independent water resources management entity following IWRM principles and practice. For recollection, the four pillars of IWRM are:

1. Establishment of an independent entity (WRMA for example) for the management of water resources following IWRM principles and practice and in accordance with the provisions of the water resources master plan (see below);
2. Establishment of a National Water Resources Information System (NWRIS) where all water resources and relevant water sector data/information is regularly collected, analysed, archived and diffused freely³³ to stakeholders and the general public via a WebGIS type application³⁴. The NIWRS is managed by the WRMA;

3. Establishment of a Water Forum, a consultative body (sort of Water Parliament) where all stakeholders meet (e.g. quarterly or twice a year) to determine water allocations, abstraction and discharge tariffs and approve water resources master plans. The WRMA acts as the secretariat to the Water Forum which can be seen as the application of the "participatory principle" in IWRM;
4. Establishment of a water sector trust fund, managed by the WRMA, which is credited with the part of the proceeds of raw water abstraction and effluent discharge fees (municipal, industry and agriculture), various levies on water and sewerage bills and if required government subsidies. This trust fund is used for targeted loans/grants to water sector projects which have positive impacts on water resources (quality & quantity) such as WWTPs, restoration of wetlands etc. The remaining monies collected help meet the running costs of the WRMA. The objective is that the sector becomes gradually financially self-sufficient in application of the principle "water pays for water".

The adoption of primary and secondary legislation for the establishment of an independent entity, entrusted with the management of water resources following IWRM principles and practices, should be preceded by and aligned with relevant IWRM policies, and/or by the revision of existing environmental policies as laws not aligned with existing policies are bound to be challenged in the courts.

One of the sought outcomes is the restoration of freshwater systems in the Eastern Caribbean countries, including the smaller water scarce islands in the north,

³³ Some specific specialized services can be however be billed to stakeholders/customers.

³⁴ A good example is the Martinique Water Observatory (a comprehensive Water Resources Data Base) managed by ODE Martinique with comprehensive water sector data sets and interactive WebGIS maps: <https://www.observatoire-eau-martinique.fr/>

as this is deemed beneficial and has many direct benefits (social, economic and environmental)³⁵. The aforementioned is aligned with the objectives set forth by the UN's 2023 Water Conference, the first in half a

century, where the Freshwater Challenge was launched, with the aim of restoring 30 percent of degraded rivers and wetlands by 2030³⁶.

Modernization of Hydrometeorological and Climatic Systems

Based on the findings of the rapid diagnosis (refer to section 3), there is need to strengthen the network of streamflow and rain gauges in the water catchments across the larger Eastern Caribbean countries which have sufficient surface and ground water resources to warrant such a network. Existing networks are indeed incomplete at best and in dire need of rehabilitation/expansion/integration.

The need for integration of meteorological and hydrological services in the Caribbean at large (including the Eastern Caribbean) also calls for the establishment of effective collaborative mechanisms between these two services to enable the development/implementation of predictive tools and services (based mainly on rainfall previsions & hydrological modelling of water catchments/basins). These tools can greatly improve prevision of flood and drought, issuance of timely alerts and disaster preparedness. Examples of successful implementation of these predictive tools abound, including in Europe, Africa and Latin America.³⁷

As stated in the rapid diagnosis (refer to Section 3), some of the recommendations to improve climate services in the countries under study include:

1. Policy-maker buy-in;
2. Procurement of new equipment, as well as funding for maintenance and routine replacement of equipment;
3. Training and capacity building of new and existing staff to develop new products, to produce long-range forecasts and to conduct climate impact assessments;
4. Establishment of dedicated staff assigned for product development and refinement;
5. Establishment of dedicated research units with a clear long term research strategy and strong links to established research institutions;
6. Improvement to the Met Service websites, including interactive WebGIS maps and services; and
7. Increased opportunities for routine interaction with climate information users.

35 As described in the following paper: high cost of cheap water – WWF – 2023

36 Over the past 5 decades, one third of wetlands have disappeared and freshwater species populations have plummeted by 83 percent on average (high cost of cheap water – WWF – 2023)

37 Refer to the following websites: <https://www.wimes.fr/> & <https://www.predictservices.com/en/who-we-are/>

Preliminary Assessment of Investments Needs in Watershed Management Improvement

The preliminary assessment of investment needs in watershed management improvement is reported in the following table.

Note that investments were not computed for the following countries:

1. Anguilla, Antigua and Barbuda, BVI, Montserrat, St Kitts & Nevis as there was insufficient information available to determine investment requirements with a sufficient degree of accuracy;
2. Martinique and Guadeloupe as agencies of the French State have already allocated significant investments

(under the respective "Plan Eau DOM") for enhancing water resources management, water & sanitation services, flood and drought management and overall water security in these two French islands and their dependencies.

These proposals need to be validated, fine-tuned, and prioritized with the respective agencies & line ministries in the various countries.

CAF will then be able to identify/select projects which best align with their water security policies and objectives and initiate discussions with the relevant authorities to initiate preinvestment studies (whenever required) and develop investment programmes.

Table 4.1

Preliminary Assessment of Investment Needs in Watershed Management Improvement in countries of the OECS & Barbados

Country	Pop.	% Urbanisation	Utility	Water Network Coverage %	Sewerage Network Coverage %	Sewerage Gap %	Water Resources Investments			
							Designation	Impacted population	Estimated Budget USD	Priority 1 to 5
Barbados	303.000	31%	BWA	100%	8%	23%	Establish legislative, institutional and regulatory framework for an independent WRA	303,000	\$500,000	1
							Contribute to meeting the UN 2030 Freshwater Challenge including RAMSAR Sites	33 ha	\$500,000	2
							Aquifer recharge with impounding dams or treated WW	20,000	\$3,000,000	3
							Total Barbados		\$4,000,000	
Dominica	75.000	72%	DOWSACO	95%	20%	52%	Operationalize Water Resources Policy 2011	72,000	\$500,000	1
							Watershed management and reforestation (in coordination with other agencies)	20,000	\$3,000,000	3
							Groundwater resources assessment	22,000	\$1,000,000	2
							Total Dominica		\$4,500,000	
Grenada	114.000	37%	NAWASA	90% (est)	5%	32%	Review existing legislation, establish institutional and regulatory framework for an independent WRMU	114,000	\$500,000	1
							Contribute to meeting the UN 2030 Freshwater Challenge including RAMSAR Sites	518 ha	\$2,000,000	2
							Watershed management and reforestation (in coordination with other agencies)	20,000	\$3,000,000	3
							Total Grenada		\$5,500,000	

Continued on the next page →

Country	Pop.	% Urbanisation	Utility	Water Network Coverage %	Sewerage Network Coverage %	Sewerage Gap %	Water Resources Investments			
							Designation	Impacted population	Estimated Budget USD	Priority 1 to 5
Guadeloupe	396.000	80%	EPCI	95%	44%	36%	Total Guadeloupe		\$0	
Martinique	367.000	80%	EPCI	100%	42%	38%	Total Martinique		\$0	
Saint Lucia	168.000	19%	WASCO	100%	7%	12%	Review & optimize legislative, institutional & regulatory framework to fully align with IWRM principles & practices	168,000	\$300,000	1
							Contribute to meeting the UN 2030 Freshwater Challenge including RAMSAR Sites	85 ha	\$1,000,000	2
							Watershed management and reforestation (in coordination with other agencies)	20,000	\$3,000,000	3
							Total Saint Lucia		\$4,300,000	
Saint Vincent & the Grenadines	101.000	54%	CWSA	90%	4%	50%	Establish legislative, institutional and regulatory framework for an independant WRMU	101,000	\$500,000	1
							Watershed management and reforestation (in coordination with other agencies)	20,000	\$3,000,000	3
							Total St Vincent & the Grenadines		\$3,500,000	
GRAND TOTAL									\$21,800,000	

Water Supply Improvement

Strategic Planning & Master Planning

Based on findings of the rapid diagnosis, there is a need to improve the planning, programming and execution capabilities of water utilities in the countries of the Eastern Caribbean.

The objective is to systematize the development of 5-Year Strategic Plans and 10-year Master Plans for efficient service delivery, customer satisfaction and optimal asset management. These plans, partly or entirely executed by specialized Consultants contracted by the utilities, should be regularly reviewed (ideally yearly or bi yearly), by comparing outputs with set objectives and adjusted/ updated accordingly.

Resilience, adaptation, flexibility & cost effectiveness should guide the development of these planning documents. The optimal combination of structural and non-structural measures as well as grey (traditional) and green (nature

based) solutions should be considered during the planning exercise to ensure sustainability.

The mainstreaming of freshwater restoration initiatives should also be prioritized and funded under both environmental and infrastructure financial portfolios, and not only under the former as freshwater systems (lakes, rivers, aquifers, mangroves etc.) provide invaluable direct benefits (economic, social, environmental, biodiversity, protection against natural hazards) which have too often been undervalued and overlooked.

Both Strategic Plans and Master Plans constitute investment tools which guide the sustainable and cost-effective improvement of respectively services & customer satisfaction and infrastructure development.

Rehabilitate & Expand Water Treatment Plants

As stated in the rapid diagnosis, pipe borne water supply coverage throughout the countries under study is high and the nominal capacities of WTPs are generally considered as adequate.

There is however urgent need for additional investments in WTP rehabilitation/upgrade/expansion to compensate for the historical under-investments in plant maintenance and the deterioration of raw water quality of surface water bodies due to increased pollution and turbidity levels in surface water bodies. Process adjustments are at times required to increase filtration & settling capabilities of plants, at times with the introduction of specialized chemical adjuvants (e.g. coagulant/flocculant agents and/or polymers).

Automation of the WTPs should also be pursued via the installation of local SCADA systems (with PLCs and RTU) which facilitate WTP operations and increase the quality of treated water outputs. These local WTP SCADA systems should be upscalable and compatible with the overall utility SCADA (for alarm & monitoring, local control or remote control of facilities such as WTPs, pump stations and networks).

Additional raw water storage upstream the WTPs (e.g. in dams and/or aquifers) also serves to enhance water supply security in the event of surface water contamination or during flood and drought episodes. This is also closely tied to the quality and effectiveness of the management of water catchments including the restoration of freshwater systems which should result in:

1. Lower peak flows (wet season) and higher baseline flows (dry season) in surface water bodies;
2. Higher aquifer recharge, yields and lower saltwater intrusion in coastal aquifers.

The same applies for additional treated water storage downstream the WTPs Expand Storage Capacity

As mentioned in the rapid diagnosis, there is generally insufficient communal treated water storage capacity in the countries of the Eastern Caribbean (generally less than 6h of daily water demand) which is an impediment to continuity of supply and resilience to emergency situations.

Consequently, in many countries experiencing some form of water rationing, household storage is the norm with usual size of storage tanks comprised between 400 USgal and 1,000 USgal (i.e. between 1.5 m³ and 3.8 m³). Note however that there is virtually no household storage in Martinique³⁸ and Guadeloupe³⁹ because of water quality/sanitary regulations.

Treated water communal storage capacity should therefore be increased to attain a minimum of 25% of daily water demand (or 6h of average supply). The ideal location of storage facilities is at elevated points of the network to allow gravity supply (especially in the event of power supply interruptions). Head tanks or balancing tanks (closer to the gravity centre of demand) can be contemplated depending on the topography and the configuration of the water supply system and networks.

Tank material (concrete, glass coated steel, etc.) should be selected according to soil bearing capacity, accessibility, and constructability considerations. Tanks should be systematically equipped with:

- Upstream altitude valves with upstream filters to prevent overflows (a component of NRW);
- Downstream water meters (with upstream and downstream valves and by-passes for larger DN) to allow network zoning and the establishment of water balances.

³⁸ 24/7 water supply in Martinique

³⁹ Non 24/7 water supply in Guadeloupe due to high demand and NRW levels (currently being addressed with the financial assistance of entities linked to the French State)

Rehabilitate, Replace & Reinforce Ageing Water Networks

As stated in the rapid diagnosis, water supply networks are generally well sized and extend to the entire service area of utilities which in most cases also include a significant part of the rural areas.

The main issues usually lie with the advanced age of the network and the historical lack of investments in maintenance and renewal which, together with sub-optimal O&M practices, lead to high levels of NRW. Lack of quality of materials and workmanship are also factors which increase NRW levels.

There is therefore urgent need to plan and implement water network renewal starting with the older, failing and/or leak prone sections of the networks in accordance with the priorities defined by the Asset Management tools (refer to Section 4.3.7).

Network renewal plans should be aligned with network zoning plans which usually also call for network reinforcements (to avoid an excessive number of boundary valves and meter points along DMZ and DMA perimeters).

Network materials should also be carefully selected according to site characteristics & constraints, anticipated asset lifecycle, O&M requirements, exposure to natural hazards, knowhow of utility construction teams and those of local contractors, etc. It is thus good practice to include a material comparison component in major water network feasibility projects.

Use of uncoated and unlined steel pipes, frequently used in valve and water meter chambers and for river/utility crossings should be prohibited (due to excessive corrosion and reduced lifecycle) and the systematic replacement of colonial area AC pipes should be pursued (for obvious health reasons).

Implement Network Zoning, Water Balances & SCADA

As mentioned in the diagnosis report, few water distribution networks in the eastern Caribbean are fully sectorized (in DMZs and/or DMAs) thus impeding the establishment of water balances, effective network management, NRW management and the optimal allocation of limited operational and financial resources.

There is therefore an urgent need to implement network zoning projects, starting with network modelling, measurement campaigns (flow, pressure and reservoir levels) and network zoning designs, followed by procurement & installation of zoning equipment and the completion of the associated construction works.

The aim of the measurement campaign is to obtain a better understanding of actual network operating conditions (via the measurement and analysis of existing flows, pressures, and reservoir level data) and to calibrate the network model so that model output mirrors measurements. The calibrated model will then allow to simulate different operational and

water demand scenarios and design the required network reinforcements accordingly.

As previously mentioned:

1. Network zoning should be construed as a part of both network management and NRW management and should be undertaken in parallel with network renewal projects (as defined by the asset management teams);
2. Network zoning calls for the installation of boundary valves and water meters at along DMZ and DMA perimeters and some elements of network reinforcements (to avoid installing excessive

As mentioned in the rapid diagnosis, there is a general lack of distribution network automation and SCADA, thus leading to a lack of real time knowledge of network pressures and flows, longer reaction times, sub-par customer information and satisfaction.

SCADA systems can be designed to:

1. For monitoring and generation of alarms;
2. For local automation of facilities (e.g. WTPs, pump stations, valve chambers, etc.);
3. For remote control of facilities from a centralized SCADA room.

Utilities should design flexible and upscalable SCADA systems based on robust and proven equipment

(sensors, PLCs, HMIs, RTUs etc.) and software with public communication protocols which include the latest security protocols (avoid proprietary communication systems which generally tie the utility to a given equipment manufacturer and/or service provider).

Just as local SCADA systems are recommended for WTPs, they are also recommended for implementation on water network components (whether pump stations or water networks).

Implement Universal Metering

As reported in the rapid diagnosis, whilst universal metering is a reality in many islands (including Barbados, Martinique, Guadeloupe & Saint Lucia), and most islands meter their largest customers (industrial, commercial, institutional) others have yet to systematically meter all their customers (including domestic customers).

Universal metering is a non-regret action that should be systematically implemented as it is a key component of water demand management which includes management/reduction of both leakage on utility networks and wastage at customer premises.

Indeed, universal metering allows the application of the user pay principle and, in combination with an appropriate tariff scheme (progressive stepped tariffs with social tariffs for the lower income groups), acts to moderate consumption and wastage whilst allowing some element of cross subsidy to satisfy the water rights of the lower income customers.

Thus, universal metering can no longer be considered a luxury but is a necessity in this area where utilities face:

1. Reduced water resources availability as a result of climate change/variability;
2. Competing demands from irrigation, industry and to maintain ecological baseline flows;
3. Increasing water demand as a result of economic growth including tourism;

4. High costs (CAPEX & OPEX) linked with desalination systems;

5. Affordability and willingness to pay issues linked with higher tariffs.

It is noteworthy mentioning that many utilities across the Caribbean Region, including some in the Eastern Caribbean, have already embraced the new generation of static meters (full bore, no mechanical parts) instead of the older mechanical meters (either singlejet, multijet or volumetric) due the fact that static meters are impervious to water quality issues (e.g. high turbidity) and do not register air (an appreciable feature in networks with scheduled water supply).

The downside of static meters is their cost (approximately three times more expensive than similar mechanical meters) but this is compensated by their relative higher accuracy, longer lifecycle and shorter payback period (in the Caribbean context). Quality static meters from reputable brands (including public communication protocol features) are thus recommended for systematic deployment throughout the Eastern Caribbean, as part of universal metering projects.

Improve NRW Management and Reduction

As evidenced by the relatively high NRW levels in the countries of the Eastern Caribbean, there is scope for the design and deployment of comprehensive NRW management and reduction programmes throughout the region.

NRW programs focus on the management and reduction of:

1. Physical losses (e.g. leakage);
2. Commercial losses (e.g. meter under-registration, illegal connections).

As previously mentioned, the management component of these programs also include network zoning (including network modelling, measurement campaigns and model calibration) and the establishment of monthly water balances (in DMZs and DMA) to monitor NRW levels and allow the optimal allocation of scarce finances and resources to reduce NRW.

Customer information census, universal metering and the application of a progressive tariff scheme are also key components of NRW management and reduction programs as their absence lead to non-registered customers and water wastage at customer premises (and unmetered water wastage which supersedes the flat tariff assumptions is equivalent to a commercial loss).

The traditional Technical Assistance (TA) approach to NRW projects has generally failed to make significant and sustainable impacts on NRW levels, thus attesting to the fact that NRW issues are not only related to availability of funds, to access to modern tools/methods and to capacity building of utility teams but also to governance issues (which are not always the focus or not always addressed in TA projects).

One way to circumvent the above limitations is to consider the implementation of Performance Based Contracts (PBCs) for NRW management and reduction. Typically, in PBC contracts, a third party PBC contractor will be contracted by the Utilities or by their line ministries over a five-year period⁴⁰ to undertake the following:

1. Within the 1st year:
 - a. Set up modern NRW management tools/methods;
 - b. Provide capacity building and change management to utility teams that will work alongside the PBC contractor;
 - c. Determine NRW baseline levels within the project area;
 - d. Finalize NRW reduction targets to be achieved over the contract period (assuming 5 years);
2. Within years 2 to 4 included:
 - a. Implement the reduction of physical losses;
 - b. Implement the reduction of commercial losses;
 - c. Regularly assess (monthly, quarterly, yearly) achieved results in terms of NRW reduction and adjust interventions accordingly;
 - d. Provide training, capacity building and change management to utility teams to ensure continuity and sustainability;
 - e. Calculate PBC contractor remuneration (fixed and results based) according to NRW management and reduction results achieved and contractual weightings (between fixed and results based components);
3. Within year 5:
 - a. Final capacity building and change management initiatives;
 - b. Gradual handing over of activities & tools to utility staff;
 - c. Final evaluation of NRW management and reduction results achieved;
 - d. Determine PBC contractor overall performance and final remuneration.

⁴⁰ Some PBC contracts are executed over a three (3) year period but this is not considered ideal given the complex and integrated nature of NRW management and reduction activities and the need to ensure sustainability of results via capacity building of utility staff and change management.

In the Caribbean Region, examples of NRW PBC contracts range from 40 MUSD (IDB financed, 5-year project, Kingston Jamaica) to 15 MUSD (Commercial loan, 3-year project, Montego Bay Jamaica).

PBC type contacts could thus be considered for implementation on the larger countries of the Eastern

Caribbean where NRW levels are high and where there is appetite and support (from utility boards and managers, civil servants and the political establishment) for harnessing private sector know how and efficiency in the management and reduction of NRW.

Improve Asset Management

Asset management is notably lacking in the countries of the Eastern Caribbean. Rarely are preventive and predictive maintenance schedules developed/implemented and corrective as well as emergency maintenance are unfortunately the norm.

Asset management tools and methods (e.g. based on the many iterations of the MAXIMO software) are required to:

1. Tag all assets (movable and buried);
2. Determine and manage maintenance schedules (preventive, predictive);
3. Determine optimal life cycles of assets;
4. Plan and manage asset replacement;
5. Feed into utility workflow programmes.

Mainstream Rainwater Harvesting

Rainwater harvesting should be mainstreamed in the Eastern Caribbean region and dedicated to non-potable yard and household uses (car washing, irrigation of plants and lawns, flushing etc.). Projects should also include roofing and gutter improvements, purchase and installation of a ½" or ¾" inch pump alongside the 400 US gal to 1,000 US gal HDPE water tank.

Some countries have already mainstreamed rainwater harvesting, for potable and non-potable uses due to increasing water scarcity (e.g. smaller countries in the northern part of the Eastern Caribbean). Use of rainwater for potable uses can be a health hazard and regular/systematic roofing and gutter refurbishment as well as household disinfection are required.

Other islands (e.g. Barbados under GCF financing) are deploying rainwater harvesting projects as part of holistic water sector resilience initiatives which also include wastewater reuse, aquifer recharge, increased household storage, water sector energy optimization (solar panels, gas turbines) etc. These types of holistic projects which enhance water sector resilience, sustainability and ultimately water security should be adapted to the specific context of each country and replicated throughout the Eastern Caribbean.

Preliminary Assessment of Investments Needs in Water Supply Improvement

The preliminary assessment of investment needs in water supply improvement is reported in the following table.

Note that investments were not computed for the following countries:

1. Anguilla, Antigua and Barbuda, BVI, Montserrat, St Kitts & Nevis as there was insufficient information available to determine investment requirements with a sufficient degree of accuracy;
2. Martinique and Guadeloupe as agencies of the French State have already allocated significant investments (under the respective "Plan Eau DOM") for enhancing

water resources management, water & sanitation services, flood and drought management and overall water security in these two French islands and their dependencies.

These proposals need to be validated, fine-tuned, and prioritized with the respective agencies & line ministries in the various countries.

CAF will then be able to identify/select projects which best align with their water security policies and objectives and initiate discussions with the relevant authorities to initiate preinvestment studies (whenever required) and develop investment programmes.

Table 4.2

Preliminary Assessment of Investment Needs in Water Supply Improvement in countries of the OECS & Barbados

Country	Pop.	% Urbanisation	Utility	Water Network Coverage %	Sewerage Network Coverage %	Sewerage Gap %	Water Supply Investments			
							Designation	Impacted population	Estimated Budget MUS\$	Priority 1 to 5
Barbados	303,000	31%	BWA	100%	8%	23%	Package desalination plants	20,000	\$15,000,000	1
							Rehabilitation ageing and leak prone network sections (100 km)	20,000	\$20,000,000	2
							Total Barbados		\$35,000,000	
Dominica	75,000	72%	DOWSACO	95%	20%	52%	Rehabilitate surface water intakes (15)	25,000	\$7,500,000	1
							Use of flexible HDPE pipes or pipes with anchored joints in areas of high declivity (60km)	25,000	\$24,000,000	2
							Increase communal storage capacity (12,500 m ³)	25,000	\$6,250,000	3
							Sectorization (15 x DMZs & DMAs) with PRVs	25,000	\$1,500,000	3
							Total Dominica		\$39,250,000	
Grenada	114,000	37%	NAWASA	90% (est)	5%	32%	Replacement of 50,000 ageing customer meters	103,000	\$25,000,000	1
							Sectorization (30 x DMZs & DMAs)	103,000	\$3,000,000	2
							Water network replacement (100km)	20,000	\$20,000,000	3
							Automation & SCADA	103,000	\$1,500,000	2
							Rain Water Harvesting	15,000	\$2,500,000	3
							NRW Performance Based Contract (3 to 5 years)	103,000	\$15,000,000	4
							Total Grenada		\$67,000,000	

Continued on the next page →

Country	Pop.	% Urbanisation	Utility	Water Network Coverage %	Sewerage Network Coverage %	Sewerage Gap %	Water Supply Investments			
							Designation	Impacted population	Estimated Budget MUSD	Priority 1 to 5
Guadeloupe	396,000	80%	EPCI	95%	44%	36%	Total Guadeloupe		\$0	
Martinique	367,000	80%	EPCI	100%	42%	38%	Total Martinique		\$0	
Saint Lucia	168,000	19%	WASCO	100%	7%	12%	Automation & SCADA	168,000	\$1,500,000	1
							Sectorization (30 x DMZs & DMAs)	168,000	\$3,000,000	2
							Water network replacement (100km)	20,000	\$20,000,000	2
							NRW Performance Based Contract (3 to 5 years)	168,000	\$15,000,000	4
							Total Saint Lucia		\$39,500,000	
Saint Vincent & the Grenadines	101,000	54%	CWSA	90%	4%	50%	Rehabilitation of five (5) WTPs	15,000	\$3,000,000	1
							Sectorization (30 x DMZs & DMAs)	91,000	\$3,000,000	2
							Water network replacement (50km)	10,000	\$10,000,000	2
							Construction of 4 desalination plants in the Grenadiines	15,000	\$16,000,000	1
							NRW Performance Based Contract (3 to 5 years)	91,000	\$15,000,000	4
Total St Vincent & the Grenadines								\$47,000,000		
GRAND TOTAL								\$227,750,000		

Sanitation and Sewerage Improvement

Strategic Planning & Master Planning

Refer to Section 4.3.1 which also applies to sanitation and sewerage strategic and master planning.

If the emphasis of water supply planning (strategic and master planning) is primarily focused on operations (continuity of supply, improved efficiency, demand management, reduced NRW levels) and secondarily

on assets (rehabilitation/renewal), that of sewerage is focused both on operations (reduce I&I, improve final effluent quality from WWTPs) and expansion of asset (given the persistence of an important sewerage gap = difference between % of urban population and % sewerage coverage).

Rehabilitate Existing Sewerage Systems

Networks & Pump Stations

As sated in the rapid diagnosis, public sewerage networks in the Eastern Caribbean are often plagued with operational issues such as:

1. Grease plugs in the sewerage networks (an indication of absence and/or non-functioning grease traps at customer premises, especially commercial properties);
2. High levels of Infiltration & Inflow (I&I) in the separate sewerage networks which result in hydraulic overloading and network overflows as well as flushing effects in the WWTPs;
3. Long rising mains which lead to H₂S emissions, an occupational hazard which is also detrimental to operations and to the longevity of sewerage assets (pump stations, networks, WWTPs);
4. Low connection ratio to the sewer system, and lack of enforcement of sewer connection regulations.

The rehabilitation of sewerage networks & pump stations entail:

1. The modelling of sewer catchments/ networks, measurement campaigns (to determine effluent flows, I&I and allow model calibration) and the identification of design and/or construction issues;
2. The condition assessment of pump stations, including an energy audit, and the identification of design and/or construction issues;
3. The assessment of O&M procedures and practices (including Standard Operating Procedures or SOPs) which, if poorly developed or partially applied, can lead to serious operational issues;
4. The development of prioritized and cost-effective rehabilitation programmes for sewerage networks and pump stations including:
 - a. Systematic installation of adequately sized grease traps at large commercial customer premises and elimination of grease plugs in the sewer network;

- b. Management and reduction of I&I (including elimination of root penetrations, elimination of infiltrations at non watertight pipe joints and manholes and elimination of storm water discharges to sewer networks);
- c. Sewer lining or structural repairs/reinforcements;
- d. Replace failed or inadequately designed/constructed sections of sewer networks;
- e. Use of trenchless technologies whenever justified and cost effective: either pipe jacking or microtunneling or Horizontal Directional Drilling (HDD);
5. Similar to that proposed for water supply systems, the implementation of SCADA systems on sewer network components (mains and pump stations) to allow real time monitoring of systems and automation of key facilities (especially pump stations);
6. The implementation of these rehabilitation programmes;
7. Capacity building to utility staff to improve sewer network and pump station O&M capabilities and resources.

Wastewater Treatment Plants

As mentioned in the rapid diagnosis:

1. Centralized WWTPs in the countries understudy entail either preliminary/primary treatment with outfalls (e.g. Barbados South Coast, Baytown in Dominica) or waste stabilization ponds (e.g. Bridgetown Barbados, Rodney Bay Saint Lucia).
2. In some instances, sewerage networks spew untreated sewage directly to the sea via short outfalls (e.g. Castries St Lucia, Kingstown Saint Vincent & the Grenadines);
3. Plants in Martinique and Guadeloupe usually entail secondary treatment though plant output does not always meet discharge standards.

Also, ageing WWTP facilities and insufficient maintenance over the years have resulted in deteriorating WWTP assets which are in dire need of rehabilitation/upgrade.

Pursuant to the above, there is need to rehabilitate existing WWTPs to:

1. Improve efficiency of preliminary treatment and primary treatments;
2. Upgrade plants to allow secondary treatment of effluents;

3. Introduce tertiary treatment and wastewater reuse (if there is a demand for wastewater reuse in the vicinity of the rehabilitated WWTP (e.g. aquifer recharge, municipal use, irrigation, industrial use).

The introduction of local SCADA systems on the larger WWTPs is also warranted to allow the automation of the facilities and improve the reliability of operations and the final quality of treated effluents.

Expand Sewerage Coverage

General

The persistent sewerage gap in the Eastern Caribbean should be gradually closed to avoid negative environmental consequences (with ripple negative social and economical impacts).

This calls for significant investments in sewerage network infrastructure in densely populated urban areas where household sanitation is still the norm.

In Eastern Caribbean countries with mountainous terrain and high declivity, decentralized sewerage catchments with standalone WWTPs based on sustainable nature-based solutions such as constructed wetlands should be considered (as currently implemented in a number of islands⁴¹ under the CARIBSAN project). This avoids the construction of long rising mains between catchments which invariably lead to H₂S formation, a HSE hazard which is also detrimental to asset lifespan.

Just as it was the case for the rehabilitation of existing sewerage systems, the implementation of local SCADA systems on the larger networks and WWTPs is also warranted to allow the automation of the facilities (new pump stations and WWTPs) and improve the reliability of operations and the final quality of treated effluents.

Networks & Pump Stations

New sewers and pump stations should be designed and constructed in unsewered urban areas following best international practices and should be adapted to the local context and constraints.

Quality of designs should be carefully monitored to ensure adequacy with current and future effluent flows, as well as compatibility with site characteristics/constraints. Designs should cater for system flexibility, adaptability and sustainability. Quality of construction should also be closely monitored to ensure quality of materials and workmanship and the minimization of I&I. Designs as well as the selection of equipment and materials should ensure durability, constructability and the minimization of corrosion and risk of theft.

Pump stations should be located at appropriate sites with the required buffer distances to existing buildings to avoid nuisances and complaints. They should be designed to avoid excessive retention times and include H₂S mitigation equipment. As far as possible, the sewerage system should be designed to avoid long rising mains which inevitably lead to H₂S formation, HSE hazards and corrosion.

The feasibility of condominium sewerage systems versus traditional sewerage systems should also be systematically explored as condominium sewers allow significant cost

⁴¹ Martinique, Guadeloupe, St Lucia and Dominica

reductions (especially CAPEX) when compared to that of traditional sewer systems.

Stakeholder consultation and management including effective communication strategies are key to stakeholder buy in and acceptance of new sewerage systems, especially for pumpstations and WWTPs.

These cost reductions of condominium sewers stem from:

1. Design based on the attainment of minimum shear stress factor (τ_{min}) = 1 Pa instead of minimum velocity 0.6 m/s;
2. Simplified designs (smaller diameters, lower slopes, reduced depths);
3. In block and in road sewers as opposed to in road sewers only for traditional sewers.

Condominium sewer systems can also entail the construction of interceptor tanks (usually septic tanks in the Caribbean context) which retain sludge/solids before discharge of the supernatant to a solid free sewer. This allows designing sewers with even lower slopes (essential in the presence of a high water table or rocky subsoil).

Despite its obvious advantages, the downsides of condominium sewerage are:

1. Reduced accessibility for O&M (in the event of in block sewers);
2. The necessity of customer sensitization & education and regular emptying of interceptor tanks (in the event of interceptor tanks and solid free sewers);

3. The necessity of enhanced network policing and the persistence of a faecal sludge value chain (in the event of interceptor tanks and solid free sewers).

Wastewater Treatment Plants

New WWTPs should be designed and constructed following best international practices and include at a minimum secondary treatment. As previously mentioned, tertiary treatment and wastewater reuse should be considered in the event that reuse is economically feasible in the vicinity of the WWTP and after adoption of the appropriate regulations (to standardize designs, processes and avoid HSE hazards).

Whenever land availability is not an issue, WWTPs based on the lagoon concept should be considered as these systems require minimal O&M and are resilient to excess loading and natural hazards. If properly designed, constructed and managed, they can also contribute to the restoration of biodiversity.

As previously mentioned, constructed wetlands (require much smaller footprint than lagoon systems) should be considered in Eastern Caribbean countries with high declivity to improve WWTP reliability and sustainability and avoid long rising mains and H₂S formation. These systems are currently being considered/implemented in Martinique, Guadeloupe, St Lucia and Dominica and should be replicated in other Eastern Caribbean islands, whenever deemed feasible.

As mentioned in the previous section, stakeholder consultation and management including effective communication strategies are key to stakeholder buy in and acceptance of new WWTPs.

Improve Household Sanitation

In the Eastern Caribbean countries, household sanitation is usually executed by either private developers or landowners, the public utility being responsible for the approval of designs and final inspection of works.

Utilities should officially adopt enhanced household sanitation systems based on the septic tank + filter concept. The systematic installation of filters at the outlet of septic

tanks should indeed be considered to improve treatment and mitigate against the contamination of the surface aquifers.

Trials in several Eastern Caribbean countries have shown that filters with coconut chip media are particularly cost-effective as the surface/void ratio of this media is high and hydraulic loading (300 mm/day) is more than 3 times that of a sand filter (50mm to 100mm/day).

Expand Wastewater Reuse

Wastewater reuse is insufficiently developed in the countries of the Eastern Caribbean though some countries (e.g. Barbados) are considering wastewater reuse projects.

Various forms of tertiary treatment and disinfection are usually necessary prerequisites for the wastewater reuse for:

1. Aquifer recharge;
2. Municipal use (e.g. flushing, watering);
3. Irrigation (in agriculture);
4. Industrial use (e.g. cooling, washing).

Reuse of treated effluents from public WWTPs should be subject to stringent quality regulations and controls to avoid HSE hazards. Wastewater reuse is mainstreamed in several Middle Eastern countries (e.g. Jordan and Israel) and their regulations could be reviewed and adapted to the Eastern Caribbean context.

There is also scope to expand wastewater reuse from private WWTP facilities such as those installed at hotels or large commercial & industrial sites. There are regional examples of successful and cost-effective wastewater reuse from private WWTPs which can inform future programmes.

Among the key factors determining the cost effectiveness of wastewater reuse are:

1. The marginal costs associated with mobilizing/ abstracting additional water resources (which are increasing as accessible freshwater resources are gradually being exhausted and are being negatively impacted by climate change/variability);
2. The reuse of treated effluents in the vicinity of the WWTP to avoid the high CAPEX/OPEX associated with construction of separate water reuse networks and pump stations.

In the water scarce countries of the Eastern Caribbean, additional resources often equate desalination. In those instances, the costs (CAPEX, OPEX PDV) of wastewater reuse can thus be compared with that of desalination and that of water demand management. The latter however usually yields results over longer timeframes and has an element of uncertainty which might not be compatible with the pressing needs/demands to be satisfied (by reuse or desalination).

Wastewater reuse should however be balanced with the need to maintain baseline ecological flows in the surface water bodies, moreso in the countries with small catchments/landmass where discharges of treated wastewater from WWTPs account for a non-negligible % of dry weather baseline flows.

Improve Asset Management

Refer to Section 4.3.7 which also applies to the asset management of sewerage systems.

Preliminary Assessment of Investments Needs in Sanitation & Sewerage Improvement

The preliminary assessment of investment needs in sanitation & sewerage improvement is reported in the following table.

Note that investments were not computed for the following countries:

1. Anguilla, Antigua and Barbuda, BVI, Montserrat, St Kitts & Nevis as there was insufficient information available

to determine investment requirements with a sufficient degree of accuracy;

2. Martinique and Guadeloupe as agencies of the French State have already allocated significant investments (under the respective "Plan Eau DOM") for enhancing water resources management, water & sanitation services, flood and drought management and overall water security in these two French islands and their dependencies.

Table 4.3

Preliminary Assessment of Investment Needs in Sanitation & Sewerage Improvement in countries of the OECS & Barbados

Country	Pop.	% Urbanisation	Utility	Water Network Coverage %	Sewerage Network Coverage %	Sewerage Gap %	Sewerage & Sanitation Investments			
							Designation	Impacted population	Estimated Budget USD	Priority 1 to 5
Barbados	303,000	31%	BWA	100%	8%	23%	Pilot project constructed wetlands WWTP + network	5,000	\$7,500,000	2
							Rehabilitate existing sewerage networks	20,000	\$9,000,000	3
							Expand Sewerage Systems including on West Coast (Networks + WWTP)	50,000	\$65,000,000	5
							Pilot household sanitation project with coconut chip media filters	500	\$2,000,000	1
							Total Barbados		\$83,500,000	
Dominica	75,000	72%	DOWSACO	95%	20%	52%	Rehabilitate Baytown WWTP	15,000	\$5,000,000	1
							Rehabilitate existing sewerage networks	15,000	\$6,750,000	2
							Pilot project constructed wetlands WWTP + network	5,000	\$7,500,000	1
							Decentralized sewerage networks and WWTPs (constructed wetlands) in other remote towns	10,000	\$15,000,000	4
							Pilot household sanitation project with coconut chip media filters	500	\$2,000,000	1
							Total Dominica		\$36,250,000	
Grenada	114,000	37%	NAWASA	90% (est)	5%	32%	Construction of 2 x WWTPs (50,000 EH in total) at outlet of existing sewerage systems	50,000	\$17,500,000	1
							Lower Carbon Emissions (e.g. solar panels in sewerage Pump Stations)	50,000	\$1,500,000	3
							Expansion of the sewerage network in Grenville	3,000	\$6,000,000	2
							Decentralized sewerage networks and WWTPs (constructed wetlands) in remote towns	10,000	\$15,000,000	4
							Pilot household sanitation project with coconut chip media filters	500	\$2,000,000	1
							Total Grenada		\$42,000,000	
Guadeloupe	396,000	80%	EPCI	95%	44%	36%	Total Guadeloupe		\$0	

Continued on the next page →

Country	Pop.	% Urbanisation	Utility	Water Network Coverage %	Sewerage Network Coverage %	Sewerage Gap %	Sewerage & Sanitation Investments			
							Designation	Impacted population	Estimated Budget USD	Priority 1 to 5
Martinique	367,000	80%	EPCI	100%	42%	38%	Total Martinique		\$0	
Saint Lucia	168,000	19%	WASCO	100%	7%	12%	Construction of the Castries WWTP (10,000 EH)	10,000	\$3,500,000	2
							Rehabilitation of other 3 WWTPs (5,000 EH)	5,000	\$1,500,000	1
							Decentralized sewerage networks and WWTPs (constructed wetlands) in other remote towns	10,000	\$15,000,000	3
							Pilot household sanitation project with coconut chip media filters	500	\$2,000,000	1
							Total Saint Lucia		\$22,000,000	
Saint Vincent & the Grenadines	101,000	54%	CWSA	90%	4%	50%	Construction of the Kingstown WWTP (2,000 EH)	2,000	\$1,500,000	1
							Rehabilitate existing sewerage networks in Kingstown	1,500	\$1,000,000	2
							Decentralized sewerage networks and WWTPs (constructed wetlands) in other remote towns	10,000	\$15,000,000	3
							Pilot household sanitation project with coconut chip media filters	500	\$2,000,000	1
							Total St Vincent & the Grenadines		\$19,500,000	
GRAND TOTAL									\$203,250,000	

These proposals need to be validated, fine-tuned, and prioritized with the respective agencies & line ministries in the various countries.

CAF will then be able to identify/select projects which best align with their water security policies and objectives and initiate discussions with the relevant authorities to initiate preinvestment studies (whenever required) and develop investment programmes.

Drought management and flood control

Spatial Planning and National Physical Development Plans

The absence of modern spatial planning tools and updated physical development plans or the lack of enforcement of physical planning laws and regulations is a major hindrance for drought management and flood control in many countries of the Eastern Caribbean.

Indeed, hillside development policies and regulations, whenever they exist, are often ignored and construction in flood plains are a common sight. In some countries, hillsides are plagued with housing developments on slopes

> 1/4, slash and burn agriculture and quarries resulting in increased hillside erosion, river siltation increased peak river flows and flooding.

There is therefore need to strengthen national spatial planning legislation, regulations, institutions, tools and methods throughout the Eastern Caribbean region.

A few countries in the region stand out for improved spatial planning and natural hazard prevention plans such as:

1. The Dominican Republic for water catchment management including the protection of forested areas and hillsides;
2. Martinique for the development of natural hazard prevention plans.

In Martinique, the Natural Risk Prevention Plan (PPRN in French) is a document produced by the State that regulates the use of land at the municipal level, according to the risks to which it is subject. It makes it possible to consider natural risks in development, to control the urbanization of the territory by avoiding increasing the stakes in high-risk

areas and by reducing the vulnerability of the existing ones. These regulations range from a ban on building to the possibility of building under certain conditions.

The PPRN Martinique is available online⁴² and the web site includes useful interactive maps with colour coding of risks and land use regulations.

These positive examples should be replicated throughout the Eastern Caribbean region after review and adjustment to the specific local contexts and constraints.

Strategic Planning & Master Planning

Refer to Sections 4.3.1 and 4.4.1 which also apply to drought and flood control strategic and master planning.

Structural Measures

Structural measures are traditionally the cornerstone of flood management and drought control programmes and are often the most costly.

Usual structural measures (grey infrastructure) include:

1. River mouth maintenance (monitoring, desilting & dredging);
2. Desilting and dredging of water courses;
3. Sediment traps along river tributaries;
4. Construction or restoration of embankments;
5. Construction and rehabilitation of pump stations;
6. Channel and drain rehabilitation and widening;
7. Construction of new channels and drains;

8. Rehabilitation and construction of urban drainage systems;

9. Culvert rehabilitation and construction;

10. Mapping and asset management (flood control and drought management);

11. Etc.

The emphasis of structural measures should not only be on traditional (grey) infrastructure but also on nature based (green) infrastructure, the cost effectiveness, resilience and sustainability of the latter being often much higher than that of the former.

The concept of sponge cities⁴³ is an interesting and prime illustration of the benefits of combining grey and green flood management infrastructure in cities based on sustainable urban drainage and using the storage and infiltration capacities in the city.

⁴² <https://www.observatoire-eau-martinique.fr/politique-de-l-eau/plans-d-action/plan-de-prevention-des-risques-naturels>

⁴³ <https://www.adb.org/sites/default/files/publication/838386/adb-brief-222-sponge-cities-prc.pdf>

The restoration of freshwater systems (lakes, rivers, aquifers, swamps) should also be pursued under not only environmental funds but also infrastructure funds as they play an essential role in the protection against extreme weather events, including droughts and floods. Their importance has long been undervalued despite the huge benefits they procure (climate regulation, biodiversity and extreme event protection).

As previously mentioned in this report, over the past 5 decades, one third of wetlands have disappeared and freshwater species populations have plummeted by 83

percent on average⁴⁴ (high cost of cheap water – WWF – 2023). As a result, the UN's 2023 Water Conference, the first in half a century where the Freshwater Challenge was launched, with the aim of restoring 30 percent of degraded rivers and wetlands by 2030.

Pursuant to the above, the optimal combination of grey and green infrastructure, including the restoration freshwater systems, should be the cornerstone of structural programmes for flood management and drought control.

Non-Structural Measures

Non-structural measures should be implemented upstream or in conjunction with structural measures and are usually highly cost effective.

Examples of non-structural measures for drought management and flood control are:

1. Flood Proofing & Resilience Manual;
2. Flood Education & Awareness Programme;
3. Definition of Responsibilities and Coordination related to Flood Management;
4. Capacity Building in Agencies involved in Water Management;
5. Institutional Strengthening;
6. Upgrade of Hydrological Data Network;
7. Flood Early Warning System;
8. Storm Water Drainage Manual;
9. Preparation of Flood Risk Maps;
10. Flood Reporting System;
11. Etc.

Multipurpose Projects

Multipurpose projects (i.e. those fulfilling several functions such as for example water supply and flood control) should be systematically pursued and prioritized as they usually display high cost benefit ratios.

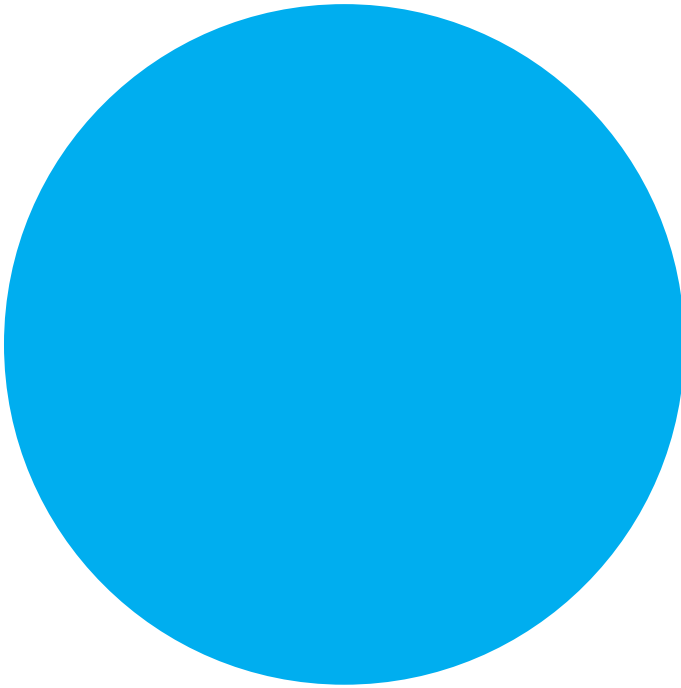
Necessary prerequisites for the success of these multipurpose projects are however effective institutional and governance arrangements (as multipurpose projects usually cut across the responsibilities of different agencies with varying interests) and meaningful stakeholder consultations (to foster buy in and support).

⁴⁴ High cost of cheap water – WWF – 2023



5

Water Security - Island Case Studies



Barbados

Legal, Institutional & Regulatory Landscape

In Barbados, the Ministry of Transport, Works and Water Resources is responsible for overseeing various aspects related to transportation, infrastructure, drainage and water resources.

The Barbados Water Authority (BWA), a body corporate, was established by the Barbados Water Authority Act, 1980 as the entity responsible for water supply and distribution, wastewater management, and related services, and operates under the purview of the Ministry of Transport, Works and Water Resources. BWA is also responsible for water resources management under the economic regulation of the Fair Trading Commission.

The proposal for a separate Water Resources Authority under the Ministry of Health and the Environment has for now been shelved.

The Drainage Division (under the Ministry of Transport, Works and Water Resources), is the entity responsible for implementing measures to prevent flooding, control water flow, and manage stormwater runoff and for managing and maintaining the island's drainage infrastructure.

The Barbados Meteorological Services (BMS) is the entity responsible for providing meteorological services in Barbados. It operates under the Ministry of Transport, Works, and Water Resources. The BMS is responsible for monitoring and forecasting weather conditions, issuing warnings and advisories, and providing other meteorological information to the public, government agencies, and various sectors that depend on accurate weather forecasts.

The Barbados Agricultural Development and Marketing Corporation (BADMC), an agency under the Ministry of Agriculture and Food Security, is involved in agricultural development activities, which includes initiatives related to irrigation and water management in agriculture.

Water Resources Management

The island of Barbados' freshwater systems consist of nineteen (19) groundwater units in the coral covered section of the island (84% of the island), three major springs and a large number of small springs and rainfed streams contained within the Scotland District on the east coast. The Scotland District has no coral cover and limited groundwater resources.

There are no perennial and large rivers on the island, but there are many deep and dry gullies, which cut into the coral rock and carry rainfall runoff to the sea during the rainy season. The biggest perennial surface water body is contained in the Graeme Hall Swamp, in the southern part of the island, which has been developed into a privately owned bird sanctuary.

The Barbados Water Authority (BWA) is responsible for the monitoring, assessment, control and protection of the island's water resources.

Given its extensive karst landscape:

1. Barbados has few above ground streams and rivers which contributes to a scarcity in its freshwater supply;
2. More than 80 per cent of the island's freshwater is sourced from underground aquifers.

These aquifers are under increased pressure and coastal aquifers are vulnerable to saltwater intrusion because of:

1. Increase in freshwater water demand due to socio economic development and warmer temperatures;
2. Reduced surface recharge of aquifers due to changing precipitation patterns, land development and urban spread;
3. Rising sea levels due to climate change.

The risk of saltwater intrusion is particularly high in aquifers along Barbados' west coast due to the low-lying topography of the area.

Aquifer recharge initiatives are reportedly underway on the West Coast (St James) under the "Roof to Reef" project⁴⁵. Six (6) retention dams have already been built along drainage channels to allow aquifer recharge.

Nationwide efforts are being taken to sensitise Barbadians about the importance of shifting from solely conserving water to storing it, which would be useful during periods of low rainfall.

45 Implemented by Prime Minister's Office under GCF funding.

Existing Infrastructure (water supply & sanitation)

Description

Water Supply

For its raw water supply, BWA relies on groundwater (77%) and on desalination (23%). Daily water production is on average 100,000 m³/day.

The percentage of desalination is due to increase in the coming years due to the gradual increase in salinity of BWA's coastal aquifers, especially in the North. In April 2023, the GoB announced that an additional temporary (containerised) desalination plant was to come online over the coming months to augment the nation's water reserves.

BWA operates 2 Water Treatment Plants (WTPs) in the St Lucie Parish. The 30,000 m³/day capacity BWRO desalination plant in St Michael began operating in 2000 under a BOOT type agreement between BWA and General Electric/William's Industries.

BWA operates 2,500 km of water supply network, the majority of which are aged and in need of replacement. Current investments in water network replacement are reportedly below 1.5% per year which is largely insufficient. As a result, leakage prevalence is reportedly high.

Rainwater harvesting (as well as wastewater reuse) is gradually being introduced under the GCF funded "Roof to Reef" project.

Sanitation

According to 2017 figures⁴⁶, access to improved sanitation in Barbados is 97%.

Barbados capital Bridgetown and the South Coast are sewered (represents 8% of the population). The average age of Bridgetown's sewer system is 40 years and that of the South Coast 20 years.

Currently, the only WWTP that treats water to a secondary level (contact stabilization) is that in Bridgetown which serves just over a thousand Bajans

(12% of the Bridgetown area) and has a capacity of approximately 9,000 cubic meters/day.

*BWA's WWTP on the South Coast was built under IDB financing in the early 2000s with a nominal capacity of 18,000 m³/day. The process consists of preliminary, primary treatment and a sea outfall and the WWTP is in dire need of upgrade.

Non sewered areas rely on household sanitation systems, usually septic tanks + soakaways (or more rarely filters to mitigate aquifer contamination). Most non sewered hotels are equipped with package WWTPs. A number of hotels practise reuse of treated wastewater for non-potable uses (for example irrigation of garden plants and lawn grass or irrigation of golf course).

BWA is currently looking at expanding decentralized WWTPs in the vicinity of its main well fields to mitigate the risk of aquifer contamination. Four areas have been identified:

1. Two (2) in Bridgetown;
2. Two (2) in Bell Point;
3. One (1) in St. George.

GoB funding for the above decentralized WWTPs is reportedly in the vicinity of 20 MUSD.

Coverage & Quality of Service

Water Supply

Piped borne water supply coverage is close to 100%. In 2014, 94% of BWA water quality samples were within the WHO standards⁴⁷.

Due to the advanced age of large sections of the water supply network, leakage prevalence is high (3 to 4 daily bursts reported on mains with DN > 100mm). This negatively impacts continuity of service and customer satisfaction.

⁴⁶ Governance Position Paper Caribbean Water Sector – IDB – Dec 2019

⁴⁷ Governance Position Paper Caribbean Water Sector – IDB – Dec 2019

As previously mentioned, there is need to significantly increase investments in water system renewal and upgrades. A proposal is reportedly being prepared by BWA and its line Ministry for pipeline replacement with a total funding of 950 MUSD.

There is also need to increase storage volumes and rehabilitate WTPs. Under CAF and EIB financing, a 12 MUSD project to rehabilitate several water systems (BWIRP) is underway and should be completed in 2025.

Sanitation

If improved sanitation coverage is 97%, sewerage coverage is only 8%, slightly less than the regional average of 11%⁴⁸ but much lower than Trinidad and Tobago's sewerage coverage (35%). Barbados capital (Bridgetown) and the South Coast are seweraged but not the West Coast, an important tourism hub.

The percentage of urban population in Barbados is 31%⁴⁹ so there is need to increase sewerage coverage as centralized sewer systems are generally cost effective in urban environments.

The difficulties of expanding sewerage coverage in Barbados can be attributed to a number of factors:

1. Funding and implementation bottlenecks;
2. Subsurface coral soils in a number of areas (not conducive to gravity sewerage);
3. Negative economic impact (especially on tourism) of traffic disruptions along main roads during construction of sewerage networks.

As previously mentioned, Barbados' South Coast WWTP treats effluents up to primary level only and is in dire need of upgrade to allow further treatment and water reuse.

Operational and Financial Performance

Operational Performance (Water Supply & Sanitation)

According to BWA 2018/2019 figures⁵⁰:

1. NRW = 45 % which is considered "basic" and slightly below the regional average of 45%⁵¹;
2. Staff productivity = 6.7 staff per 1,000 connections, which is considered "good" and slightly lower than the regional average of 6.8 staff per 1,000⁵²;
3. Electricity cost = 13% of OPEX which is below the regional average of 22%⁵³;
4. Gross accounts receivable days (indicators of a utility's ability to collect from its customers) = 208 days, which is slightly higher than the regional average of 201 days;
5. Residential Monthly Water Bill in 2019 (for 15 M3) = 20.77 USD which is slightly lower than the regional average of 23.87 USD (for 15 m³).

BWA's sewerage system reportedly experiences several operational issues such as:

1. Grease plugs in the sewerage networks (an indication of absence and/or non-functioning grease traps at customer premises, especially commercial properties);
2. High levels of clear water infiltration (Infiltration & Inflow⁵⁴) in the sewerage networks which result in hydraulic overloading of the system and flushing effects in the WWTPs;
3. Long rising mains which lead to H₂S emissions, an HSE hazard which is also detrimental to operations and longevity of sewerage assets (pump stations, networks, WWTPs);

48 The Caribbean Water Study - IDB - Oct 2021.

49 Refer to Section 4 of this Report.

50 The Caribbean Water Study - IDB - Oct 2021

51 Governance Position Paper Caribbean Water Sector - IDB - Dec 2019

52 Governance Position Paper Caribbean Water Sector - IDB - Dec 2019

53 Governance Position Paper Caribbean Water Sector - IDB - Dec 2019

54 Infiltration & Inflow is commonly referred to as I&I

4. Insufficient treatment levels and efficiency at the main South Coast WWTP (primary treatment only + outfall). The plant has reportedly been malfunctioning since 2016⁵⁵.

Also:

1. The operational status of package plants (hotels, etc.) is reportedly not always optimal and there is scope for improvement and possibility of tertiary treatment for effluent reuse;
2. A number of surface aquifers are susceptible to contamination from household sanitation systems that are not equipped with filters (with sand or other suitable filtration media) after the septic tank.
 - a. As previously mentioned, the above has prompted BWA to consider expanding decentralised sewerage systems + WWTPs in the vicinity of its main well fields;
 - b. The systematic installation of filters at the outlet of septic tanks could also be considered to improve treatment and mitigate against the contamination of the surface aquifers. Trials in the Caribbean have shown that filters with coconut chip media are particularly cost-effective as the surface/void ratio

of this media is high and hydraulic loading (300 mm/day) is more than 3 times that of a sand filter (50mm to 100mm/day).

Financial Performance (Water Supply & Sanitation)

According to BWA 2018 figures^{56 57}:

1. BWA's EBITDA margin = 7% and operating cost coverage = 1.08;
2. BWA's profitability (after interest, taxes, depreciation/amortization) = -2%;
3. BWA's return on assets = -0.4% (the calculated regional average = 2%);
4. BWA's current ratio (measure of liquidity = current assets/current liabilities) = 1.4 (the calculated regional average = 1.3);
5. BWA's debt service coverage ratio (measure of solvency = EBITDA/reimbursement principal + interests) = 1.2 (the calculated regional average = 0.9);
6. BWA's debt to equity ratio (measure of financial leverage) = 0.7.

Vulnerability to Extreme Weather Events - Adaptation & Mitigation

Like many other island nations in the Caribbean, Barbados is highly susceptible to the impacts of extreme weather events. Its geographical location in the hurricane-prone Atlantic Basin, coupled with factors such as topography, population density, and socio-economic conditions, make it particularly vulnerable to hurricanes, tropical storms, and other climate-related disasters.

In recent decades, climate change has led to Barbados facing rising sea levels, extreme weather events, coastal erosion, warmer temperatures, and changing precipitation patterns.

The last major natural disaster in Barbados was Hurricane Elsa, which affected the island in early July 2021. Elsa was the first hurricane of the 2021 Atlantic hurricane season and caused impacts across the Caribbean, including Barbados.

Hurricane Elsa passed over Barbados as a Category 1 hurricane, bringing heavy rainfall, strong winds, and storm surges. The storm resulted in localized flooding, power outages, and some damage to infrastructure. The Barbados Meteorological Services and the Department of Emergency Management (DEM) provided timely warnings and updates to the public to ensure preparedness and safety measures were in place.

⁵⁵ Governance Position Paper Caribbean Water Sector – IDB – Dec 2019

⁵⁶ Governance Position Paper Caribbean Water Sector – IDB – Dec 2019

⁵⁷ The Caribbean Water Study - IDB - Oct 2021

The government activated emergency response mechanisms, and various agencies, including the Barbados Defence Force, the Royal Barbados Police Force, and the Barbados Fire Service, were involved in response and recovery efforts. The National Disaster Emergency Response Team (NDERT) was mobilized to coordinate the overall response to the hurricane.

While Barbados experienced significant impacts from Elsa, the country's emergency management and preparedness measures helped minimize the extent of damage and facilitate a swift response to the aftermath.

Status of Hydrometeorological and Climate Monitoring Systems

The Barbados Meteorological Services (BMS) is sited at the Grantley Adams International Airport (GAIA) in the south of the island in the parish of Christ Church from where the service performs its daily functions, including data collection, conducting hourly weather observations and making public weather forecasts.

The BMS, operates a synoptic weather station and an automatic weather station at the GAIA, as well as rain gauges across the island. The Caribbean Institute for Meteorology and Hydrology (CIMH) which is head quartered in Husbands, St. James, Barbados, also owns and operates an automatic weather station as well as a fully equipped manual climatological station.

As of August 2015, the Barbados Meteorological Service (BMS) classified itself as a Category 2 climate services provider offering a basic range of climate services and products, as well as climate predictions.

The BMS has been delivering climate information for more than 10 years. Currently, the BMS downscales messages from all 7 of the regionally produced climate products¹ to produce monthly summaries and issue three-month precipitation and temperature forecasts at the national level.

The socio-economic sectors that the BMS interacts with and therefore currently benefit from climate services are the agriculture, water, disaster risk management, health and tourism sectors. Specific organisations with which the BMS interacts are:

1. The Ministry of Agriculture;
2. The Barbados Water Authority;
3. The Department of Emergency Management;
4. The Ministry of International Transport;
5. The Ministry of Environment and Drainage;
6. The Division of Energy;
7. The Barbados Agricultural Development and Marketing Corporation;
8. The Ministry of Health; and
9. The Coastal Zone Management Unit.

BMS recommendations to improve its climate services capability include:

1. The procurement of state-of-the-art equipment especially geared for GIS and other graphical outputs; and
2. The uploading of the national climate forecast and summaries on the Met Service website.

Emergency Response Plans and Disaster Preparedness

The National Emergency Management System is the overarching mechanism which facilitates emergency management in Barbados. It not only consists of the Department of Emergency Management (DEM) which is responsible for the coordination of stakeholders and activities but also the following groupings:

1. National Emergency Management Advisory Council;
2. National Emergency Operations Centre /Emergency Management Teams;
3. Fifteen (15) Emergency Management Standing Committees;
4. Thirty (30) District Emergency Organisations (DEOs).

The National Emergency Management System is comprised of representatives of the National Disaster Committee which is called the Emergency Management Advisory Council (EMAC) whose membership comprises of representatives of the Emergency Services, key government ministries and departments, the Private Sector, Non Governmental Organisations NGOs, Community Based Organisations CBOs and international and regional emergency management organizations.

Under the EMAC there are fifteen (15) sub committees called standing committees which are organised

along Emergency Response Functions such as Shelter, Evacuation, Mass Feeding, Emergency Telecommunications, and Public Utilities amongst others.

The National Emergency Operations Centre is the centralised location from which the mobilisation and coordination of responses and resources is carried out in the event of a major incident, emergency or disaster. The NEOC is staffed by the EOC Management Teams: The Emergency Management Teams are structured to provide a twenty-four hour round the clock operation in the event of any major disaster. The Teams are made up of the Technical Heads/representatives of the agencies which are members of the National Disaster Committee.

The District Emergency Organisation operates as the volunteer arm of the Department of Emergency Management, the agency responsible for the National Emergency Management System. The role of the DEO's is to organize and coordinate the resources of the community to allow for an effective response in time of crisis. The DEO works with the community to develop and operationalise disaster prevention and disaster preparedness programmes to lessen the impact of identified hazards such as hurricane, flood and earthquake, fire, aircraft and vehicular accidents and is also becoming more and more involved in the fight against environmental hazards such as love vine and the Giant African Snail

Asset Planning & Development

BWA, under supervision of its line Ministry, is responsible for asset planning and renewal in the water supply and sanitation sub-sector.

If water supply coverage is close to 100%, the network is old and there is insufficient renewal of ageing water supply assets (less than 1.5% yearly), the required minimum percentage is 2% for assets with a 50 year life cycle and higher percentages are required for assets with a lower life cycle.

The above is illustrated by the following figures.

1. According to available data⁵⁸, BWA CAPEX per connection fell from 276 USD/c in 2017 to 71 USD/c in 2018. This can be compared to the regional average of 184 USD/c calculated in a previous 2019 IDB Report⁵⁹;
2. According to the same IDB 2019 report, BWA's 2018 Gross Book Value (GBV⁶⁰) per customer = 3,890 USD/c (above the regional average of 3,138 USD/c) with an Accumulated Depreciation/GBV ratio⁶¹ = 30% (lower than the regional average of 43%). Note that this depreciation figure of 30% is surprisingly low considering the absence of renewal investments and calls into question the accuracy of the figures quoted in the report and/or depreciation calculations.

There is therefore need for significant investments in water supply system renewal/upgrades and BWA has estimated the required investments in network renewal only at 950 MUSD to which must be added investments in the upgrade/expansion of WTPs and storage tanks. If a number of projects are underway (e.g. BSNUP & BWIRP – refer to following section), there is need to accelerate efforts to achieve BWA's water security objectives.

There is a significant gap in sewerage coverage as 8% only of the population is sewerage (mainly Bridgetown and South Coast) whilst the urbanization ratio is 31%. Significant investments are thus required to close that gap and it is noteworthy mentioning that feasibility studies for the sewerage of the West Coast are reportedly being considered by BWA (including the use of trenchless technologies to minimize traffic disruptions and negative economic impacts).

Investments are also required to remedy/mitigate the current issues of the existing sewerage system (Bridgetown and South Coast). A 300 MUSD debt for climate swap initiative is reportedly underway, proceeds of which would be earmarked for the upgrade of the South Coast WWTP. As part of this upgrade, BWA is reportedly considering secondary and tertiary treatment of effluents (100 MUSD being considered for a RO plant for reuse including aquifer recharge).

As previously mentioned, BWA is currently looking at expanding decentralized WWTPs in the vicinity of its main well fields to mitigate the risk of aquifer contamination under an estimated budget of 20 MUSD.

Investments in household sanitation system upgrades (including for example systematic installation of coconut chip filters after the septic tank) are required to mitigate aquifer contamination in other areas.

Historical Investments by Subsector

The major ongoing investment initiatives in the water and sanitation sub-sector in Barbados are described below:

Barbados Water Supply Network Upgrade Project

Financing:

1. Caribbean Development Bank (CDB): 35 MUSD (soft loan)

2. Government of Barbados: 8.4 MUSD (Counterpart financing)

Duration: 2016 – 2020 (ongoing due to delays)

Status: Completed 46% (as of April 2023)

Scope/Objectives: As part of an initiative to achieve the goals of a twenty (20) year long term strategic plan for improved services to the Barbadian public, the Barbados Water Authority (BWA) has embarked on the Water Supply Upgrade Network Project (WatSNUP), funded by the

58 The Caribbean Water Study - IDB - Oct 2021

59 Governance Position Paper Caribbean Water Sector – IDB – Dec 2019

60 GBV per customer = indicator which provides a measure of the value of fixed assets relative to the number of customers

61 Accumulated Depreciation / GBV = indicator which provides a measure of the extent to which a water utility's fixed assets have deteriorated

Caribbean Development Bank. This project, designed to mitigate the challenges experienced by the BWA, will address issues pertaining to failing infrastructure, inefficiency in operations and frequency of water outages currently experienced throughout the island. In this regard, the overall goal of the project is to increase the level of efficiency of operations, through investments in areas that impact service, delivery and efficiency.

Barbados Water Infrastructure Rehabilitation Project (BWIRP)

Financing:

1. Development Bank for Latin America and the Caribbean (CAF) & European Investment Bank (EIB): 12 MUSD (soft loan);
2. Government of Barbados: 6.1 MUSD (Counterpart financing).

Duration: 2020 – 2025

Status: Completed 15% (as of November 2023)

Scope/Objectives: The Barbados Water Infrastructure Rehabilitation Project (BWIRP) is jointly funded by the Corporación Andina de Fomento (CAF), the European Investment Bank (EIB) and the Government of Barbados (GOB). Loan Contract No. 87645 was signed between the Government of Barbados and EIB on May 15, 2020. The Barbados Water Authority is the Executing Agency for the project.

This project is in alignment with the Barbados Water Authority Strategic Plan 2016 – 2021, strategic imperatives listed below:

1. Reduce non-revenue water.
2. Enhance and update operational infrastructure.
3. Implement water resource sustainability projects.

The objective of this program aims at improving the reliability and efficiency of the water supply distribution system as well as its resilience against climate change throughout the island.

Water Sector Resilience Nexus For Sustainability in Barbados

Financing:

1. Green Climate Fund (GCF): 27.6 MUSD (grant)
2. Government of Barbados: 17.6 MUSD (Counterpart financing)

Duration: 2019 – 2024

Status: Completed 60% (as of November 2023)

Scope/Objectives: The main objectives of the projects are to:

1. Build greater resilience to extreme storm events and drought conditions by utilizing cleaner energy sources, decentralising water storage, promote rainwater harvesting at the household and community level, and improve the efficiency with which rainwater runoff replenish aquifers in Barbados;
2. Further advance adaptation and mitigation initiatives in the water sector of Barbados by redirecting and mobilising local funds through a revolving adaptation fund;
3. Reduce the greenhouse gas emissions intensity of water provision by integrating renewable energy with back-up natural gas turbines and sustainable Water Loss Reduction (WLR) initiatives;
4. Contribute to capacity building via knowledge sharing and lessons learnt platforms within communities, educational organizations, private sector, civil society, BWA and the Government of Barbados to manage and monitor water resources;
5. Support the review and development of a legislative framework to supports climate smart development and water sector resilience;
6. Collate and disseminate lessons learnt for use in developing further adaptation and mitigation initiatives and raising public awareness about climate change, water conservation, recycle and reuse, the revolving adaptation fund, Green Climate Fund and in general this project.

Increasing Distributed Storage

In terms of increasing distributed storage volumes (to enhance water supply resilience):

1. The BWA launched its Personal Tank Programme (PTP) in 2017 which supplies 400-gallon tanks to help those who are unable to purchase their own water tanks and are living in areas affected by drought to have a method of water storage;

2. As part of the GCF's project, the BWA has been able to provide portable tanks to supply households, schools, and businesses and improve outdated infrastructure in order to build the island's resistance in the face of climate change.

Dominica

Legal, Institutional & Regulatory Landscape

The Water and Sewerage Act of 1991 governs water resources management and gives the Dominica Water and Sewerage Company (DOWASCO) the responsibility for supply and distribution of potable water, wastewater services and management of water resources. DOWASCO is a registered company wholly owned by the Government of Dominica and falls under the portfolio of the Ministry of Public Works and the Digital Economy.

DOWASCO is currently regulated by the Ministry of Health (water quality only) and there are plans afoot for the economic regulation of DOWASCO by the Independent Regulatory Commission (IRC) which currently regulates energy services in the country.

The Water Resources Policy 2011 which lays the principles of Integrated Water Resources Management (IWRM) was never formally adopted nor implemented and DOWASCO, the national water and wastewater utility, continues to regulate water resources with a focus on the watersheds where its water intakes are situated, and there are capacity limitations at DOWASCO to effectively manage the nation's water resources.

The responsibility for irrigation in Dominica falls under the Ministry of Agriculture and Fisheries. The ministry is generally responsible for agricultural policies, including irrigation practices, to support the development of the agricultural sector in the country.

The National Emergency Planning Organization (NEPO) is the umbrella organization comprising of all participants in national disaster management efforts. NEPO membership includes representatives from Government and Non-Government Organizations (NGO's) as well as Private Voluntary Organizations (PVO's) and individual volunteers. The NEPO Advisory Committee develops and recommends policies, plans and guidelines for prevention, mitigation, preparedness, response, and recovery measures for Dominica. The Advisory Committee reports directly to the NEPO Chairman (the Prime Minister) who is responsible for activating the National Plan if necessary.

The Office of Disaster Management (ODM) is the Secretariat of NEPO and is responsible for establishing and managing a National Emergency Operations Centre (NEOC). Under the guidance of the ODM, District Emergency Committees are responsible for establishing and managing District Emergency Operations Centres (DEOC's) and Community Emergency Committees, Community Emergency Operations Centres (CEOC's) as necessary.

Water Resources Management

In Dominica, there are about 365 rivers and streams emanating from 35 watershed areas into which the island is divided. The ten largest rivers are the Indian, Picard, Layou, Roseau, Blenheim, Hampstead, Clyde, Pagua, Castle Bruce and Rosalie rivers.

As previously mentioned, DOWASCO is responsible for managing the nation's water resources as the Water Resources Policy (2011), which called for a separate water resources regulator (following good international practice), was never formally adopted nor implemented.

DOWASCO has limited capacity to effectively execute its water resources management mandate and focuses on

catchments where water intakes are situated. DOWASCO has recently appointed a Water resources Officer and collaborates with other agencies such as Forestry Division.

DOWASCO has also recently upgraded several streamflow gauges under the recently completed Water Resources Disaster Vulnerability Remediation Project.

To summarize, water resources management in Dominica is deficient and does not follow IWRM good practices. There is need to operationalize the Water Resources Policy 2011 and beef up

Existing Infrastructure (water supply, sanitation, irrigation and drainage)

Description

Water Supply

DOWASCO has over 42 surface water production facilities located throughout Dominica with a total production capacity of 7 iMGD (31,800 m³/day). For the purpose of water supply, the island is divided into Zones (North, East, South and West) and most water supply systems are gravity fed with occasional pumping stations to feed high points in the network.

Raw water from mountain streams/sources usually undergoes simple disinfection using one of three types of chlorination methods. DOWASCO is gradually implementing filtration systems at its intakes upstream of the disinfection units to cater for increased raw water turbidity levels during storm/hurricane episodes.

Hurricanes Erica (2015) and Maria (2017) exposed the vulnerability of DOWASCO's water supply systems to natural hazards, especially in the mountainous areas. Many treatment facilities could not cope with the increased turbidity levels and shallow/surface networks were washed away by the raging torrents.

DOWASCO is therefore committed to boosting the resilience of its infrastructure by implementing adaptation projects such as:

1. Installing filtration systems at its surface water intakes;
2. Exploring tapping groundwater resources;
3. Increasing storage capacity within the water supply system;
4. Use of flexible pipes with welded or anchored joints in areas of high declivity to avoid disjuncting of pipes during natural hazards.

Reportedly, there are however financial bottlenecks due to the reluctance of the Government to take on additional debt for water infrastructure development/adaptation projects and the heavy reliance on grant funding.

Sanitation

Sewerage systems cover the capital city Roseau as well as Goodwill, Stockfarm, Bath Estate, Newtown, Canefield and Jimmit areas.

The WWTP is located in Baytown. This facility treats raw sewerage before extracting floatables and pumping the treated effluent out into the open sea via an outfall.

It is estimated that sewerage coverage is 20% of the population and that the remaining 80% rely on household sanitation systems, whether septic tanks & soakaways or pit latrines.

Reportedly, Dominica, like Saint Lucia, is participating in the CARIBSAN Project where nature based decentralized WWTPs such as constructed wetlands are being implemented on a pilot scale. The advantage of constructed wetlands lies in the low cost and low maintenance requirements of such systems thus allowing the implementation of sustainable decentralized sewerage systems (especially in areas of high declivity) instead of CAPEX intensive integrated sewerage systems. The latter systems usually call for sewerage pump stations and long pumping mains which increase OPEX requirements and the risk of H₂S emissions, an occupational and health hazard which also reduces the life cycle of impacted assets (networks and pump stations).

Irrigation

In Dominica, bananas are the major crop, exported mostly to the UK. Citrus crops (oranges, grapefruit and limes) are also important and coconut crop are consumed primarily for production of soap and cooking oil. Other agricultural products consist of coffee and cocoa crops, pilot aquaculture projects, and cultivation of ornamental flowers for export.

The productivity of farmlands in certain areas had been compromised by extended drought periods during the dry season from January to July. These drought periods have been exacerbated by climate change. A number of irrigation projects have thus been implemented to provide a consistent and reliable supply of water for the farmers so as to increase the productivity of the farms.

Coverage & Quality of Service

95% of the population has access to piped borne water supply and 20% to sewerage services (the remaining 80% relying on household sanitation systems)⁶².

DOWASCO's water quality standards are reportedly within the international standards as set by the World Health Organization (WHO) though DOWASCO's existing treatment systems (chlorination only) cannot cope with increased raw water turbidity levels occurring during tropical storms and hurricanes.

Also, there is minimal treatment occurring at the Baytown WWTP (pretreatment only) and raw sewage is pumped to the sea via an outfall. The efficiency of the WWTP/outfall has not been determined though increasing wastewater treatment levels at the WWTP should be considered, especially in a time of climate change/variability which also affects ocean levels and currents.

Operational and Financial Performance

Operational Performance (Water Supply & Sanitation)

According to DOWASCO 2018/2020 figures⁶³:

1. NRW = 53 % which is considered "high" and above the regional average of 45%⁶⁴;
2. Staff productivity = 6.7 staff per 1,000 connections, which is considered "good" and slightly lower than the regional average of 6.8 staff per 1,000⁶⁵;
3. Electricity cost = 12% of OPEX which is below the regional average of 22%⁶⁶;
4. Gross accounts receivable days (indicators of a utility's ability to collect from its customers) = 145 days, which is lower than the regional average of 201 days;
5. Residential Monthly Water Bill in 2019 (for 15 m³) = 19.11 USD which is lower than the regional average of 23.87 USD (for 15 m³).

62 The Caribbean Water Study - IDB - Oct 2021

63 The Caribbean Water Study - IDB - Oct 2021

64 Governance Position Paper Caribbean Water Sector – IDB – Dec 2019

65 Governance Position Paper Caribbean Water Sector – IDB – Dec 2019

66 Governance Position Paper Caribbean Water Sector – IDB – Dec 2019

Financial Performance (Water Supply & Sanitation)

According to DOWASCO 2020 figures^{67 68}:

1. EBITDA margin = 25% and operating cost coverage = 0.9;
2. Profitability (after interest, taxes, depreciation/amortization) = -11%;
3. Return on assets = -1% (the calculated regional average = 2%);
4. Current ratio (measure of liquidity = current assets/current liabilities) = 1.4 (the calculated regional average = 1.3);
5. Debt service coverage ratio (measure of solvency = EBITDA/reimbursement principal + interests) = -0.19 (the calculated regional average = 0.9);
6. Debt to equity ratio (measure of financial leverage) = 0.79.

Vulnerability to Extreme Weather Events - Adaptation & Mitigation

Like many other island nations in the Caribbean, Dominica is highly susceptible to the impacts of extreme weather events. Its geographical location in the hurricane-prone Atlantic Basin, coupled with factors such as topography, population density, and socio-economic conditions, make it particularly vulnerable to hurricanes, tropical storms, and other climate-related disasters.

For example, in 2017, the British Virgin Islands and Dominica were the most affected by Category 5 hurricanes Irma and Maria with losses estimated at 148% and 110% of GDP respectively. Overall losses to these systems throughout the Caribbean were substantial and estimated at more than US\$100 billion. Irma and Maria resulted in extensive disruption to emergency communications in the impacted

states, damage to airports, emergency shelters, roads and bridges, schools, hospitals, business facilities and the housing stock.

In Dominica, in the aftermath of hurricane Maria, damages to irrigation and inaccessible feeder roads significantly hindered the country's ability to begin regenerating its food production and related livelihoods. These damages have also created setbacks for reestablishing Dominica's food security, as well as providing farmers' access to their traditional export markets. The restoration of the agriculture sector was a priority for the Government of Dominica for national food security and to ensure that all farmers, especially those in remote areas, had access for their produce to get to the market.

Status of Hydrometeorological and Climate Monitoring Systems

The Dominica Meteorological Service (DMS), established in 1969, maintains two meteorological stations, one at the Canefield Airport and the other at the Douglas-Charles Airport. There are also approximately 9 non-airport automatic stations (eg. Ministry of Agriculture, Forestry Division, DOMEX gauges) that are not under the jurisdiction of the DMS but to which they have access.

As of August 2015, the Dominica Meteorological Service (DMS) reports that it is a Category 2 climate services provider offering a basic range of climate services and products, as well as climate predictions.

67 Governance Position Paper Caribbean Water Sector – IDB – Dec 2019

68 Governance Position Paper Caribbean Water Sector – IDB – Dec 2019

The DMS provides a seasonal outlook via its website, monthly weather summaries and addresses specialized requests for data. In addition, as of January 2016, sectors benefit from a new, generic meteorological bulletin called the Dominica Meteorological Bulletin. This monitoring and forecast product which has not been tailored to any specific sectoral context is produced on a quarterly basis. There are no institutionalised agreements for the co-production of specific climate services with sectors. However, in the past, the DMS has offered the agricultural sector a tailored product – a monthly Agro-Meteorological Bulletin – which has been produced since April 2012.

DMS recommendations to improve its climate services capability include:

1. Policy-maker buy-in;
2. Increased resources (human and otherwise);
3. Training and technical assistance for Met Service staff;
4. The establishment of relationships with research partners such as the Dominica State College;
5. An increase in hardware and software;
6. Have the various sectors indicate their needs and provide necessary thresholds, definitions and baseline information;
7. Provision of necessary equipment for sectors to access and analyse data;
8. Better collaboration including the free exchange of data between the Met Service and sectors; and
9. Capacity building of Met Service staff to interact with sectors.

Emergency Response Plans and Disaster Preparedness

The Office of Disaster Management (ODM) coordinates the implementation of Comprehensive Disaster Management (CDM) in the Commonwealth of Dominica through the National Emergency Planning Organization (NEPO), a governmental organization with responsibility for the planning and organization of counter-disaster measures at central level. This is done in collaboration with national, regional, and international stakeholders from the public sector, private sector, and civil based organizations.

The Comprehensive Disaster Management (CDM) activities of the ODM are implemented through the support of the District Disaster Management Committees Mechanism. There are seven (7) Disaster Districts and the Kalinago Territory comprising of numerous communities.

1. Portsmouth (Northern) District;
2. St. Joseph (Western) District;
3. Roseau (South Western) District;
4. Grandbay (Southern) District;
5. La Plaine (South Eastern) District;
6. Castle Bruce (Eastern) District;
7. Marigot (North Eastern) District;
8. Kalinago Territory.

DOWASCO is represented on a number of NEPO's subcommittees (Utility & Environment Protection) and must submit annually to the ODM updates on its state of disaster readiness & damage reports.

A 2018 UNISDR study⁶⁹ of the private sectors in Dominica and the British Virgin Islands found that even though most businesses had disaster continuity plans, hurricanes Maria and Irma revealed that they were unprepared for a level 5 hurricane. This study sought to review the efforts of the private sector in the British Virgin Islands and Dominica impacted by hurricanes Irma and Maria, in preparing for, responding to and recovering from these events.

⁶⁹ <https://www.undrr.org/publication/private-sector-study-preparedness-enhanced-resilience-after-hurricanes-irma-and-maria>

It is noteworthy mentioning the Climate Resilience Execution Agency for Dominica (CREAD) a statutory government agency established in 2018 under the Office of the Prime Minister in the aftermath of hurricane Maria. CREAD leads and coordinates strategic initiatives across sectors in Dominica with the ambitious goal of making the country the world's first climate resilient nation. As reported on its website⁷⁰, "CREAD acts to bolster the ability of the business community, public services, and social sector partners to build strong and resilient communities, develop adaptive infrastructure, accelerate economic growth, strengthen institutional systems, enhance Dominicans' capacity to respond to the local impacts of global climate change."

CREAD was set up with the assistance of UK funds as a temporary institute to mainstream adaptation in Dominica. CREAD sits on the Project Steering Committee (PSC) of a number of resilient related infrastructure projects including DOWASCO projects.

Reportedly, CREAD was also directly executing projects (20 flagship projects in 2022) under funding which expired in December 2023 and there is need to secure additional financing to allow CREAD to extend its mandate and actions.

Asset Planning & Development

DOWASCO, under supervision of its line Ministry, is responsible for asset planning and renewal in the water supply and sanitation sub-sector.

Though piped borne water supply coverage is high (95%), as previously mentioned, there is insufficient system resilience to natural hazards:

1. Surface water intakes are currently equipped with simple chlorination systems which cannot cope with sudden increases in raw water turbidity during storms and hurricanes;
2. Water pipes in mountainous areas are highly vulnerable to surface runoff and erosion as evidenced by the extensive damage to DOWASCO's networks during storms Erica and Maria;
3. DOWASCO has insufficient storage capacity which hinders its ability to maintain sufficient supply during pipe repairs and natural hazards.

There is therefore need for significant investments in water supply system resilience and system renewal/upgrade. If several projects are underway (funded by CDB), there is need to accelerate efforts to achieve DOWASCO's water security objectives.

There is also a significant gap in sewerage coverage as 20% only of the population is sewered (mainly Roseau and other urban centres) whilst the urbanization ratio is 72%. Significant investments are thus required to close that gap.

Investments are also required to increase the efficiency of existing sewerage systems including:

1. Reducing infiltration and inflow (I&I) in the sewerage networks which lead to hydraulic overloads, overflows and are detrimental to overall system operation;
2. Refurbish/expand existing WWTP in Baytown where sewage undergoes preliminary treatment only before discharge to the sea via an outfall.

As previously mentioned, DOWASCO will be implementing decentralized WWTPs (constructed wetlands) under the Regional CARIBSAN project. This nature based resilient & sustainable wastewater treatment technology has been successfully implemented in a number of Caribbean islands (Guadeloupe, Martinique and Saint Lucia).

Investments in household sanitation system upgrades (including for example systematic installation of coconut chip filters after the septic tank) are required to mitigate aquifer contamination in other areas.

⁷⁰ <https://www.creadominica.org/>

One important investment bottleneck seems to be the heavy reliance on grant funding for CAPEX projects as the government is reluctant to take on additional loans for capital projects. As a result, available funds for capital projects are not commensurate with the investment requirements in the water and sanitation subsectors.

This is understandable to some extent as the fiscal space of the government is limited given the devastating effects

of hurricanes Irma and Maria which wiped out respectively 148% and 110% of national GDP. There is reportedly a water tariff review underway and a new tariff regime could be adopted early 2024 which would provide DOWASCO and its line Ministry with additional revenues to meet operational costs (OPEX) and hopefully also implement a number of urgent CAPEX projects.

Historical Investments by Subsector

DOWASCO has implemented several projects over the last ten years with a view to increase the resilience of its water supply and sanitation systems and renew ageing assets.

The following are noteworthy mentioning:

Third Water Supply Project (Area 1 Water Network Upgrade)

This project, funded under a 11 MUSD CDB loan, covers Water Area 1 which includes the capital city Roseau and surroundings (approximately 40% of DOWASCO's customers).

The project includes:

1. Construction of a new WTP;
2. Renewal/replacement of ageing water network sections;
3. Water network extensions;
4. A Technical Assistance (TA) component including a tariff study and a water audit.

The project is reportedly in its final phase of completion though additional components are being considered, some with IDB co-financing (which would allow the participation of US suppliers and service providers).

Water Sector Strategic Development Plan

This project was initiated in the aftermath of hurricane Maria (2018) under a 9.26 MUSD loan from the UK government.

The objective of this holistic project was to execute urgent repairs to the impacted water supply and sanitation systems, reinstate service and increase system resilience.

It included CAPEX components (loan funding) and studies (grant funding).

The Water sector Strategic Plan was developed by Consultants Fichtner GMBH (Germany). To date, 17 project components have been completed and 2 are pending completion.

Grenada

Legal, Institutional & Regulatory Landscape

There is no sole legislation for Grenada's water sector, neither is there a sole entity providing oversight for it. Various departments and authorities address certain areas as summarized in the table below:

Table 5.1
Responsibility of Main Agencies in Grenada's Water Sector⁷¹

Agency	Responsibility	Legislation
National Water and Sewerage Authority (NAWASA)	Provision and maintenance of water and sewerage services. Management of Water Resources	National Water and Sewerage Authority Act, Cap. 208, as amended (2008)
Ministry of Agriculture	Protection of watersheds (including forests and protected areas)	Forest, Soil and Water Conservation Act, Cap. 116 Grand Etang Forest Reserve Act, Cap. 124 National Parks and Protected Areas Act, Cap. 206, as amended Pesticides Control Act, Cap. 238
Ministry of Health	Oversight & audit functions to ensure compliance with drinking water quality standards	Public Health Act, Cap. 263 (2012)
Physical Development Authority	Managing physical planning matters including requiring developers to carry out Environmental Impact Assessments & enforcement of the Building Code	Physical Planning and Development Control Act, 2016 (includ. S.R.O. 42)
Sanitary Authority	Operation of the Water Quality Act which governs matters related to the quality of water intended for human consumption	Water Quality Act, Cap. 334B (2005)

The following is also noteworthy mentioning:

The National Water and Sewerage Authority (NAWASA) is the primary agency responsible for water supply and wastewater services in Grenada. It plays a central role in providing safe and reliable water and sewerage services to the population and manages the country's water resources. NAWASA falls under the purview of the Ministry of Infrastructure Development, Public Utilities, Energy, Transport, and Implementation which is responsible for

policy development, oversight of public utilities and the broader infrastructure development. There is currently no independent regulation of NAWASA's tariffs and services though there are bills before parliament to establish the Public Utilities Regulator Commission (PURC – an economic regulator) and a separate Water Resources Management Unit (WRMU) under the PURC (see further below).

The Ministry of Climate Resilience, the Environment, Forestry, Fisheries, Disaster Management, and Information,

⁷¹ <https://climatefinance.gov.gd/water-governance/>

is responsible for establishing policy and overseeing the management of various water sector functions via its agencies such as:

1. The Environmental Division is involved in environmental protection and management, including initiatives related to ambient water quality and conservation;
2. National Disaster Management Agency (NaDMA) plays a crucial role in coordinating and implementing disaster preparedness, response, and recovery efforts in Grenada.

The Ministry of Agriculture, Lands, Forestry, Fisheries, and the Environment is responsible for overseeing various aspects related to agriculture, including irrigation practices and water resource management for agricultural purposes.

Grenada's revised and updated National Water Policy 2020⁷² is the overarching document that guides water sector management and development in a sustainable and equitable manner. It was formulated through a participatory process of focus groups and consultations involving a large number of persons from government ministries and agencies, as well as non-government stakeholders.

The Policy proposes four key areas that need to be addressed, namely the:

1. Management of the country's water resources;
2. Provision of water and wastewater services;
3. Water quality regulation as it relates to public and environmental health, and
4. Economic and service regulation.

Further institutions are necessary for the Policy's implementation. To separate water services provision from water resources management, a new entity was proposed to carry out the day-to-day management of Grenada's water resources in their entirety. It is also proposed that the Public Utilities Regulatory Commission (established by the Public Utilities Regulatory Commission Act, 2016) will provide policy-level and administrative oversight of the proposed Water Resources Management Unit (WRMU) as well as regulation (economic regulation) of the provision of water and wastewater services by NAWASA.

Water Resources Management

As previously mentioned, NAWASA is currently responsible for the management of water resources in Grenada with other government agencies involved in the spatial planning & protection of watersheds. Operationalization of the National Water Policy (2020) and the future establishment of the WRMU should streamline responsibilities and functions in the water resources sector and promote Integrated Water Resources Management (IWRM).

Dams in the mountain ranges of the northern region are the main source of water supply for the island of Grenada.

Groundwater contribution to domestic water supply is small, accounting for about 7% of total annual withdrawal of about 14.1 million m³. Groundwater is used mainly during the dry season, since surface water yields can then drop by 25 percent (UNDESA, 2012).

Desalination is currently utilized by two major private sector entities in Grenada, and to supplement the harvested rainwater domestic supply in Carriacou and Petite Martinique.

NAWASA has been collecting data on the nation's main water resources (used for water supply) over the last 20 years. The quality and completeness of this data is unknown.

Very little data are available on the quality of the water resources in Grenada.

⁷² <https://climatefinance.gov.gd/embedded-pdf/national-water-policy/>

Existing Infrastructure (water supply, sanitation & irrigation)

Description

Water Supply and Sanitation

Drinking water comes mainly from water harvested in dams in the mountain ranges of the northern region and is distributed to households through gravity systems.

NAWASA's current daily production capacity is between 7 iMGD and 8 iMGD (i.e. between 31,800 m³/day and 36,400 m³/day).

All public drinking water supplies are treated to meet WHO standards and there is a protocol for monitoring water quality by NAWASA and the Ministry of Health (UNDESA, 2012).

Regarding the NAWASA distribution network, the following is highlighted:

- The water network is gravity fed via ductile or cast iron, PVC, steel or galvanised steel pipes (GI). Due to the mountainous nature of the study area, the setting up of homogeneous distribution zones can be a difficult undertaking. Consequently, some distribution zones have inadequate boundaries, and this results in substantial pressure variations between high and low points. The excessive pressures experienced in low points (13 bars measured in some instances!) contribute significantly to a high rate of pipeline failures;
- NAWASA's current storage capacity is 5 iMG (i.e. 22,700 m³) equivalent to between 62% and 71% of daily water production. Projects are underway to double existing storage capacity. Also, NAWASA recommends a minimum of 3 days of household storage, the National Water Policy having set a target of 6 days of household storage;
- The average age of the network is a notable concern, with some pipes being 70 years old or more. Additionally, due to the ad hoc approach to past expansion efforts, the existing network is not fully documented, nor has it been optimized

- Tapping collars are generally installed on lateral (tertiary) galvanised steel pipes. Customer service pipes are also in galvanised steel and an aggressive metering campaign was launched in 1995. To date, close to 100% of NAWASA's customers⁷³ are metered, though the meter park is old (overwhelmingly mechanical meters) and NAWASA is considering the replacement of its old meter park with modern communicating smart meters (full bore flow);
- Non-Revenue Water (NRW) is also a major concern though the latest NAWASA estimates (2018/2019) provide a surprisingly low figure of 26%⁷⁴. The real NRW figure is probably higher and comprises both physical losses and commercial losses. If physical losses (leakage) are expected to be high due to both the network's advanced age and prevailing high pressures, commercial losses (meter under-registration and non-registered consumption) should not be underestimated because of the relative old age of some of the meters installed (mechanical second-hand meters installed in some instances), age being a significant contributing factor to meter under-registration.

There are two (2) operational sewerage systems in Grenada which service the urban catchments of St. George and Van Norman Dam (< 5% of the population). Both systems discharge partially treated effluents directly to the sea via outfalls.

The reuse of wastewater is not a widespread practice in Grenada, but it is receiving increasing attention as a response to periodic and longer-term water scarcity. The increasing attention being paid to this potential resource needs to be accompanied by building positive public perception through education, and appropriate levels of treatment that reflect the different categories and accompanying quality standards required for hygiene and to protect public health.

⁷³ Approximately 50,000 customers in 2023

⁷⁴ An NRW estimate comprised between 25% and 30% of production was mentioned during the interview on 28th Feb. 2024.

Rain Water Harvesting (RWH) has been used in the northern parts of the mainland, in remote communities where supply from NAWASA is not available, and in Carriacou and Petite Martinique where it is well developed as the main potable supply. RWH ponds have been used in livestock production and, in a few cases, for the provision of water for intensive vegetable production. It is now being promoted in 'climate smart agriculture' and for the augmentation of public water supply.

Irrigation

Grenada's agriculture is predominantly rain-fed (98% of arable land), however, estimates of the agricultural water demand were placed at 15% of the total demand. Water for agriculture is typically pumped from the downstream of rivers (about 92%) for larger operations, while for small backyard-type gardening, treated water from public mains is the main water source (about 6.5%). Water for livestock production comes from the public water supply, but there are little efforts to treat the generated wastewater before discharging into public waterways (Weaver, 1989).

Coverage & Quality of Service

About 98% of the population has access to improved water supply and most the island's domestic users are now metered.

Less than 5% of the population of Grenada has access to sewerage services (2 small sewer systems in areas of St. George and Van Norman Dam).

Operational and Financial Performance

Operational Performance (Water Supply & Sanitation)

According to NAWASA 2018/2019 figures^{75 76}:

1. NRW = 26 % which is considered "good" and below the regional average of 46%⁷⁷;
2. Staff productivity = 5.3 staff per 1,000 connections, which is considered "good" and lower than the regional average of 6.8 staff per 1,000⁷⁸;
3. Electricity cost = 3.9% of OPEX which is well below the regional average of 22%⁷⁹;
4. Gross accounts receivable days (indicators of a utility's ability to collect from its customers) = 46 days, which is lower than the regional average of 201 days;
5. Residential Monthly Water Bill in 2019 (for 15 m³) = 21.32 USD which is slightly lower than the regional average of 23.87 USD (for 15 m³).

Financial Performance (Water Supply & Sanitation)

According to NAWASA 2018 figures^{80 81}:

1. EBITDA margin = 19% and operating cost coverage = 1.4;
2. Profitability (after interest, taxes, depreciation/amortization) = 22%;
3. Return on assets = 7% (the calculated regional average = 2%);
4. Current ratio (measure of liquidity = current assets/current liabilities) = 2.1 (the calculated regional average = 1.3);
5. Debt to equity ratio (measure of financial leverage) = 0.03.

75 The Caribbean Water Study - IDB - Oct 2021

76 Governance Position Paper Caribbean Water Sector – IDB – Dec 2019

77 Governance Position Paper Caribbean Water Sector – IDB – Dec 2019

78 Governance Position Paper Caribbean Water Sector – IDB – Dec 2019

79 Governance Position Paper Caribbean Water Sector – IDB – Dec 2019

80 The Caribbean Water Study - IDB - Oct 2021

81 Governance Position Paper Caribbean Water Sector – IDB – Dec 2019

Vulnerability to Extreme Weather Events - Adaptation & Mitigation

Grenada is exposed to a number of hazards and has a historical experience of being impacted by cyclones, floods, landslides, rock falls, earthquakes and forest fires.

Grenada is highly vulnerable to the impacts of these hazards and has suffered significant losses from previous impacts over time.

Table 5.2
Priority Actions to Strengthen Grenada's Disaster Risk Management

DRR Priority Actions	Key Activities	Responsible Agencies
Development of a Regulatory Framework for DRM and for Environmental Management	• Develop legislation for DRM - Adopt the draft CDM Policy - Review CDEMA Model Legislation - NEAC/CDEMA • Revisit Environmental Laws - Consolidate and update - Enforcement with punitive measures • Formulate comprehensive Land Use Policy - Zoning for environmental hazards - Integrate CCA	NaDMA
Assignment of Budget for Preparedness and Emergency Response	• Advocate for an operational budget for NaDMA • Advocate for Line ministries to have a dedicated line item for Disaster Management in their budgets • Private sector organizations involved in high risk operations must have a dedicated budget for disaster response or be mandated by law to contribute to a fund for national disaster response.	NaDMA Secretariat at the meetings of the NEAC Permanent Secretaries Civil society
Development of Hazard Maps Based on Probabilistic Criterion	• Conduct Risk Assessment based on data from credible sources. • Develop and implement Zoning for different hazards - Hazard Specific - Land use • Identify and locate appropriately response units. • Clearly identify evacuation routes to be used during emergencies. • Clearly identify the location of the most vulnerable population and develop strategies to assist them in times of disasters.	NaDMA/Local community/Red Cross Physical Planning Department; Ministry of Communication and Works; Ministry of Health; Land Use Department NaDMA; Ministry of Works; National Security Services. National Security Services. Ministry of Social Development, Civil Society.
Enhancing the Capacity of Institutional Response Structures	• Development of clear protocols including MOU & SOPS • Simulation exercises. • Information sharing. • Coordination of institutions with similar services or capabilities. • Identifying key service providers. • Identify location for waste disposal or storage in the aftermath of a hazard impact	NaDMA; Red Cross; Tele- communication companies; Police Force, Meteorological services; Health services; Energy companies; Ministry of Works; and private companies. Grenada Solid Waste Management Authority.

There is a need to reduce Grenada's vulnerability to hazards and to strengthen its resilience. Priority actions that would set Grenada on such a path include:

1. Development of a Regulatory Framework for DRM and for Environmental Management;
2. Assignment of a Budget for Preparedness and Emergency Response;

3. Development of Hazard Maps Based on Probabilistic Criteria;

4. Enhancing the Capacity of Institutional Response Structures.

These High Priority Actions are further detailed in table 5.2⁸².

Status of Hydrometeorological and Climate Monitoring Systems

The Meteorological Services at Maurice Bishop International Airport (MBIA) was established on the 28th of October 1984. Forecasts began in 1987. The stations were established primarily to provide meteorological services for the islands aviation sector by meeting the International Civil Aviation Organisation (ICAO) standards and requirements for meteorological services to international aviation.

Currently, the Meteorological Department is directed by the Grenada Airports Authority (a statutory body) under the Ministry of Civil Aviation and Tourism. Its primary responsibility is to the aviation sector but it plays a vital role in public weather services as it relates to providing early

warnings on adverse weather conditions. Other sectors such as Agriculture, Construction, Marine and research also benefit from the use of current and statistical data

The Grenada Meteorological Service⁸³ is a member of the Caribbean Meteorological Organisation (CMO), and its associated entities.

NAWASA monitors several streamflow gauging stations along the country's rivers and has collected approximately 20 years of data. As previously mentioned, the operational status of this monitoring network and completeness & quality of the data collected is unknown

Emergency Response Plans and Disaster Preparedness

The National Disaster Management Agency (NaDMA) was established in 1985 and is responsible for coordinating all disaster management activities throughout Grenada, Carriacou & Petite Martinique.

The National Disaster Management Plan (revised in 2005) sets out the structure and operating procedures for addressing all aspects of Comprehensive Disaster Management in Grenada. The plan seeks to ensure that disaster management is executed in a coordinated and collaborative manner, ensuring that the protection of life and property is paramount.

The revised NDMP outlines the responsibilities and composition of the National Emergency Advisory Council (NEAC) and the National Disaster Management Committees. The functions and activities of governmental organisations, the private sector, NGOs and service clubs are also defined in the revised NDMP.

The coordination protocol for the declaration of National and Subnational disasters in Grenada is reported on the following table:

⁸² Country Document on Disaster Risk Reduction for Grenada, NaDMA (2014)

⁸³ <https://weather.gd/>

Table 5.3

Declaration of National Disasters in Grenada – Responsibility Allocation Schedule

Responsibility Allocation Schedule	
Individual/Agency	Responsibility
National Disaster Management Agency (NaDMA)	Lead responsibility for management of the prevention, preparation, response, mitigation and immediate recovery phases of disasters.
Damage and Needs Analysis Committee (DANA)	Local and/or Regional committees responsible for initial damage assessment and preparation of related technical reports.
National Emergency Advisory Council (NEAC)	Advisory body responsible for the compilation of regional reports and advising NaDMA
Ministry of National Security, Public Administration, Home Affairs, Information & Disaster Management	Line ministry responsible for disaster management
Prime Minister	Convener of Cabinet and signatory of disaster declarations
Cabinet	Policy making and approval for the designation of disaster zones

Asset Planning & Development

NAWASA, under supervision of its line Ministry, is responsible for asset planning and renewal in the water supply and sanitation sub-sector.

Reportedly, the latest sewerage master plan was developed in 1999 and is in need of update, though many of its findings and recommendations are still relevant.

Though piped borne water supply coverage is high (98%), there is insufficient system resilience to natural hazards:

1. Surface water intakes are vulnerable to sudden increases in raw water turbidity during storms and hurricanes;
2. NAWASA has insufficient storage capacity which hinders its ability to maintain sufficient supply during pipe repairs and natural hazards.

Also, given the advanced age of the network and the declivity (resulting in high network pressures), there is need for significant network replacement and network sectorization (establishment of DMAs). NAWASA currently invests approximately 6 MUSD/year in network renewal which, according to the Consultant's estimate, is below the required minimum yearly 2% asset value threshold.

As previously mentioned, NAWASA intends to replace its ageing park of mechanical water meters (approximately 50,000) with modern smart meters (full bore with communication capabilities). The estimated budget for such an undertaking is 20 MUSD.

There is therefore need for significant investments in water supply system resilience and system renewal/upgrade. Several important projects are underway (funded by GCF & UK), and additional funding is required to achieve the National Water Policy (2020) targets and NAWASA's water security objectives.

There is also a gap in sewerage coverage as 5% only of the population is seweraged (mainly St. George and Van Norman Dam areas) whilst the urbanization ratio is between 37% and 40%. Significant investments are thus required to close that gap.

To lower the high costs of centralized sewerage network establishment, NAWASA could usefully consider decentralized sewerage networks & WWTPs (constructed wetlands) This nature based resilient & sustainable wastewater treatment technology has been successfully implemented in a number of Caribbean islands such as Guadeloupe, Martinique and is being implemented on a

pilot scale in Dominica and Saint Lucia under the Regional CARIBSAN project.

Investments in household sanitation system upgrades (including for example systematic installation of coconut chip filters after the septic tank) are required to mitigate aquifer contamination in other areas.

During the interview on 28th Feb. 2024, NAWASA representatives listed the following priority investment areas:

1. Management and reduction of Non-Revenue Water (NRW) including the replacement of 50,000 ageing mechanical customer meters;
2. Water network sectorization and establishment of DMAs (allowing enhanced network management and pressure control);
3. Water network replacement (to replace ageing and leak prone sections of the network);
4. Construction of Waste-Water Treatment Plants (WWTPs) at the outlet of the existing sewerage systems (to achieve optimal pollution abatement and avoid the discharge of untreated sewage to the sea);
5. Watershed Management and reforestation: This would ideally require the prior establishment of the WRMU, coordination with other agencies and implementation of IWRM procedures & practices;
6. Automation of NAWASA's systems (including progressive implementation of SCADA systems);
7. Lower Carbon Emissions (e.g. solar panels in sewerage pumping stations);
8. Expansion of sewerage network (to close the current sewerage gap: 5% of the population is sewered versus an urbanization ratio comprised between 37% and 40%). The next major urban area to be sewered is Grenville.

Historical Investments by Subsector

The following major projects are currently being implemented by NAWASA:

Grenada Climate Resilience Water Sector Project (G-CREWS)⁸⁴

The Grenada Climate Resilient Water Sector (G-CREWS) project (42 M€ in total) is designed to increase climate change resilience in Grenada's water sector. The project aims to achieve this by addressing resilience at the level of water governance, households, businesses and the water supply system.

The project is jointly financed by the Green Climate Fund (GCF) and the German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) under its International Climate Initiative (IKI), and the Government of Grenada.

Over 6-year project (5 years have already elapsed), the Government of Grenada, the Grenada Development Bank and the National Water and Sewerage Authority (NAWASA) in partnership with the German Development Corporation (GIZ) will implement the project's five components which are as follows:

1. Climate-Resilient Water Governance;
2. Climate-Resilient Water Users;
3. Climate-Resilient Water Supply System;
4. Additional Contributions of the Water Sector to Grenada's NDC (financed by BMUB, Germany);
5. Regional learning and replication (financed by BMUB, Germany).

⁸⁴ <https://grenadadevelopmentbank.com/about-g-crews.html>

Some of the projects being undertaken under the G-CREWS project are listed below:

1. Construction of small raw water impoundments;
2. Rehabilitation of several Water treatment Plants (WTPs);
3. Expansion of communal water storage facilities by 5 iMG (i.e. 22,700 m³);
4. Network rehabilitation and expansion;
5. Bulk metering;
6. SCADA systems for critical WTPs and associated pump stations and networks.

Southern St. George Water Expansion Project

This 20 MUSD 2-year project is financed by UKCIF (United Kingdom Caribbean Infrastructure Partnership Fund) via the Caribbean Development Bank (CDB).

This project was launched in February 2024 and aims to:

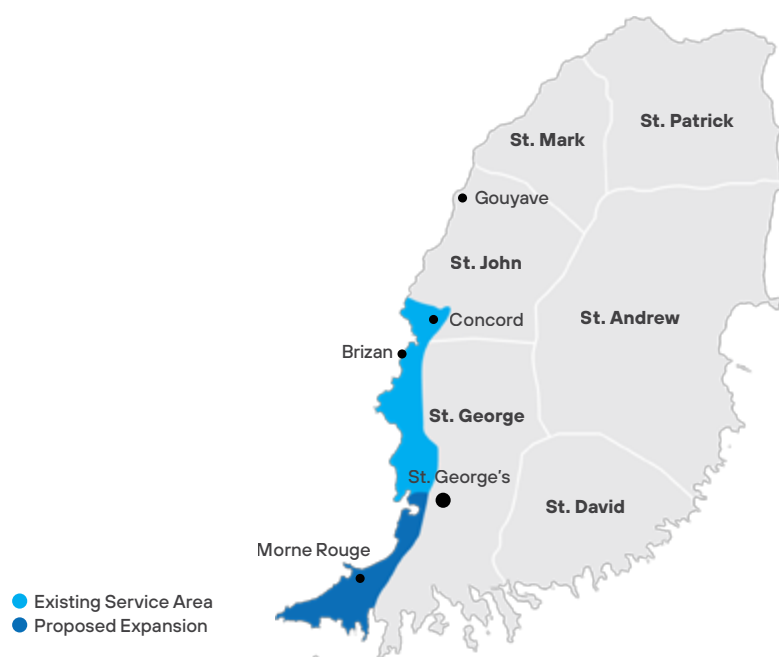
1. Improve water supply;
2. Increase access to safe drinking water;
3. Create a climate resilient water network;
4. Provide job opportunities;
5. Promote economic development.

This project will expand and upgrade Grenada's water distribution and wastewater networks while improving the sewerage infrastructure in the capital city, St. George's. It will enhance the quality and quantity of water resources available to residential and economic sectors. The project will increase the efficiency and climate resilience of the water sector in Grenada and improve the availability of potable water supplies for St. George's and tourism developments in the south of the island.

The existing and expanded NAWASA service areas in St. George are reported in the following figure.

Figure 5.1

Existing and Expanded NAWASA Service Area – Southern St. George Water Expansion Project



Guadeloupe

Legal, Institutional & Regulatory Landscape

Guadeloupe is a French overseas department (Département Outre Mer or DOM in French) and as such, the laws of the French Republic apply.

The water sector in Guadeloupe is governed by a combination of French national legislation and local regulations specific to the island. At the national level, the legal framework includes the 2006 Water Act (transposition into French law of the European Water Framework Directive 2000/60/CE), which establishes the principles of water resource management, including allocation, protection, and conservation. Additionally, the French Environmental Code outlines various aspects of environmental protection, which encompasses water resources.

On the local level, Guadeloupe has established specific institutions to oversee water management. The Directorate for the Environment, Planning, and Housing (DEAL) is responsible for implementing national environmental policies in Guadeloupe, including those related to water resources. The Water Resources Agency of Guadeloupe (Office de l'Eau de la Guadeloupe or ODE in French) is a key local institution charged with the management of water resources.

The regulatory landscape also includes specific measures for water quality monitoring, pollution control, and conservation efforts. This involves periodic assessments and inspections to ensure compliance with established standards and regulations. The DEAL is responsible for regulating applications for water abstraction (environmental impacts) and the ARS Guadeloupe (Regional Health Agency of Guadeloupe) is responsible for regulating water abstraction for potable water supply (social & health impacts).

As in Metropolitan France, the responsibility for water supply and sanitation historically lied with the municipalities, but since the promulgation of the NOTRe Law in 2015, those responsibilities have been redefined and shared with larger local government entities such as Intermunicipal Communities or Syndicates (Etablissement Public de Coopération Intercommunale or EPCI in French) to achieve economies of scale and greater efficiency. A new law is reportedly under preparation to share responsibilities for water supply and sanitation at even higher levels of local government such as the Departments and Regions. This upscaling is partly motivated by the effects of climate change on local water resources and the increased necessity for regional water transfers.

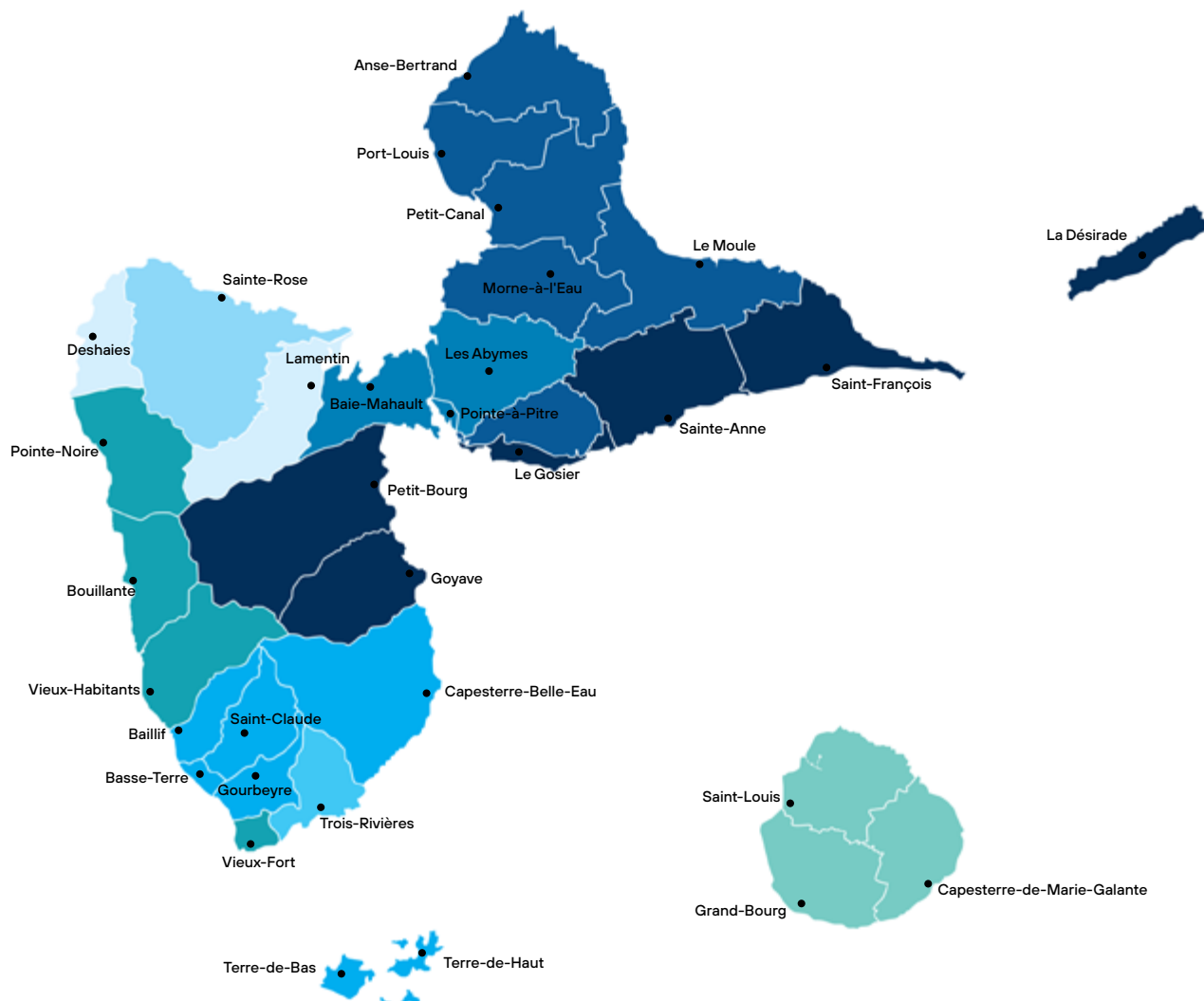
Since 2021, responsibility for water supply & sanitation in Guadeloupe is shared by two EPCI namely:

1. The SMGEAG (Guadeloupe Joint Water and Sanitation Management Syndicate) on Guadeloupe and the islands of les Saintes and la Désirade;
2. The CCMG (Intercommunal Community of Marie-Galante), on the island of Marie-Galante.

The above entities are the asset holding companies which delegate water and sanitation operations to a number of public and private entities as shown in the following figures:

Figure 5.2

Water Service Providers Guadeloupe (2020)

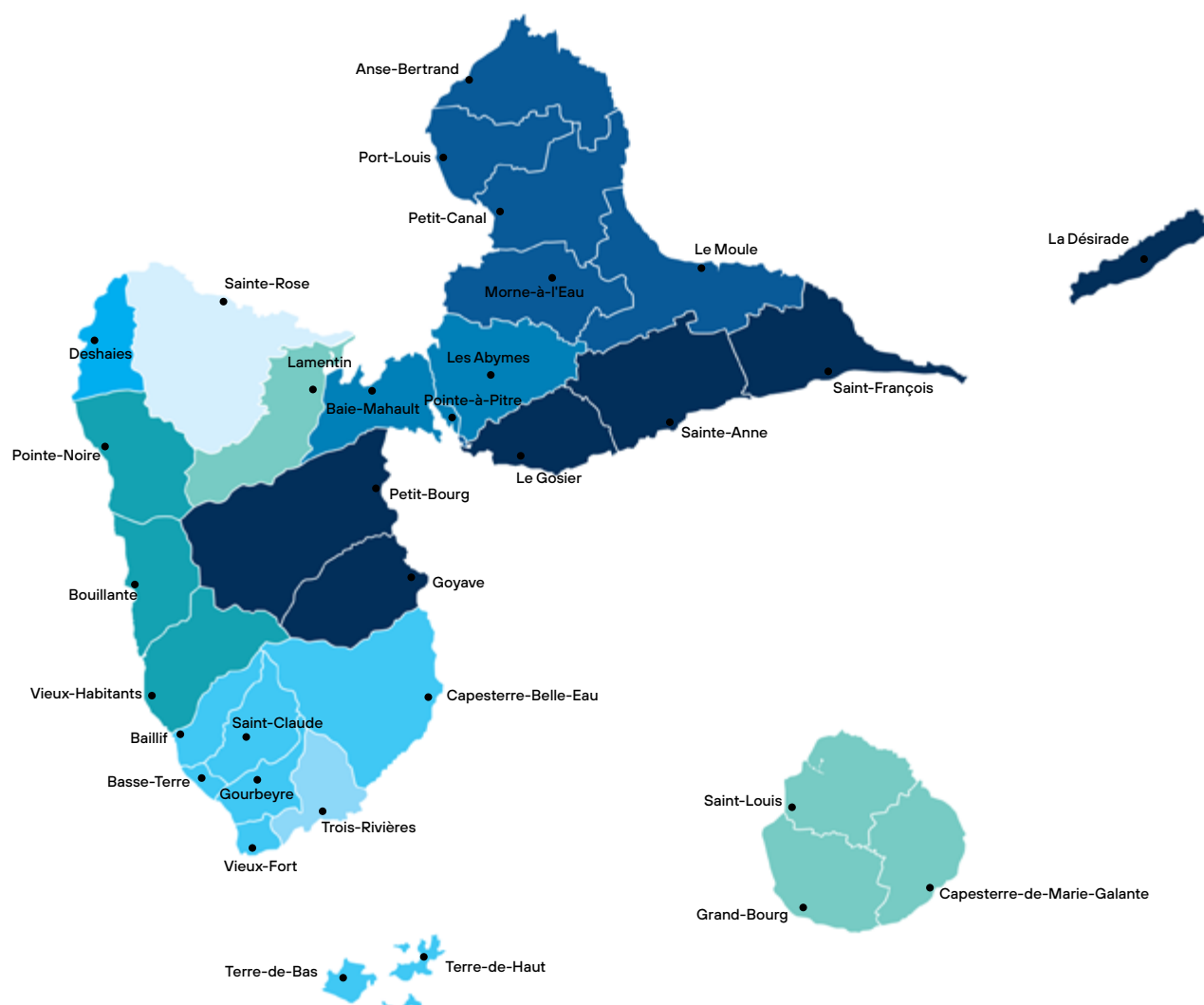


Exploitants en eau potable

- Régie du SIAEAG
- Régie Eau Nord Caraïbes (RENOC-Eau)
- Régie Eau d'Excellence (ODEX)
- Régie de la CAGSC
- Régie communale de Trois-Rivières
- Régie communale de Sainte-Rose
- Eaux'Nodis
- CGSP (dénommée Saur Guadeloupe depuis juillet 2020)
- Karuker'ô

Figure 5.3

Sewerage Service Providers Guadeloupe (2020)

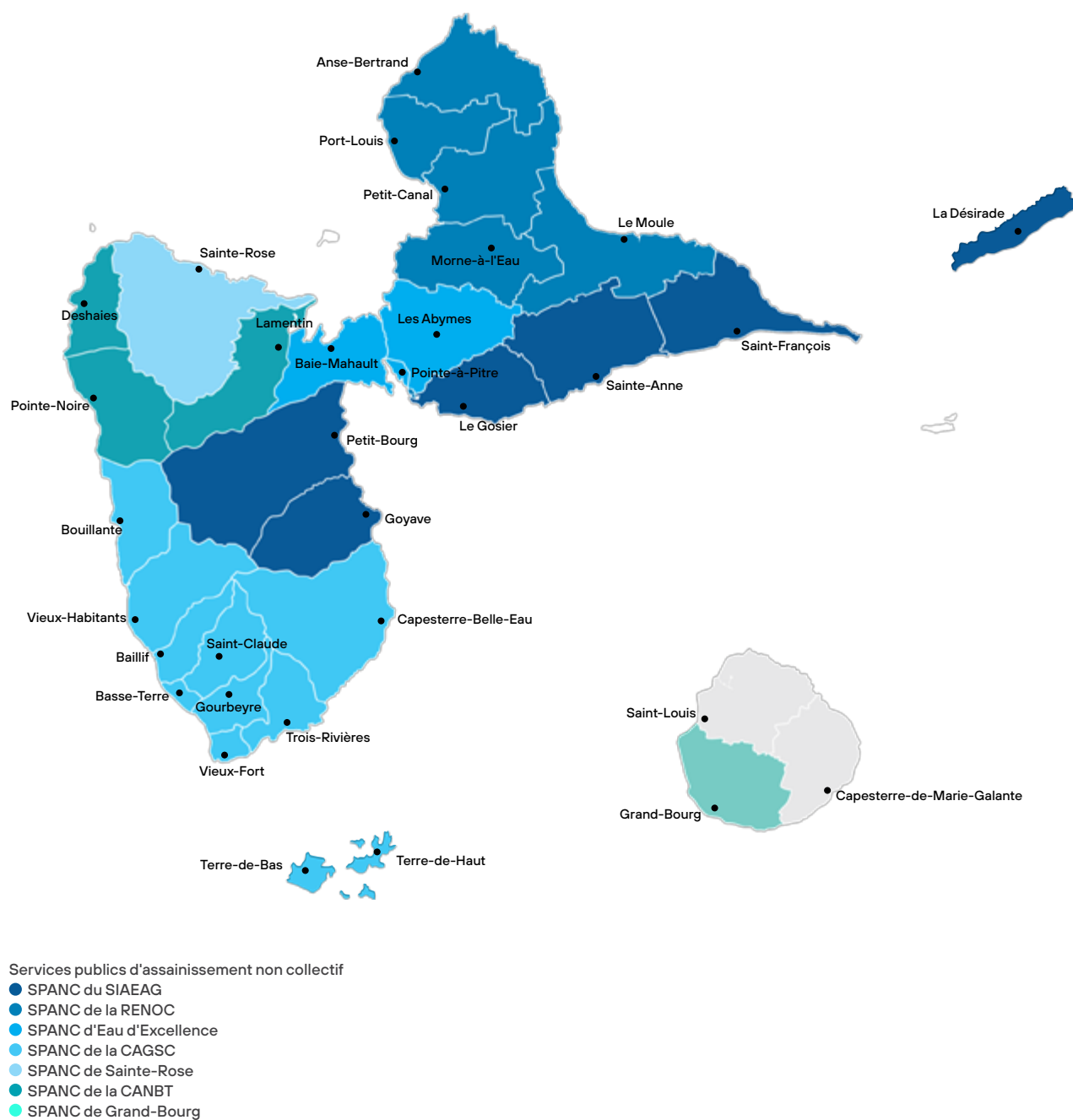


Exploitants en assainissement collectif

- Régie du SIAEAG
- Régie Assainissement Nord Caraïbes (RENOC-Assainissement)
- Régie Eau d'Excellence (ODEX)
- CANBT
- Régie de la CAGSC
- Régie communale de Trois-Rivières
- Régie communale de Sainte-Rose
- CGSP (dénommée Saur Guadeloupe depuis juillet 2020)
- Karuker'ô

Figure 5.4

Household Sanitation Service Providers Guadeloupe (2020)



The above reflects the general organisation of water supply and sanitation services in France where asset holding & development on the one hand and service provision on the other hand are undertaken by different entities. The asset owners usually directly regulate the service providers. Water and environmental police are undertaken by the DEAL, representing central government.

In Guadeloupe, the Department (Local Government) is responsible for regulating and managing irrigation projects. Since 2021, drainage as well as flood prevention/alleviation⁸⁵ are under the purview of the aforementioned Intermunicipal Communities (EPCI).

The responsibility for disaster preparedness and response lies with several agencies and organizations:

1. The Prefecture of Guadeloupe (Préfecture de la Guadeloupe) plays a significant role in coordinating and overseeing disaster management efforts on the island. This includes planning, coordination, and response activities in the event of natural disasters;
2. The Departmental Fire and Rescue Service (Service Départemental d'Incendie et de Secours or SDIS) also plays a crucial role in disaster response and often collaborates closely with the Prefecture;
3. Additionally, the Local Government entities (Department and Region Guadeloupe and Municipalities) have their own roles and responsibilities in disaster preparedness and response.

Water Resources Management

With 1,600 mm of annual rainfall and sufficient renewable water resources, Guadeloupe is neither a water scarce nor a water stressed island.

On Basse-Terre (which is mountainous), the presence of high rainfall coupled with a pronounced relief favours surface runoff. Aquifer characteristics are poorly defined, due to the recent and complex volcanic formations.

Conversely, on the other islands of Guadeloupe, surface runoff is less significant. Grande-Terre, Marie-Galante and La Désirade are constituted of ancient limestone formations, which are more conducive to aquifer recharge. Les Saintes is made up of volcanic formations and their groundwater resources are not well known.

In 2020, total water abstraction was 104.4 Mm³ and was distributed as follows:

1. 86.6. Mm³ for water supply (83%);
2. 14.9 Mm³ for irrigation (14%);
3. 2.9 Mm³ for other economic e.g. industrial (3%).

79% of water abstraction is from rivers, 13% from mountain sources and 8% from aquifers.

Basse Terre (with high declivity and rainfall) accounts for 82% of total water abstraction (surface water abstraction only) and Grande Terre (flatter with less rainfall) and the other smaller islands account for 18% of total water abstraction (aquifers only). There are important water transfers between Basse Terre and Grande Terre and the other islands. The Department of Guadeloupe (Local Authority) is the principal owner of raw water transfer systems (operated by a contracted service provider) which feed both irrigation networks (70% of irrigation volumes provided by DOG) and an increasing percentage of volumes for potable water supply.

Water abstraction has increased 2% annually up to 2018 and then between 4% and 6% annually between 2018 and 2020. This increase is mainly attributable to water supply requirements and more specifically to the Covid 19 pandemic (in 2020 only) and to higher system losses (leakage) as the island's population has been steadily decreasing over the same period. There has also been an increase in irrigation volumes over the period considered due to severe droughts.

⁸⁵ Flood prevention and alleviation is the responsibility of the GEMAPI (under the EPCI)

Water Resources Management is under the purview of the Office de l'Eau de la Guadeloupe (ODE Guadeloupe) which translates in English as the "Water Resources Agency of Guadeloupe". The ODEs were initially established in France (a separate ODE in each regional hydrological catchment) by the 1964 Water Act which was subsequently completed/amended by various pieces of legislation, the most important being the 1992 Water Act and the 2006 Water Act (transposition into French law of the European Water Framework Directive 2000/60/CE).

As in metropolitan France, the water resources management landscape in Guadeloupe via the ODE is well defined and organized around four main pillars:

1. The establishment of a consultative & deliberative body on water resources and biodiversity, the Comité de l'Eau et de la Biodiversité (CEB) de la Guadeloupe which translates in English as "Water and Biodiversity Committee of Guadeloupe", sort of water & biodiversity parliament where the main water and biodiversity stakeholders are represented;
2. Establishment of a data repository on water and biodiversity in Guadeloupe (Observatoire de l'Eau de la Guadeloupe) where relevant and historical data is freely accessible online (on topics in relation with water supply & sanitation, surface and ground water resources, wetlands, coastal and near shore waters, etc.);
3. Constitution of a water and biodiversity fund managed by the ODE, via a deduction on the water and sanitation bill of consumers. This fund serves to finance partially or entirely projects geared towards water resources and biodiversity management, protection & restoration in Guadeloupe;
4. Development of a Master Plan for Water Development and Management for Guadeloupe (Schéma Directeur d'Aménagement et de Gestion des Eaux de la Guadeloupe or SDAGE in French) which is the main tool for the implementation of French water policy and serves as a management plan recommended by Europe.

The SDAGE are developed at the level of each French river basin, including that of Guadeloupe, and are a planning tool that define, for a period of six years, the main guidelines for a sustainable and equitable management of water resources as well as the ambient water quality and quantity objectives to be achieved in Martinique. The SDAGE have a legal scope: administrative decisions in the field of water must be compatible or made compatible with the.

provisions of the SDAGE. The current SDAGE Guadeloupe covers the period 2022 to 2027.

The following is noteworthy highlighting:

1. The French Water Act 1964 and its subsequent amendments constituted the template for Integrated Water Resources Management (IWRM) which has been adopted internationally as a process which promotes the coordinated development and management of water, land and related resources in order to maximise economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems and the environment;
2. Despite this institutional & regulatory maturity, water resources in Guadeloupe are facing challenges such as:
 - a. Small landmass, high declivity and runoff, limited storage volumes and retention times in both surface and ground water bodies;
 - b. Pollution of soils and aquifers by the organochlorine pesticide chlordecone (under brand name "Kepone") which was extensively used in the banana industry for over 40 years. The pesticide was banned in metropolitan France in 1990 and subsequently in Martinique and Guadeloupe in 1993, although it was illegally imported and used in these islands under a different brand name until around 2003;
 - c. Effects of climate change: 5 of the 6 most severe droughts spells recorded in Guadeloupe have occurred since 2020 thus negatively impacting water resources availability;
 - d. Saline intrusion in coastal aquifers due to non-sustainable abstraction from wells and insufficient recharge (compounded by severe droughts linked to climate change).

Further information on the ODE and its constitutive bodies/functions is available at the following websites (in French):

<https://www.eauguadeloupe.com/>

<https://www.eauguadeloupe.com/analyse-de-l-eau-guadeloupe>

<https://www.eauguadeloupe.com/sdage>

Existing Infrastructure (water supply & sanitation)

Description

Water Supply

In 2010, Guadeloupe had a total of 52 operational water treatment plants (WTPs) for a total capacity of 157,000 m³/day. 50% of these WTPs had a capacity comprised between 10 m³/day and 100 m³/day. In 2010, only a minority of these WTPs had back up generators installed though this might have changed in recent years.

In 2010, these WTPs were fed via 25 surface water intakes and 23 boreholes (with only 12 operational boreholes).

In 2010, the island had 149 potable water storage tanks, totalling 111,000 m³ of usable volume. This corresponded to 0.8 days of average consumption which is low.

In 2010, water supply was provided by approximately 3,000 kilometres of networks (excluding connections). They were mainly made of ductile iron (66%) and PVC (14%). Since 2010, the remaining AC pipes have been gradually replaced and many HDPE pipes laid.

Sanitation

In 2018, there were sewerage networks mainly in the urban and peri-urban areas. Rural areas rely on household sanitation.

Along the sewerage network, more than 200 sewage pumping stations were in operation in Guadeloupe which is a large number considering the relative modest size of the island.

In 2018, there were 125 Waste Water Treatment Plants (WWTPs) in Guadeloupe with a total capacity of 282,115 EH (Equivalent Habitants).

The treatment capacities of WWTPs are very heterogeneous: Out of the 125 WWTPs, 18 only had a capacity above 2,000 EH and represented 82% of the total capacity.

It is noteworthy mentioning the increasing use of constructed wetlands WWTPs in peri urban areas and compact filters (with coconut chip media) for household sanitation in rural areas. These solutions have proven to be cost effective, resilient and sustainable in the Caribbean context and could ideally be considered for implementation in other islands.

Irrigation

The management and development of irrigation systems are the competence of the Department.

Irrigation is essentially undertaken in Grande Terre, the flatter part of Guadeloupe where cultivation is undertaken.

Coverage & Quality of Service

Water Supply

Water supply coverage in Guadeloupe is reportedly high (95%) though continuity of service is poor with 25% of the population receiving rationed water supply due to both increased system losses and severe drought episodes (due to climate change).

There is universal metering in Guadeloupe and average per capita water use in 2020 was 82 l/c/day which is deemed very low (160 l/c/day in Martinique). This low per capita usage is in part attributable to rationed supply which have been exacerbated by the occurrence of severe drought episodes since 2020.

The average water tariff (3.43 €/m³ in 2021) is however high (compared to 2.7 €/m³ in Martinique and 2.11 €/m³ in Metropolitan France in 2021) and has been steadily increasing over the past years.

The 2021 sewerage tariff in Guadeloupe varied between 1.07 €/m³ and 3.80 €/m³ which is comparable to the average tariff in Martinique (2.8 €/m³) and higher than the average sewerage tariff in France (2.19 €/m³).

There are various reasons behind these high tariffs (demography, geography, EU regulations, high CAPEX, high OPEX, municipal ownership of assets, etc.) which have led to affordability issues for the lowest income groups and occasional social unrest.

In 2020, potable water quality was generally within standards with however continued challenges as regards certain parameters such as: turbidity (40% of WTPs had nonconformities), aluminium (21% of WTPs had nonconformities) and the pesticide chlordecone (9% of WTPs had nonconformities). Also, in the distribution network, 97.5% of distributed water were within the potability standards.

In 2020, despite rationing and operational challenges, customer satisfaction was acceptable with on average less than 30 complaints per 1,000 customers per year. This can be compared to the regional 2019 average of 54 complaints per 1,000 customers per year⁸⁶.

Sanitation

In 2020, 44% of the population in Guadeloupe was connected to sewerage networks, the remaining 56% relying on household sanitation. This is significantly higher than the regional average of 11% connected to sewerage networks⁸⁷.

There are however persistent challenges with sewerage systems which impact quality of service:

1. Ageing sewerage networks, presence of Infiltration and Inflow (I&I) which lead to hydraulic overloads of sewerage systems;
2. Presence of H₂S (an occupational and health hazard) in several facilities due to long force mains. H₂S also results in higher levels of corrosion;
3. Ageing WWTP facilities, insufficient levels of O&M leading to the underperformance of WWTPs with only 28% of the plants (with capacity > 2,000 EH) declared in conformity with discharge standards;

4. Slack environmental and water policing by some municipalities which is detrimental to the identification of non-conformities and the implementation of corrective actions.

Whenever population density and land use allow, the implementation of smaller scale sewerage networks & controlled wetland WWTPs (in peri urban areas) or compact filters (with coconut media) in rural areas generally lead to improved operational performance, quality of service and sustainability. These solutions (more in tune with nature-based solutions) are particularly adapted to the Caribbean context.

Operational and Financial Performance

Water Supply

The water supply sector in Guadeloupe is in great difficulty with daily water rationing organized in certain geographical areas (25% of the population, as mentioned above). Operators report their inability to meet operational costs (OPEX), let alone the investment (CAPEX).

According to 2020 figures, average distribution network yield is low at 40% (equivalent to 60% NRW) and there is scope for improvement. It is noteworthy mentioning that 90% of leaks were located on the service connections.

The following graph shows NRW levels (2020) in various parts of Guadeloupe.

Significant efforts have been undertaken over the last few years to physical losses (leakage) and commercial losses (meter under-registration and illegal connections) on the water transmission and distribution networks in Guadeloupe and the situation is gradually being stabilized.

In 2020, accounts receivable of service providers in Guadeloupe amounted to 110 days (sales revenues) which is similar to the regional standard (82 days)⁸⁸.

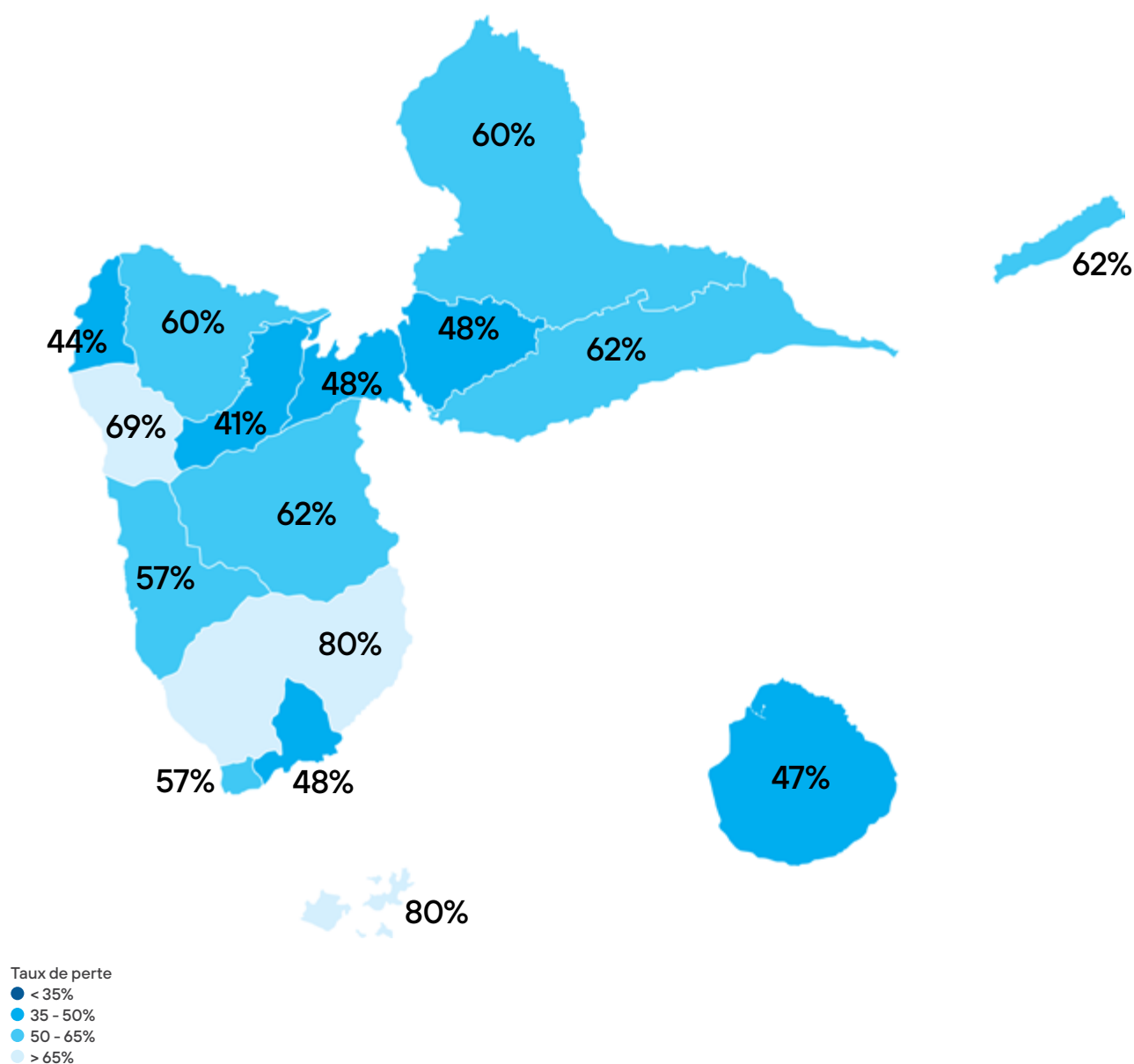
86 The Caribbean Water Study - IDB - Oct 2021

87 The Caribbean Water Study - IDB - Oct 2021

88 The Caribbean Water Study - IDB - Oct 2021

Figure 5.5

NRW levels (%) in various parts of Guadeloupe (2020)

**Sanitation**

As mentioned above, though sewerage coverage in Guadeloupe (44%) is significantly higher than in the neighbouring islands (11%), sewerage systems are generally underperforming as described below.

Sewerage systems are separate in Guadeloupe and as such, sewage and storm flows are designed to be collected/evacuated by separate systems. According to the ODE Guadeloupe website, there are high levels of Infiltration & Inflow (I&I) in sewerage networks which lead to hydraulic overloading of sewerage networks and WWTPs (flushing).

According to 2010 estimates, on average, 50% of WWTP influents were attributable to infiltration and inflows varied between 500 m³/ha and 1,450 m³/ha of active surfaces (which drain to the sewer system). Obviously, I&I varies per sector depending upon network age, quality of design and construction, level of O&M and network policing⁸⁹.

In Guadeloupe, the high density of sewerage pump stations (> 200) and the length of the force mains also lead to operational & maintenance issues such as the formation of H₂S. This constitutes an occupational, environmental

and health hazard and also contributes to the corrosion of sewerage facilities and higher levels of maintenance.

The WWTPs are in poor condition, and the trend seems to be deteriorating. In 2020, 28% only of the WWTPs with capacity > 2,000 EH were declared compliant with the discharge standards whilst the national French average is 93% (2013). In 2019, this figure was 33% and in 2017, 39%.

On the contrary, 97% of household sanitation systems in Guadeloupe were declared in conformity with the standards in 2020.

Vulnerability to Extreme Weather Events - Adaptation & Mitigation

Like many other island nations in the Caribbean, Guadeloupe is highly susceptible to the impacts of extreme weather events. Its geographical location in the hurricane-prone Atlantic Basin, coupled with factors such as topography, population density, and socio-economic conditions, make it particularly vulnerable to hurricanes, tropical storms, and other climate-related disasters.

The island's topography includes mountainous terrain and low-lying coastal areas. This combination increases the risk of landslides and flooding during extreme weather events. Coastal regions are particularly vulnerable to storm surges, which can result in severe coastal erosion and damage to infrastructure.

Guadeloupe is home to diverse ecosystems, including coral reefs, mangroves, and tropical rainforests. These natural habitats are crucial for the island's ecological balance and provide valuable services such as storm surge buffering and erosion control. However, they are also highly sensitive to disruptions caused by extreme weather events.

Deforestation, land development, and improper land use practices have weakened the island's natural defences against extreme weather events. Loss of vegetation cover reduces the capacity to absorb excess rainfall, leading to increased runoff and the potential for flash floods and landslides.

Guadeloupe has a relatively high population density, with many residents concentrated in urban areas along the coast. Urbanization and the construction of infrastructure in vulnerable zones have increased the exposure of communities to extreme weather events.

Socio-economic disparities within the island's population can exacerbate the impacts of extreme weather events. Vulnerable communities, often lacking resources and access to protective measures, may face heightened risks and difficulties in recovery efforts.

While significant efforts have been made to enhance climate resilience on the island, there is still a need for further investment in early warning systems, robust building codes, and community-based disaster preparedness programs.

Guadeloupe's vulnerability to extreme weather events is a multifaceted challenge that requires a comprehensive and integrated approach. It is crucial for the island to continue investing in climate resilience measures, sustainable land use practices, and community empowerment. By doing so, Martinique can enhance its ability to withstand and recover from the impacts of future extreme weather events, safeguarding the well-being and livelihoods of its residents.

⁸⁹ Network policing has reportedly been slack in a number of municipalities in Guadeloupe

Status of Hydrometeorological and Climate Monitoring Systems

The quantitative monitoring of Guadeloupe waterways is carried out by the DEAL (Department of the Environment, Planning and Housing). Hydrometric and hydrological data can be found online at the following website: www.hydro.eaufrance.fr.

Developed by the Central Service for Hydrometeorology and Support for Flood Forecasting (SCHAPI), the Hydroportal provides all public data relating to the height and flow of rivers. These data are available for all existing or former measuring stations on French rivers.

Meteorological predictions and management of monitoring systems is the responsibility of the national agency Météo France. It relies on an extensive network of meteorological stations and weather satellites. Its local branch Météo France Guadeloupe has a dedicated website where historical weather data and weather forecast can be consulted: <https://meteofrance.gp/fr>

The following information is available on the website:

1. Weather Vigilance and Cyclone Warnings;
2. Satellite animations over the past 24 hours and radar animations over the past 3 hours;
3. Weather forecasts for today, tomorrow and up to 15 days;
4. A specific section dedicated to real-time cyclone activity: Phenomena in progress, visualization of trajectories, analysis and forecast bulletins;
5. A section dedicated to marine meteorology: Charts and marine weather reports (coastal and offshore), forecasts for Martinique's surf spots, etc.;
6. A forecast bulletin for the stranding of sargassum over Martinique;
7. A section on climate: Monthly meteorological readings, climatological normals, etc.;
8. News and seasonal trends

Emergency Response Plans and Disaster Preparedness

Guadeloupe is subject to various water related hazards such as:

1. Flooding;
2. Submersion or erosion of the shoreline;
3. Land movements (landslides, mudslides, falling boulders, landslides).

As previously mentioned, the following organisations have responsibility for disaster preparedness and response:

1. The Prefecture of Guadeloupe (Préfecture de la Guadeloupe) plays a significant role in coordinating and overseeing disaster management efforts on the island. This includes planning, coordination, and response activities in the event of natural disasters;

2. The Departmental Fire and Rescue Service (Service Départemental d'Incendie et de Secours or SDIS) also plays a crucial role in disaster response and often collaborates closely with the Prefecture;
3. Additionally, Local Government entities (Department and Region Guadeloupe and Municipalities) have their own roles and responsibilities in disaster preparedness and response.

The Natural Risk Prevention Plan (PPRN in French) is a document produced by the State that regulates the use of land at the municipal level, according to the risks to which it is subject. It makes it possible to consider natural risks in development, to control the urbanization of the territory by avoiding increasing the stakes in high-risk areas and by reducing the vulnerability of the existing ones. These regulations range from a ban on building to the possibility of building under certain conditions.

The PPRN Guadeloupe is available online⁹⁰ and the web site includes useful interactive maps with colour coding of risks and land use regulations.

Despite some challenges, Guadeloupe, like Martinique has a fairly robust disaster preparedness framework, response plan and adequate resources. It also provides assistance to its OECS neighbours struck by natural disasters (e.g. St. Lucia, Haiti, Dominica), mobilizing at times European funds dedicated to Caribbean solidarity.

Asset Planning & Development

To address the water sector disparities between Metropolitan France and French overseas departments (DOM in French), the French State, in partnership with its relevant agencies and Local Government entities in the DOM initiated the Plan Eau DOM in 2016.

The Plan Eau DOM aims to take specific action in the overseas departments to improve drinking water supply and sanitation infrastructure. It is a 10-year plan which is implemented over two (2) 5-year periods. The plan is assessed and reviewed after the first 5-year period.

The Plan Eau DOM Guadeloupe constitutes an investment tool and facility with access to grant and concessionary loans. It was signed by the two (2) EPCI responsible for water supply, sanitation and drainage in Guadeloupe between 2018 and 2019.

Several urgent non-regret projects were initiated prior to the signing of the Plan Eau DOM and were geared towards the reduction of NRW and its two components:

1. Physical losses: leakage, reservoir overflows;
2. Commercial losses: meter under registration, illegal connections, meter reading & billing losses.

The Priority Action Plan (Plan d'Actions Prioritaire in French) was launched in 2018 and includes 38 projects for a total investment of 71.4 M€.

Areas for improvement include:

1. The systematic provision of generators for the numerous sewerage pump stations as power interruptions often lead to the development of septic conditions within system (wet wells, force mains and WWTPs) which in turn result in occupational and environmental hazards as well as operational challenges;
2. Increase water storage to attain the objective of 2 days of water supply and allow gravity feed in the event of power outages. This increases the resilience of the systems.

Main funding agencies of Plan Eau DOM and Priority Action Plan represented in its Financing Committees are:

Grant funding:

1. Region and Department of Guadeloupe, the highest local government entities in Martinique, responsible for the management of the European Funds for Regional Economic Development (FEDER);
2. Region and Department of Guadeloupe, responsible for the management of the local government intervention funds;
3. Direction de l'Environnement, de l'Aménagement et du Logement (DEAL) responsible for the intervention funds dedicated to water and sanitation under BOP 123 administered by the Prefect of Guadeloupe, who is also the representative of the French Office for Biodiversity (OFB) for the monitoring of inter-basin solidarity⁹¹;
4. Water Resources Agency of Guadeloupe (Office de l'Eau Martinique or ODE);
5. Agency for the Environment and Energy Conservation (Agence de l'Environnement et de la Maitrise de l'Energie or ADEME).

⁹⁰ <https://pprn971guadeloupe.fr/>

⁹¹ i.e. financial transfers from Water Resources Agencies in Metropolitan France to their counterparts in the French Overseas Territories (DOM in French).

Loan funding (concessionary terms):

1. French Development Agency (Agence Française de Développement or AFD);
2. Caisse Des Dépôts (CDC), a French public sector financing institution under the control of the Parliament. It is often described as the "Investment arm of the French State".

Historical Investments by Subsector

In 2014, the Water Supply Security Plan (Plan de Sécurisation de l'AEP or PSEP in French) was launched under the coordination of the DEAL and included 68 projects for a total investment of 93.7 M€. Projects are implemented by the Department of Guadeloupe (Local Government entity).

As of 2020, 21 projects (44.9 M€) had been completed under the PSEP, 48% for water production improvement and 52% for the improvement of water transfer and distribution.

The repartition of completed projects under the PSEP 4 are summarised in the following table:

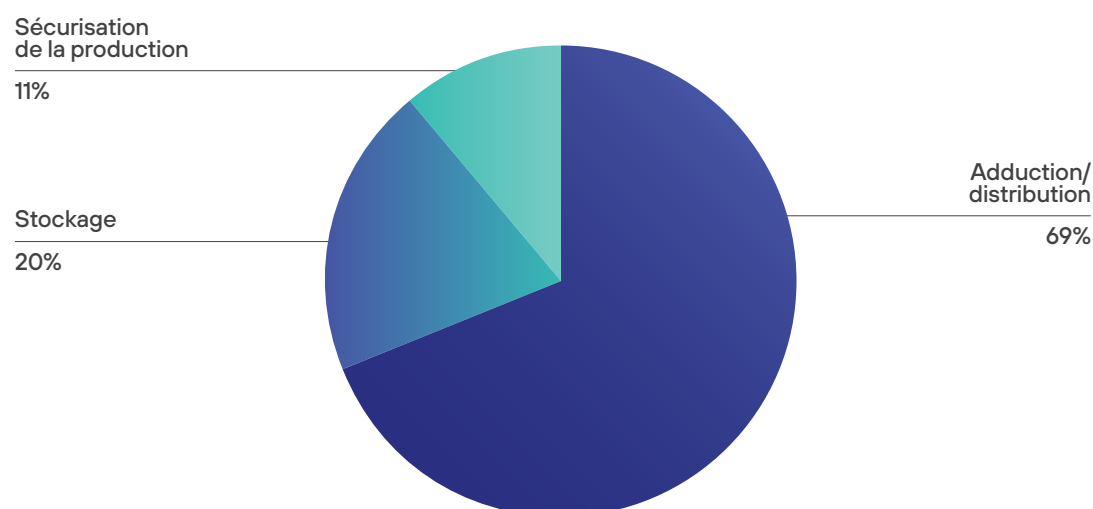
Table 5.4

Repartition of PSEP Investments - Guadeloupe

Phase	Year	Number of Projects	Investments (M€)
Phase 1	2014 - 2015	8	19.1
Phase 2	2016 - 2017	9	16.9
Phase 3	2018		8.9

Figure 5.6

Repartition of PAP Funds per Sub-Sector in Guadeloupe - 2020



The Plan Eau Dom was developed to remediate the challenges of the water sector in Guadeloupe, essentially 1) high level of water network losses due to ageing networks, 2) increase sanitation coverage and service levels and 3) increase resilience of the systems to extreme weather events. The Plan Eau Dom defines the overall strategy which is then declined in action plans as described below.

The Priority Action Plan investment portfolio comprises of 38 projects for a total investment of 71.4 million €. The following figures provide more details on the repartition of PAP funds per sub-sector, the spatial distribution of PAP funds and progress achieved as of September 2022:

Figure 5.7

Spatial Distribution of PAP Funds in Guadeloupe – 2020

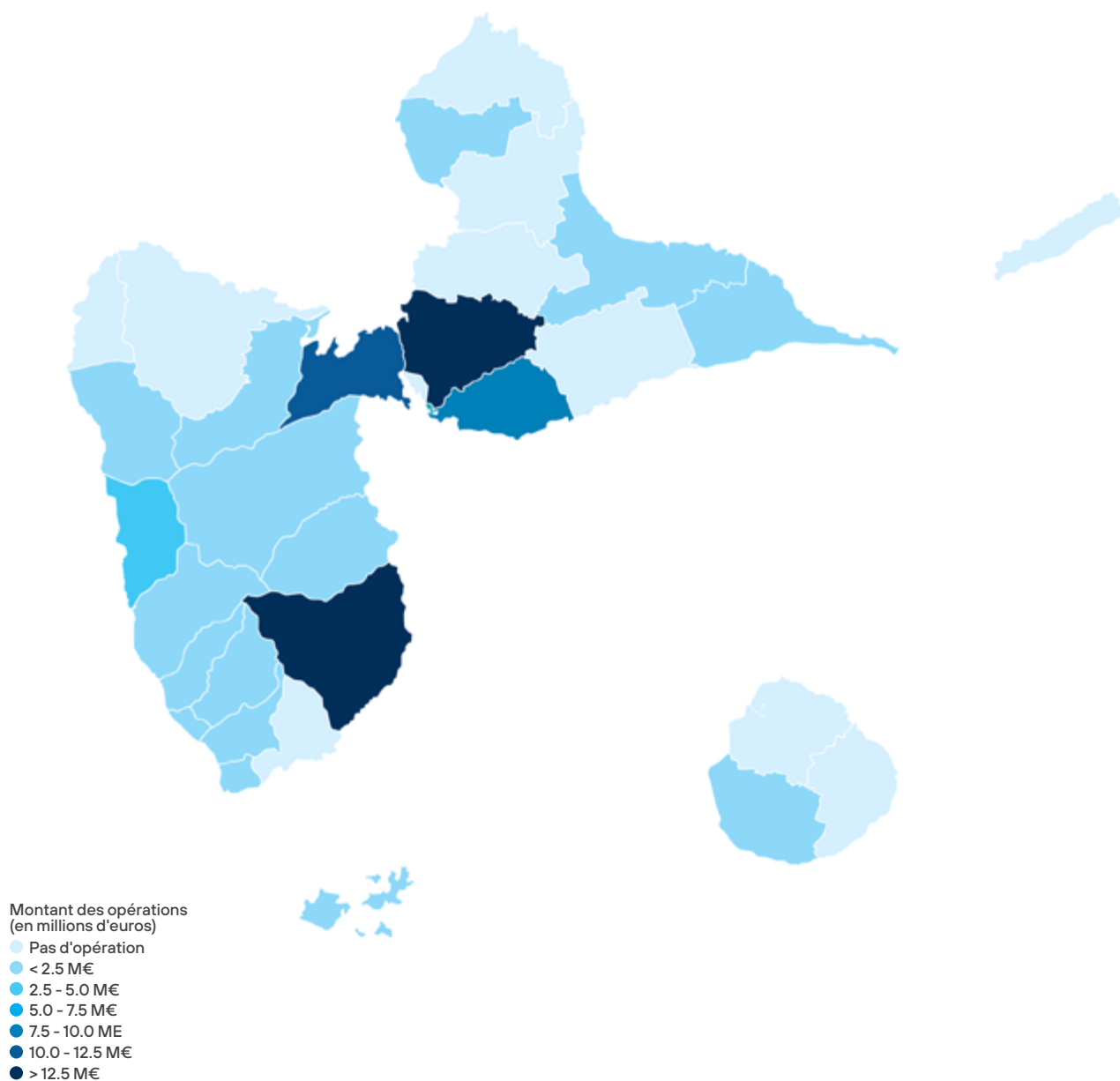
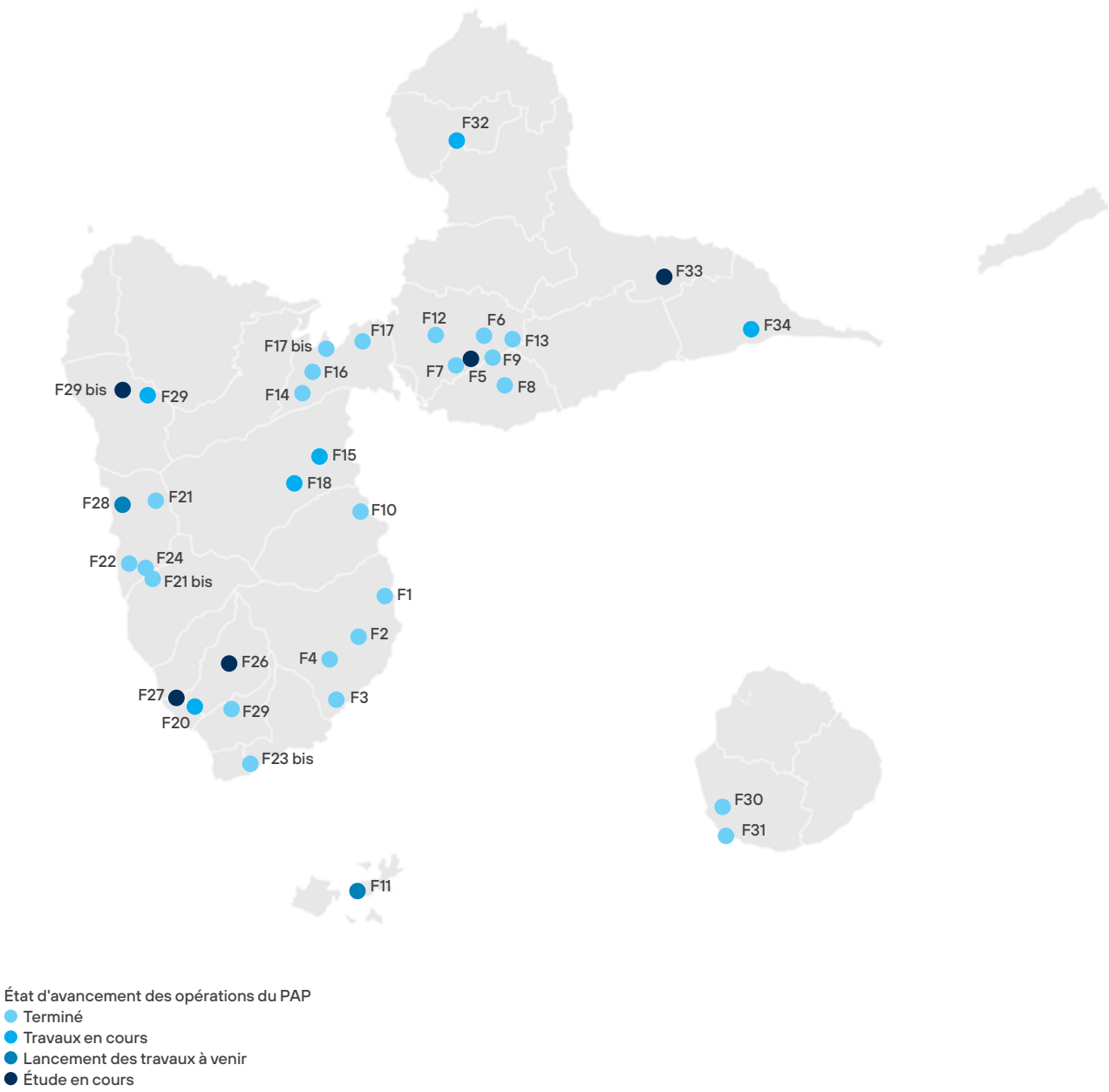


Figure 5.8
Progress Achieved under the PAP as of September 2022 in Guadeloupe



Martinique

Legal, Institutional & Regulatory Landscape

Martinique is a French overseas department (Département Outre Mer or DOM in French) and as such, the laws of the French Republic apply.

The water sector in Martinique is governed by a combination of French national legislation and local regulations specific to the island. At the national level, the legal framework includes the 2006 Water Act (transposition into French law of the European Water Framework Directive 2000/60/CE), which establishes the principles of water resource management, including allocation, protection, and conservation. Additionally, the French Environmental Code outlines various aspects of environmental protection, which encompasses water resources.

On the local level, Martinique has established specific institutions to oversee water management. The Directorate for the Environment, Planning, and Housing (DEAL) is responsible for implementing national environmental policies in Martinique, including those related to water resources. The Water Resources Agency of Martinique (Office de l'Eau de la Martinique or ODE in French) is a key local institution charged with the management of water resources.

The regulatory landscape also includes specific measures for water quality monitoring, pollution control, and conservation efforts. This involves periodic assessments and inspections to ensure compliance with established standards and regulations. The DEAL is responsible for regulating applications for water abstraction (environmental impacts) and the ARS Martinique (Regional Health Agency of Martinique) is responsible for regulating water abstraction for potable water supply (social & health impacts).

As in Metropolitan France, the responsibility for water supply and sanitation historically lied with the municipalities, but since the promulgation of the NOTRe Law in 2015, those responsibilities have been redefined and shared with larger local government entities such as Intermunicipal Communities (Etablissement Public de Coopération Intercommunale or EPCI in French) to achieve economies of scale and greater efficiency. A new law is reportedly under preparation to share responsibilities for water supply and sanitation at even higher levels of local government such as the Departments and Regions (CTM⁹² in Martinique). This upscaling is partly motivated by the effects of climate change on local water resources and the increased necessity for regional water transfers.

In Martinique specifically, responsibility for water supply & sanitation is shared by three Intermunicipal Communities (EPCI) namely:

1. South Martinique (CAESM - Espace Sud Martinique):

- Full Name: Communauté d'Agglomération de l'Espace Sud de la Martinique (Urban Community of Southern Martinique);
- Responsibility: This EPCI oversees a range of services including water supply, sanitation, waste management, and various aspects of urban development for the southern region of Martinique;

2. Central Martinique (CACEM):

- Full Name: Communauté d'Agglomération du Centre de la Martinique (Urban Community of Central Martinique);
- Responsibility: This EPCI is responsible for coordinating various municipal services and projects in the central region of Martinique, including water supply.

92 Collectivité Territoriale de la Martinique (CTM)

3. North Atlantic (CAP NORD - Nord Atlantique):

- Full Name: Communauté d'Agglomération du Nord de la Martinique (Urban Community of Northern Martinique);
- Responsibility: This EPCI oversees a range of services for the northern region of Martinique, which includes responsibilities for water supply.

The EPCI are the asset holding companies which delegate operations to the following public and private entities:

1. ODYSSEI is a public entity which provides water and sanitation services in the perimeter of the EPCI Central Martinique (CACEM) including the Capital Fort de France;
2. SME (Société Martiniquaise des Eaux), a public entity which provides water and sanitation services in the perimeter of the EPCIs South Martinique and North Atlantic;
3. SEA & SMDS (private entities) which provide sanitation services in the perimeter of the EPCI North Atlantic.

The above reflects the general organisation of water supply and sanitation services in France where asset holding & development on the one hand and service provision on the

other hand are undertaken by different entities. The asset owners usually directly regulate the service providers. Water and environmental police are undertaken by the DEAL, representing central government.

In Martinique, the Local Government (Collectivité Territoriale de la Martinique or CTM in French) and other relevant local authorities are involved in regulating and managing irrigation projects. Since 2018, drainage is under the purview of the Intermunicipal Communities (EPCI).

The responsibility for disaster preparedness and response lies with several agencies and organizations:

1. The Prefecture of Martinique (Préfecture de la Martinique) plays a significant role in coordinating and overseeing disaster management efforts on the island. This includes planning, coordination, and response activities in the event of natural disasters;
2. The Departmental Fire and Rescue Service (Service Départemental d'Incendie et de Secours or SDIS) also plays a crucial role in disaster response and often collaborates closely with the Prefecture;
3. Additionally, the Local Government (Collectivité Territoriale de la Martinique or CTM) and local municipalities have their own roles and responsibilities in disaster preparedness and response.

Water Resources Management

With 4,000 mm to 1,200mm of annual rainfall and sufficient renewable water resources, Martinique is neither a water scarce nor a water stressed island. However, due mainly to the topography and general direction of the trade winds in the Eastern Caribbean, rainfall and water resources are more abundant in the Northern part of the island as compared to the Southern part.

The above leads to water transfers between North and South Martinique, especially in the dry season which occurs annually from 15th Dec to 15th June.

In 2020, total water abstraction was 58 Mm³ and was distributed as follows:

1. 42.6 Mm³ for domestic and urban uses (73%);
2. 14.3 Mm³ for irrigation (25%);
3. 1.1 Mm³ for other uses (industrial use, etc.) (2%).

95% of water abstraction is from surface water and 5% from aquifers.

The low contribution of aquifers (5%) stems from both geology/geomorphology (limited extent of aquifers, high declivity & runoff which lead to reduced aquifer recharge) and the pollution of ground water resources by various pollutants including the pesticide clordecane⁹³.

The main surface water tapped is the White River (Rivière Blanche) along which the Manzo dam was built in 1980 (useful volume 5 million m³). The Manzo dam feeds central and southern Martinique to meet the needs of water supply and irrigation.

Irrigation is essentially practised in the South of Martinique (via the Manzo dam) and in the East of Martinique via small hillside storage reservoirs.

Water Resources Management is under the purview of the Office de l'Eau de la Martinique (ODE - Martinique) which translates in English as the "Water Resources Agency of Martinique". The ODEs were initially established in France (a separate ODE in each regional hydrological catchment) by the 1964 Water Act which was subsequently completed/amended by various pieces of legislation, the most important being the 1992 Water Act and the 2006 Water Act (transposition into French law of the European Water Framework Directive 2000/60/CE).

As in metropolitan France, the water resources management landscape in Martinique via the ODE is well defined and organized around four main pillars:

1. The establishment of a consultative & deliberative body on water resources and biodiversity, the Comité de l'Eau et de la Biodiversité (CEB) de la Martinique which translates in English as "Water and Biodiversity Committee of Martinique", sort of water & biodiversity parliament where the main water and biodiversity stakeholders are represented;
2. Establishment of a data repository on water and biodiversity in Martinique (Observatoire de l'Eau de la Martinique) where relevant and historical data is freely accessible online (on topics in relation with water supply & sanitation, surface and ground water resources, wetlands, coastal and near shore waters, etc.);
3. Constitution of a water and biodiversity fund managed by the ODE, via a deduction on the water and sanitation bill of

consumers. This fund serves to finance partially or entirely projects geared towards water resources and biodiversity management, protection & restoration in Martinique;

4. Development of a Master Plan for Water Development and Management for Martinique (Schéma Directeur d'Aménagement et de Gestion des Eaux de la Martinique or SDAGE in French) which is the main tool for the implementation of French water policy and serves as a management plan recommended by Europe.

The SDAGE are developed at the level of each French river basin, including that of Martinique, and are a planning tool that define, for a period of six years, the main guidelines for a sustainable and equitable management of water resources as well as the ambient water quality and quantity objectives to be achieved in Martinique. The SDAGE have a legal scope: administrative decisions in the field of water must be compatible or made compatible with the provisions of the SDAGE.

The following is noteworthy highlighting:

1. The French Water Act 1964 and its subsequent amendments constituted the template for Integrated Water Resources Management (IWRM) which has been adopted internationally as a process which promotes the coordinated development and management of water, land and related resources in order to maximise economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems and the environment;
2. Despite this institutional & regulatory maturity, water resources in Martinique are facing challenges such as:
 - a. Small landmass, high declivity and runoff, limited storage volumes and retention times in both surface and ground water bodies;
 - b. Pollution of soils and aquifers by the organochlorine pesticide chlordecane (under brand name "Kepone") which was extensively used in the banana industry for over 40 years. The pesticide was banned in metropolitan France in 1990 and subsequently in Martinique and Guadeloupe in 1993, although it was illegally imported and used in these islands under a different brand name until around 2003;

⁹³ The use of clordecane is arguably the biggest environmental and health hazard to have plagued the French West Indies. A 2018 large-scale study by the French public health agency, Santé publique France, shows that 95% of the inhabitants of Guadeloupe and 92% of those of Martinique are contaminated by the chemical. Guadeloupe has one of the highest prostate cancer diagnosis rates in the world.

- c. Effects of climate change: 5 of the 6 most severe droughts spells recorded in Martinique have occurred since 2020 thus negatively impacting water resources availability.

Further information on the ODE and its constitutive bodies/functions is available at the following websites (in French):

<https://www.eaumartinique.fr/l-office-de-l-eau>

<https://www.martinique.developpement-durable.gouv.fr/le-comite-de-l-eau-et-de-la-biodiversite-r137.html>

<https://www.observatoire-eau-martinique.fr/>

<https://www.eaumartinique.fr/aides-financieres-redevances/redevances>

<https://www.eaumartinique.fr/sdage>

Existing Infrastructure (water supply & sanitation)

Description

Water Supply

In 2018, Martinique had a total of 27 water treatment plants with a total production capacity of 107,000 m³/day. Their production was however uneven: the 5 largest plants (Rivière Blanche, Durand, Directoire, Didier and Vivé) produced 85% of the island's drinking water and are thus highly strategic.

These plants are fed by 36 catchments, all located in the northern half of the island: 20 river water intakes, 12 springs and 4 boreholes.

In 2018, the island has 290 drinking water storage tanks, totalling 180,000 m³ of usable volume. This corresponded to 2.8 days of average consumption.

In 2017, water supply was provided by 3,526 kilometres of networks (excluding connections). They are mainly made of PVC (59%) and cast iron (32%). Although HDPE is the preferred material for new installations, it accounted for only 6.5% of the 2017 network.

Sanitation

In 2017, there was 864 km of sewerage network in Martinique, unevenly distributed across the island (mainly in the urban and peri-urban areas). Rural areas rely on household sanitation.

Along the sewerage network, 270 sewage pumping stations were in operation in Martinique in 2017, an important number (considering the size of the island) due to the general declivity of the island and its catchments.

In 2017, there were 112 Waste Water Treatment Plants (WWTPs) in Martinique with a total treatment capacity of 337,000 Population Equivalent (PE) distributed as follows:

1. 50 WWTP in EPCI CAP NORD (North);
2. 34 WWTP in EPCI CACEM (Centre);
3. 28 WWTP in EPCI CAESM (South).

In 2017, the total treated effluents from these WWTPs was 9,067,760 m³ equivalent to 24,800 m³/day.

The treatment capacities of WWTPs are very heterogeneous: the 12 largest plants treat 62% of wastewater, or nearly two-thirds and the smallest 100 treat the remaining 38%.

It is noteworthy mentioning the increasing use of constructed wetlands WWTPs in peri urban areas and compact filters (with coconut chip media) for household sanitation in rural areas. These solutions have proven to be cost effective, resilient and sustainable in the Caribbean context and could ideally be considered for implementation in other islands.

Coverage & Quality of Service

Water Supply

Water supply coverage in Martinique is reportedly high (100%) with 24/7 service though achieving 24/7 service is becoming increasingly challenging during the dry season because of the effects of climate change and drought.

There is universal metering in Martinique and average per capita water use is 160 l/c/day which is deemed appropriate and reasonable. Average tariffs (2.7 €/m³ for water, 5.50 for water & sewerage) are however high. There are various reasons behind these high tariffs (demography, geography, EU regulations, high CAPEX, high OPEX, municipal ownership of assets, etc.) which have led to affordability issues for the lowest income groups and occasional social unrest.

Reportedly, agreed water allocations between EPCI CACEM and EPCI CAESM are not always adhered to, resulting in higher feeds towards EPCI CACEM (Centre) to the detriment of EPCI CAESM (South).

Potable water quality is good, with distributed water meeting the national standards, despite the treatment challenges posed by the contamination of surface and ground water resources by pesticides.

Sanitation

In 2019, 42% of the population in Martinique was connected to sewerage networks, the remaining 58% relying on household sanitation. This is significantly higher than the regional average of 11% connected to sewerage networks⁹⁴

There are however persistent challenges with sewerage systems which impact quality of service:

1. High density of sewage pump stations (due to natural declivity of catchments), long force mains with high retention times which leads to H₂S production and hazards/inconveniences in the vicinity of pump stations and at WWTPs;
2. Underperformance of the WWTPs with only 43% of the plants declared in conformity with discharge standards;
3. Slack environmental and water policing by some municipalities which is detrimental to the identification of non-conformities and the implementation of corrective actions.

Whenever population density and land use allow, the implementation of smaller scale sewerage networks & controlled wetland WWTPs (in peri urban areas) or compact filters (with coconut media) in rural areas generally lead to improved operational performance,

quality of service and sustainability. These solutions (more in tune with nature-based solutions) are particularly adapted to the Caribbean context.

Operational and Financial Performance

Water Supply

According to 2022 figures, there is scope for improvement in network yields, especially in the EPCI CACEM (Centre) where network yields are lowest (40%). The EPCI CAESM (South) has the highest yield on the island (74%). The average (water) network yield in the island is 56%.

The above is equivalent to writing that NRW is 60% in EPCI CACEM (Centre), 26% in EPCI CAESM (South) and 44% on average throughout the island.

The linear loss index (LLI) which is also commonly used in Europe and France translates network losses in m³ of water lost per day and per kilometre of network. In 2018, this index was 11.5 on average for Martinique (6.2 for the CAESM, 8.2 for CAP NORD and 22 for the CACEM). The national LLI average in Metropolitan France (2013) is 4.5 m³/day/km.

Sanitation

As mentioned above, though sewerage coverage in Martinique (42%) is significantly higher than in the neighbouring islands (11%), sewerage systems are generally underperforming as described below.

There is no readily available data on the water tightness of the sewerage systems and the volume of clear water inflows (infiltration & inflow or I&I) into the sewerage networks. Sewerage systems are separate in Martinique and as such, sewage and storm flows are designed to be collected/evacuated by separate systems. High I&I in sewerage systems can lead to network overflows and hydraulic overloading (flushing) of WWTPs. The % of I&I varies across jurisdictions and systems but is usually contingent upon the quality of design/construction/operation & maintenance and network policing. As network policing has historically been slack in a number of municipalities in Martinique, it can reasonably be assumed that those municipalities may experience higher I&I than the others.

⁹⁴ The Caribbean Water Study - IDB - Oct 2021

In Martinique, the density of sewerage pump stations and the length of the force mains also lead to operational & maintenance issues such as the formation of H₂S. This constitutes an occupational, environmental and health hazard and also contributes to the corrosion of sewerage facilities and higher levels of maintenance.

The WWTPs are generally in poor condition, and the trend seems to be deteriorating. In 2019, only 48 out of 112 stations (43%) were declared compliant with the discharge standards whilst the national French average is 93% (2013). However, it should be noted that some WWTPs (30 out of 112 or 27%) were by default declared non-compliant due to the lack of data.

Vulnerability to Extreme Weather Events - Adaptation & Mitigation

Like many other island nations in the Caribbean, Martinique is highly susceptible to the impacts of extreme weather events. Its geographical location in the hurricane-prone Atlantic Basin, coupled with factors such as topography, population density, and socio-economic conditions, make it particularly vulnerable to hurricanes, tropical storms, and other climate-related disasters.

Martinique is situated in the heart of the Atlantic hurricane basin, making it susceptible to destructive hurricanes and tropical storms.

The island's topography includes mountainous terrain and low-lying coastal areas. This combination increases the risk of landslides and flooding during extreme weather events. Coastal regions are particularly vulnerable to storm surges, which can result in severe coastal erosion and damage to infrastructure.

Martinique is home to diverse ecosystems, including coral reefs, mangroves, and tropical rainforests. These natural habitats are crucial for the island's ecological balance and provide valuable services such as storm surge buffering and erosion control. However, they are also highly sensitive to disruptions caused by extreme weather events.

Deforestation, land development, and improper land use practices have weakened the island's natural defences against extreme weather events. Loss of vegetation cover reduces the capacity to absorb excess rainfall, leading to increased runoff and the potential for flash floods and landslides.

Martinique has a relatively high population density, with many residents concentrated in urban areas along the coast. Urbanization and the construction of infrastructure in vulnerable zones have increased the exposure of communities to extreme weather events.

Socio-economic disparities within the island's population can exacerbate the impacts of extreme weather events. Vulnerable communities, often lacking resources and access to protective measures, may face heightened risks and difficulties in recovery efforts.

While significant efforts have been made to enhance climate resilience on the island, there is still a need for further investment in early warning systems, robust building codes, and community-based disaster preparedness programs.

Martinique's vulnerability to extreme weather events is a multifaceted challenge that requires a comprehensive and integrated approach. It is crucial for the island to continue investing in climate resilience measures, sustainable land use practices, and community empowerment. By doing so, Martinique can enhance its ability to withstand and recover from the impacts of future extreme weather events, safeguarding the well-being and livelihoods of its residents.

Status of Hydrometeorological and Climate Monitoring Systems

The quantitative monitoring of Martinique's waterways is carried out by the DEAL (Department of the Environment, Planning and Housing) and by the CTM (Territorial Collectivity of Martinique). Hydrometric and hydrological data can be found online at the following website: www.hydro.eaufrance.fr.

Developed by the Central Service for Hydrometeorology and Support for Flood Forecasting (SCHAPI), the Hydroportal provides all public data relating to the height and flow of rivers. These data are available for all existing or former measuring stations on French rivers.

DEAL has 30 stations in its database. 7 were still active in 2005. New stations are being set up and the current network is being modernised (SCADA, etc.). The issues related to the monitoring of river flows are: drought during the dry season, flooding during the winter, water resources for drinking water supply and dilution of pollutants.

Meteorological predictions and management of monitoring systems is the responsibility of the national agency Météo France. It relies on an extensive network of meteorological stations and weather satellites. Its local branch Météo France Martinique has a dedicated website where historical weather data and weather forecast can be consulted: <https://meteofrance.mq/fr>

The following information is available on the website:

1. Weather Vigilance and Cyclone Warnings;
2. Satellite animations over the past 24 hours and radar animations over the past 3 hours;
3. Weather forecasts for today, tomorrow and up to 15 days;
4. A specific section dedicated to real-time cyclone activity: Phenomena in progress, visualization of trajectories, analysis and forecast bulletins;
5. A section dedicated to marine meteorology: Charts and marine weather reports (coastal and offshore), forecasts for Martinique's surf spots, etc.;
6. A forecast bulletin for the stranding of sargassum over Martinique;
7. A section on climate: Monthly meteorological readings, climatological normals, etc.;
8. News and seasonal trends.

Emergency Response Plans and Disaster Preparedness

Martinique is subject to various water related hazards such as:

1. Flooding;
2. Submersion or erosion of the shoreline;
3. Land movements (landslides, mudslides, falling boulders, landslides).

As previously mentioned, the following organisations have responsibility for disaster preparedness and response:

1. The Prefecture of Martinique (Préfecture de la Martinique) plays a significant role in coordinating and

overseeing disaster management efforts on the island. This includes planning, coordination, and response activities in the event of natural disasters;

2. The Departmental Fire and Rescue Service (Service Départemental d'Incendie et de Secours or SDIS) also plays a crucial role in disaster response and often collaborates closely with the Prefecture;
3. Additionally, the Local Government (Collectivité Territoriale de la Martinique or CTM) and local municipalities have their own roles and responsibilities in disaster preparedness and response.

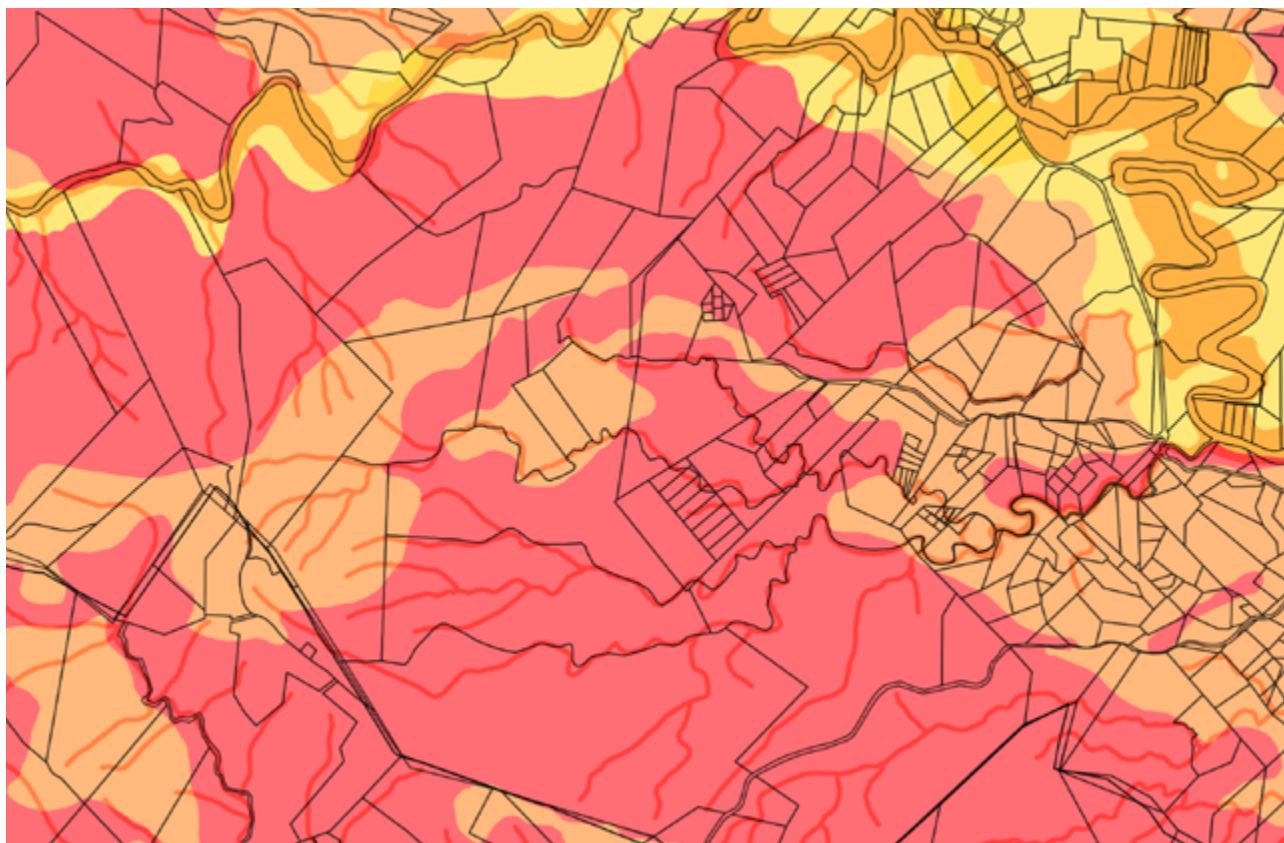
The Natural Risk Prevention Plan (PPRN in French) is a document produced by the State that regulates the use of land at the municipal level, according to the risks to which it is subject. It makes it possible to consider natural risks in development, to control the urbanization of the territory by avoiding increasing the stakes in high-risk areas and by reducing the vulnerability of the existing ones. These regulations range from a ban on building to the possibility of building under certain conditions.

The PPRN Martinique is available online⁹⁵ and the web site includes useful interactive maps with colour coding of risks and land use regulations.

Examples of interactive maps are reported in the following figure:

Figure 5.9

Natural Risk Prevention Plan – PPRN - Example of Interactive Maps



95 <https://www.observatoire-eau-martinique.fr/politique-de-l-eau/plans-d-action/plan-de-prevention-des-risques-naturels>

Considering the above and the relatively quick recuperation from historical natural disasters, it is fair to say that Martinique has a fairly robust disaster preparedness framework, response plan and the adequate resources. Also, Martinique provides regular assistance to its neighbours struck by natural disasters (e.g. St. Lucia, Haiti, Dominica).

Areas for improvement include:

1. The systematic provision of generators for the numerous sewerage pump stations as power interruptions often

lead to the development of septic conditions within system (wet wells, force mains and WWTPs) which in turn result in occupational and environmental hazards as well as operational challenges. A request has reportedly been made to include the supply & installation of generators in the Plan Eau DOM Martinique;

2. Increase water storage and the number of water tanks to feed by gravity areas below 90m ASL. Reportedly, 55% of the population of Martinique could be fed by gravity via existing and additional storage tanks.

Asset Planning & Development

To address the water sector disparities between Metropolitan France and French overseas departments (DOM in French), the French State, in partnership with its relevant agencies and Local Government entities in the DOM initiated the Plan Eau DOM in 2016.

The Plan Eau DOM aims to take specific action in the overseas departments to improve drinking water supply and sanitation infrastructure. It is a 10-year plan which is implemented over two (2) 5-year periods. The plan is assessed and reviewed after the first 5-year period.

The Plan Eau DOM Martinique constitutes an investment tool and facility with access to grant and concessionary loans (100 M€ over the first 5 years) for the implementation of water sector projects in Martinique. It was signed by the three (3) EPCI responsible for water supply, sanitation and drainage in Martinique between 2018 and 2020.

Main funding agencies of Plan Eau DOM represented in its Financing Committee are:

Grant funding:

1. Collectivité Territoriale de Martinique (CTM), the highest local government entity in Martinique, responsible for the management of the European Funds for Regional Economic Development (FEDER);

2. Collectivité Territoriale de Martinique (CTM) responsible for the management of the local government intervention funds;
3. Direction de l'Environnement, de l'Aménagement et du Logement (DEAL) responsible for the intervention funds dedicated to water and sanitation under BOP 123 administered by the Prefect of Martinique, who is also the representative of the French Office for Biodiversity (OFB) for the monitoring of inter-basin solidarity⁹⁶;
4. Water Resources Agency of Martinique (Office de l'Eau Martinique or ODE);
5. Agency for the Environment and Energy Conservation (Agence de l'Environnement et de la Maitrise de l'Energie or ADEME).

Loan funding (concessionary terms):

1. French Development Agency (Agence Française de Développement or AFD);
2. Caisse Des Dépôts (CDC), a French public sector financing institution under the control of the Parliament. It is often described as the "Investment arm of the French State".

⁹⁶ i.e. financial transfers from Water Resources Agencies in Metropolitan France to their counterparts in the French Overseas Territories (DOM in French).

Historical Investments by Subsector

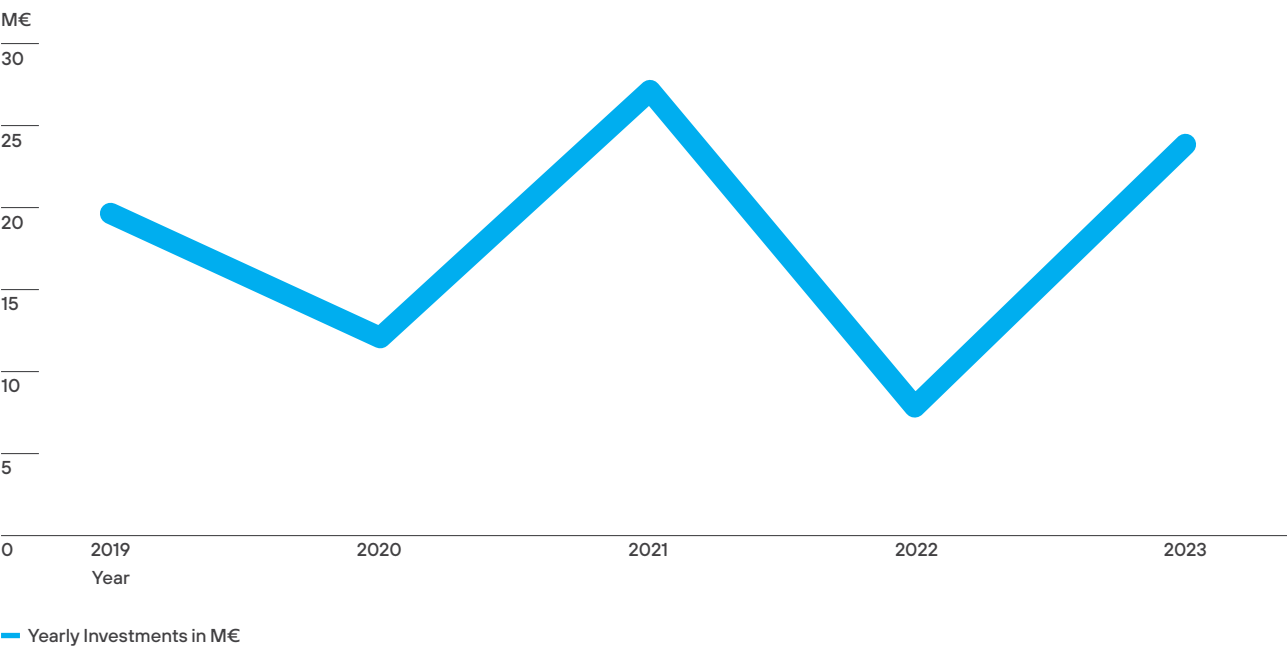
The current investment portfolio under the Plan Eau DOM Martinique (2019 – 2029) can be accessed at the following website: <https://www.plan-eaumartinique.fr/les-projets-finances/>

The current project portfolio includes 79 projects for a total investment of 90.4 million €.

Investments in the first 2 years of the Plan are 100% grant funded. Investments between years 3 and 5 included are 60% grant funded. The Plan Eau DOM is revised after 5 years.

Plan Eau DOM Martinique investment data is summarized in the following figures:

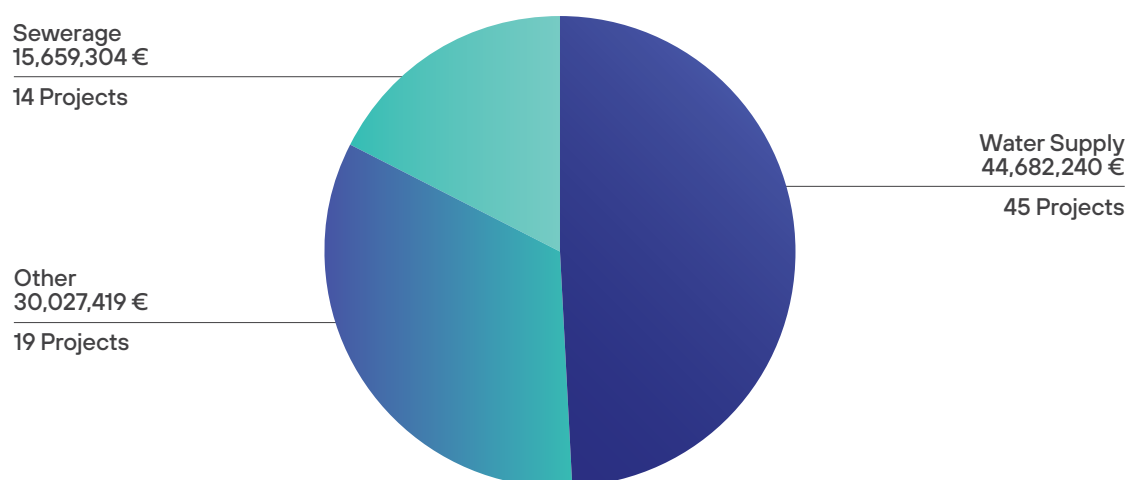
Figure 5.10
Works Implementation under Plan EAU DOM Martinique in Million € (Grants)



The investment dip observed in 2020 and 2022 are attributed to the COVID pandemic (2020) and national elections (2022). The Plan Eau DOM has thus accrued delays in its implementation.

Figure 5.11

Investment Portfolio (Plan Eau DOM Martinique) per Sub-Sector



Saint Lucia

Legal, Institutional & Regulatory Landscape

The Water and Sewerage Company Incorporated (WASCO) is responsible for the provision of water and sewerage services in St Lucia and falls under the portfolio of the Ministry of Agriculture, Fisheries, Physical Planning, Natural Resources and Co-operatives. WASCO is incorporated under the Companies Act and regulated in accordance with the provisions of the Water and Sewerage Act (2004).

The National Utilities Regulatory Commission (NURC) is the independent body responsible for regulating the water supply and sewerage services and the electricity services in Saint Lucia. The regulatory body was established pursuant to the National Utilities Regulatory Commission Act No. 3 of 2016.

The Water Resources Management Agency (WRMA), under the Ministry of Agriculture, Fisheries, Physical

Planning, Natural Resources, and Co-operatives, is the primary agency mandated by law to manage and protect the water resources of the country. The WRMA was established by the promulgation of the Water and Sewage Act 2004.

The Agricultural Division, under the Ministry of Agriculture, Fisheries, Physical Planning, Natural Resources, and Co-operatives, is responsible for the agricultural sector including irrigation.

The National Emergency Management Office (NEMO), under the under the Ministry of Equity, Social Justice, Local Government, and Empowerment, is responsible for coordinating efforts related to disaster management, including preparedness, mitigation, response, and recovery. The Disaster Management Act 2006 governs disaster management and preparedness in St Lucia.

Water Resources Management

The Water Resources Management Agency (WRMA) is the primary agency mandated by law to manage and protect the water resources of the country via the promotion of the principles of Integrated Water Resources Management. This is achieved through a series of activities that monitor water quality and water quantity across all watersheds on the island. Surface water in St Lucia is affected by land-based activities, making all private and public entities WRMA stakeholders.

WRMA is vested with the responsibility to 1. Issue abstraction Licenses 2. Promote water resources sustainability and conservation practices 3. Promote public awareness concerning the management of water resources 4. Water resources assessments, planning, monitoring; among others.

Existing Infrastructure (water supply, sanitation, irrigation and drainage)

Description

Water Supply⁹⁷

Water is sourced primarily from surface water (rivers and springs). Water is abstracted from various intakes across Saint Lucia, goes through a treatment process and distributed to households and businesses. There are 8 intakes servicing the north of the island (from Anse la Raye to Gros Islet) and 22 intakes servicing the south of the island (from Dennerly in the east to Vieux Fort in the south and to Canaries in the west).

The John Compton Dam (JCD) located on the Roseau River is the main storage reservoir which services most of the North of the island and has a design capacity of 3 million m³ (though actual capacity is 1.5 million m³ due to siltation⁹⁸). The water from the is conveyed to the Theboalds Water Treatment Plant for treatment and then distributed across several communities in the north of the island from Bexon to Cap Estate in the extreme north.

From the total water produced by WASCO, it is estimated that 57% is used for domestic purposes (including agriculture), 17% by the hotel sector, 13% by

the commercial/industrial sector and the remaining 12% by the government (including schools and hospitals).

Three hotels in the North of the island rely on package desalination plants for their water supply. As water demand increases, driven partly by the growth in tourism, it is anticipated that some hotels will turn to package desalination plants to secure their water supply.

Sanitation⁹⁹

Sewerage coverage in St. Lucia is limited to an estimated 7% of the population. According to 2017 figures, access to improved sanitation was 88%¹⁰⁰. There are four (4) sewerage systems in St. Lucia which are operated and maintained by WASCO:

1. Castries which serves approximately 15% of greater Castries and covers the business area. The network is limited to a wastewater collection system which discharges raw sewage into the marine environment via a near shore outfall;

97 CWWA Country Profile – St. Lucia - 2019

98 Heavy siltation occurred in the JCD during the passage of hurricane Thomas in 2010

99 CWWA Country Profile – St. Lucia - 2019

100 Governance Position Paper Caribbean Water Sector – IDB – Dec 2019

2. A sewerage system which includes collection, treatment and disposal located at Rodney Bay, to the north of the Island and primarily serves residential areas and hotels. The treatment capacity of this plant is 2.4MGD and treatment is through stabilization ponds; and
3. The Emerald Development and Black Bay wastewater treatment plants. These facilities are small package treatment plants designed to support housing developments where sewage is collected, treated and discharged into the natural environment within acceptable environmental limits as outlined by the World Health Organisation (WHO).

WASCO is in the process of implementing pilot decentralized WWTPs in the form of constructed wetlands in Vieux Fort (CARIBSAN Project), with partners from Martinique where such low CAPEX & low O&M systems have successfully been implemented.

Coverage & Quality of Service

The guidelines used for both water quality and wastewater are based on the water quality guidelines established by the World Health Organisation (WHO).

Water Supply¹⁰¹

Almost 100% of Saint Lucia's population has access to potable water supplied by WASCO. Although some areas have a daily supply of water, some sections of the population which have a less frequent supply of water rely on private water storage tanks and containers to maintain service during off schedule periods. Customer service programs are available to assist customers including fault reporting to WASCO's Control Room. Social media is also used as part of customer support to keep customers informed on issues such as disruptions in service, ongoing projects and water and sewer emergencies.

According to WASCO 2015 figures¹⁰², 83% of the samples met WHO standards.

Sanitation

Whilst sewerage coverage in St. Lucia is 7% of the population, 19.2% of the population is urbanised (2017 figure) thus leading to the existence of a sewerage gap.

88% of the population has however access to improved sanitation.

Four large hotels are connected to WASCO's sewerage system, the other large hotels are equipped with package WWTPs.

The rest of the population relies on household sanitation, usually septic tank and soakaways.

Operational and Financial Performance

Operational Performance (Water Supply & Sanitation)

According to WASCO 2014 figures¹⁰³:

1. NRW = 56 % which is considered "basic" and above the regional average of 45%¹⁰⁴;
2. Staff productivity = 6.1 staff per 1,000 connections, which is considered "good" and slightly lower than the regional average of 6.8 staff per 1,000¹⁰⁵;
3. Electricity cost = 23% of OPEX which is slightly higher than the regional average of 22%¹⁰⁶;
4. Gross accounts receivable days (indicators of a utility's ability to collect from its customers) = 113 days, which is lower than the regional average of 201 days;
5. Residential Monthly Water Bill in 2016 (for 15 M3) = 16.33 USD which is lower than the regional average of 23.87 USD (for 15 m³).

There are a number of operational issues with WASCO's sewerage system, including:

101 CWWA Country Profile – St. Lucia

102 Governance Position Paper Caribbean Water Sector – IDB – Dec 2019

103 The Caribbean Water Study – IDB – Oct 2021

104 Governance Position Paper Caribbean Water Sector – IDB – Dec 2019

105 Governance Position Paper Caribbean Water Sector – IDB – Dec 2019

106 Governance Position Paper Caribbean Water Sector – IDB – Dec 2019

1. Sewerage coverage gap (see previous section);
2. High Infiltration & Inflow (I&I), especially in Castries, due a non-watertight sewer and a high water table;
3. Low connection ratio to the sewer system, and lack of enforcement of sewer connection regulations.

Financial Performance (Water Supply & Sanitation)

According to WASCO 2014 figures^{107 108}:

1. WASCO's EBITDA margin = 22% and operating cost coverage = 1.2;
2. WASCO's profitability (after interest, taxes, depreciation/ amortization) = 8%;
3. WASCO's return on assets = 5% (the calculated regional average = 2%);
4. WASCO's current ratio (measure of liquidity = current assets/current liabilities) = 1.4 (the calculated regional average = 1.3);
5. WASCO's debt service coverage ratio (measure of solvency = EBIDTA/reimbursement principal + interests) = 6.4 (the calculated regional average = 0.9);
6. WASCO's debt to equity ratio (measure of financial leverage) = 0.5.

Vulnerability to Extreme Weather Events - Adaptation & Mitigation

Like many other island nations in the Caribbean, Saint Lucia is exposed to high levels of risk from meteorological and geologic hazards which have significant negative impacts on its economic and fiscal stability. Since 2010, two major natural disasters have impacted Saint Lucia – Hurricane Tomas in 2010, resulting in losses of about 40% of GDP, and severe flooding in 2013, resulting in losses of about 8% of GDP.

In 2017, the Natural Disaster Risk Reduction Program, a joint initiative of ACP, EU, The World Bank, GDFRR aimed to analyse the impact of natural disasters on social vulnerability in Saint Lucia, in order to inform Disaster Risk Management (DRM) and other relevant strategies and policies to, in particular, better target the poor and socially vulnerable in a comprehensive DRM Program.

The adverse effects of climate change and other hazards pose a threat to WASCO's infrastructure. These hazards and climatic events include hurricanes, flooding, landslides, drought and high winds. Some of the consequences of these threats on water availability and WASCO's ability to provide potable water are:

1. High levels of sedimentation;
2. Reduced capacity of reservoir;
3. Clogging of intakes;
4. Low water level within rivers and springs;
5. Low volumes of available treated water due to longer drier spells;
6. High level of turbidity from raw water sources;
7. Damage to pumping stations and transmission lines; and
8. Loss of power to pumping stations.

¹⁰⁷ Governance Position Paper Caribbean Water Sector – IDB – Dec 2019

¹⁰⁸ The Caribbean Water Study – IDB – Oct 2021

Status of Hydrometeorological and Climate Monitoring Systems

The St Lucia Meteorological Services, established in 1987, and currently under the Ministry of Infrastructure, Ports, Transport, Physical Development and Urban Renewal, provides meteorological forecasts and services.

The Saint Lucia Meteorological Service monitors two weather stations located at the two airports on the Island. These are namely, the GFL Charles Airport and the Hewanorra Airport.

The Saint Lucia Meteorological Service classified itself as a Category 2 climate service provider offering a basic range of climate services and products, as well as, climate predictions.

The socio-economic sectors that currently benefit from climate services in Saint Lucia are the agriculture, water, disaster risk management, the health and tourism sectors, as well as the public at large.

Recommendations for improving the climate services capability of the Saint Lucia Meteorological Service include¹⁰⁹:

1. Procurement of new equipment, as well as funding for maintenance and routine replacement of equipment;
2. Training and capacity building of new and existing staff to develop new products, to produce long-range forecasts and to conduct climate impact assessments;
3. Re-establishment of the climate section with dedicated staff assigned for product development and refinement;
4. Establishment of a dedicated research division with a clear long term research strategy and strong links to established research institutions;
5. Improvement to the Met Service website; and
6. Opportunities for routine interaction climate information users.

Emergency Response Plans and Disaster Preparedness

The Disaster Management Act 2006 lays down rules for the effective management and control of disasters as well as mitigation of, preparedness for, response to, and recovery from disasters and emergencies.

The Act establishes various entities such as:

1. Cabinet Sub Committee for Disaster Management, chaired by the Prime Minister, which has overall responsibility for disaster control and management in St Lucia;
2. National Emergency Management Advisory Committee (NEMAC) responsible for advising the Committee and tendering recommendations to the Committee;
3. The National Emergency Management Office (NEMO) which is responsible for coordinating efforts related to disaster management, including preparedness, mitigation, response, and recovery;
4. The National Emergency Operation Centre (NEOC), into which NEMO transforms during an emergency. The EOC is the centre from which all commands are issued and to which all demands are made. It is the seat of control for the Prime Minister as Chairman of the EOC and as leader of the State.
5. National and District Disaster Committees, under NEMO, that are involved in the planning and response against disasters.

¹⁰⁹ <https://rcc.cimh.edu.bb/files/2018/06/Country-Profile-St-Lucia.pdf>

St Lucia has:

1. A Comprehensive Disaster Management Strategy and Programme Framework which was approved by NEMAC in 2009;
2. A National Emergency Management Plan, the revised version of which was developed by NEMO in 2011.

In 1991, the Caribbean took ownership of Disaster Management in the region through the formation of CDERA, which has since been renamed the Caribbean Disaster Emergency Management Agency (CDEMA). That same year,

four sub-regional focal points were established – Antigua and Barbuda, Jamaica, Barbados and Trinidad and Tobago. Antigua and Barbuda has focal point responsibility for Anguilla, the British Virgin Islands, Montserrat and St Kitts/Nevis.

Other focal points and their assigned islands:

1. Barbados: Dominica, St Lucia, St Vincent;
2. Trinidad: Tobago, Guyana, Grenada, Suriname;
3. Jamaica: Belize, Bahamas, Turks and Caicos and Haiti.

Asset Planning & Development

WASCO, under supervision of its line Ministry, is responsible for asset planning and renewal in the water supply and sanitation sub-sector.

If water supply coverage is close to 100%, the network is old and there is insufficient renewal of ageing water supply assets. The required minimum renewal percentage is 2% for assets with a 50 year life cycle and higher percentages are required for assets with a lower life cycle.

The above is illustrated by the following figures¹¹⁰:

1. WASCO's CAPEX per connection was on average 24 USD/c between 2011 and 2014, compared to the regional average of 184 USD/c;
2. WASCO's average CAPEX/Depreciation ratio was 0.3 between 2011 and 2014, the lowest in the region and well below the regional average of 1.6;
3. According to the same data source, WASCO's 2018 Gross Book Value (GBV¹¹¹) per customer = 2,316 USD/c (below the regional average of 3,138 USD/c) with an Accumulated Depreciation/GBV ratio¹¹² = 65% (higher than the regional average of 43%).

There is therefore need for significant investments in water supply system renewal/upgrades.

As previously mentioned, there is a gap in sewerage coverage as 7% only of the population is sewered whilst the urbanization ratio is 19.2%¹¹³. Important investments are thus required to close that gap.

Investments are also required in:

1. Low cost, low maintenance decentralized WWTPs such as constructed wetlands (pilot projects underway in Vieux Fort);
2. Upgrade of private package WWTPs (mostly large hotels);
3. Household sanitation system upgrades (including for example systematic installation of coconut chip filters after the septic tank) to mitigate aquifer contamination.

It is noteworthy mentioning that WASA does not have an up-to-date Master Plan nor Strategic Plan. Reportedly, WASCO will be initiating such plans in 2024.

¹¹⁰ Governance Position Paper Caribbean Water Sector – IDB – Dec 2019

¹¹¹ GBV per customer = indicator which provides a measure of the value of fixed assets relative to the number of customers

¹¹² Accumulated Depreciation / GBV = indicator which provides a measure of the extent to which a water utility's fixed assets have deteriorated

¹¹³ Refer to Section 4

Historical Investments by Subsector

WASCO has initiated a number of projects including:

1. Castries Sewer Expansion: Designs underway including a new WWTP (3 MUSD);
2. The replacement of 5km of the DN600 raw water pipeline from the John Compton dam to the Vanard Booster Station which was launched in 2023 (design phase underway). Funding CDB (10 MUSD);
3. Micoud Water Supply Project (East Coast): Design and construction of an intake + pump station + package WTP + storage tanks + distribution mains. Funding CARICOM Development Fund (< 1 MUSD);

4. Extension 2 km of DN 500mm main in the North. (< 1 MUSD).

There is reportedly another project in the pipeline for which financing has not yet been arranged:

Greater Micoud Water Supply Project: Design and construction of an intake + pump station + WTP (13,600 m³/day) + storage tanks + distribution mains (3 MUSD).

Saint Vincent and the Grenadines

Legal, Institutional & Regulatory Landscape

The Central Water and Sewerage Authority is the agency responsible for the abstraction, treatment and distribution of potable water for domestic, commercial and institutional uses. It was established as a statutory body of the Ministry of Health in 1991, by the passing of the Central Water and Sewerage Authority Act (chapter 403). The Act also assigns to the CWSA the responsibility for the investigation and utilization of surface water and groundwater on a national scale. In addition to potable water supply, the CWSA is responsible for the disposal of sewage and solid waste and the maintenance of the nation's hydrometric network.

The Public Health Department of the Ministry of Health and the Environment is responsible for the quality of water distributed for human use. The Department is also responsible for monitoring and regulating the quality of seawater for recreational use and the effluents of the sewerage systems. The functions of the Department are governed by the Environmental Health Services Acts (Chapter 285) passed in 1991 and the Public Health Act of 1977.

Legislation was passed in 2004 to establish a National Irrigation Authority, under the Ministry of Agriculture, Forestry, Fisheries, Rural Transformation, Industry, and Labour, with the main responsibility of managing the distribution of water to farmers.

The National Emergency Management Organisation (NEMO), under the under the Ministry of National Security, Air & Sea Port Development, is responsible for coordinating efforts related to disaster management, including preparedness, mitigation, response, and recovery. The National Emergency Disaster Management Act (2006) is the primary legislation governing disaster management in St. Vincent and the Grenadines.

Water Resources Management

Several streams and some rivers traverse the island of St. Vincent. Due to general orographic and geological characteristics of the island, these streams are short and steep in their upper parts, flowing into deep gorges. The lower part of main rivers broadens into small delta shaped alluvial plains.

The largest rivers are the Colonaire, Buccament, Rabacca, Richmond, Wallilabou and Cumberland. The latter is used for the most important hydropower generation plant in St. Vincent. Rivers are perennial in the central and southern portion of the island, whilst streams in the North are mostly seasonal.

In the Grenadines, there are several streams, which flow mainly during the rainy season. Thus, these streams are not considered suitable for potable water supply and the population in the Grenadines rely on rainwater harvesting and boreholes for their water supply.

In 2008 the CWSA added a Water Resources Management Unit (WRMU) to its Engineering Department following the completion of a European Union funded project intended to produce a strategy for optimal and sustainable allocation of water resources in the state. A fairly robust hydrological network was established and completed with the help of

other agencies (e.g. UNDP) and comprises of 26 rain gauges, 10 water level sensors, five climate stations, 26 groundwater sampling points and 21 flow measuring stations.

A wide range of parameters are recorded within the monitoring network including rainfall, evaporation, relative humidity, solar radiation, barometric pressure, wind speed, maximum and minimum temperature, soil temperature, water level, conductivity, pH, water density and oxygen content.

There is no single entity that manages water resources in St. Vincent and the Grenadines which results in the different organisations acting independently and with different and competing objectives. This makes managing the nation's water resources more difficult. For example, is difficult to quantify the percentage of water presently allocated to the different stakeholders which affects forward planning in the sector. There is therefore the need for a more comprehensive national strategy which seeks to resolve issues such as right of access, monitoring and control and the financial responsibility for maintaining and upgrading the hydrometric network. Legislation is in draft to establish an independent National Water Resource Authority but is yet to be finalized and passed¹¹⁴.

Existing Infrastructure (water supply & sanitation)

Description

Water Supply¹¹⁵

The CWSA's water supply comes from rainfall catchments and small springs and streams. There are some twenty-three (23) intakes feeding sixteen (16) networks. Currently, the CWSA supplies water to over 37,500 domestic consumers and 1,320 industrial and commercial businesses. The CWSA estimates that about ninety percent (90%) of householders are connected to its water

supply system. In addition, water is sold to cruise ships and other small yachts and vessels, although this amounts to less than one percent of the water supply. The total water production for 2018 was 1.94 billion imperial gallons (24,000 m³/day).

All of the water systems are gravity fed with surface water; there is no well water, except for a few areas in the Grenadines. In the larger water treatment plants, the treatment process consists of sedimentation, filtration and disinfection. In the smaller water treatment

¹¹⁴ CWWA Country Profile – St. Vincent and the Grenadines – 2019

¹¹⁵ CWWA Country Profile – St. Vincent and the Grenadines – 2019

plants, disinfection is systematically practiced but not sedimentation/filtration and there is definitely scope for process improvement. The groundwater resources of the country have not been fully investigated for quantity or quality and are not currently part of CWSA's future development programme.

The CWSA has not yet implemented supply systems in the Grenadines. There, the few inhabitants have developed private schemes, mostly relying on rainwater harvesting and boreholes. However, during the dry season, the water supply in the Grenadines is severely affected and the CWSA provides relief by trucking water to some of the islands. Private contractors also purchase water from the main island and resell to residents and businesses in the Grenadines on demand. The CWSA is now pursuing the development of desalination systems in the Grenadines in order to achieve a more continuous supply.

Though the total length of the distribution network has not been communicated, the network combines old (1950s) and new mains with diameters comprised between DN50mm to DN400mm. New mains with DN $\geq$ 100mm are mostly ductile iron (DI) pipes (due to high prevailing network pressures) and older galvanised steel (GI) pipes with DN < 100mm are being gradually replaced with HDPE pipes.

CWSA has reportedly achieved universal metering though the meter park is ageing and comprises mostly of mechanical meters, which, in some instances, can be prone to blockages and meter under registration (due to age and water quality issues, though water quality has improved over the years). CWSA is contemplating gradually replacing its mechanical meters with static (Smart) meters which are full bore meters which do not record air and which are equipped with the latest communication devices/protocols.

Sanitation¹¹⁶

The sewerage network exists only in central area of the capital city of Kingstown and a very small section of the suburban Arnos Vale community. There are 300 sewerage connections in Kingstown and just 40 connections in Arnos Vale (2019 figures).

Most of the houses and buildings in the state are still served by septic tanks. Wastewater from the sewerage

network in Kingstown is collected and pumped offshore at a distance and depth adjudged to be sufficient for adequate dilution. The effluent from the Arnos Vale network is treated by a tile-field septic system.

Local standards with regard to wastewater discharge are currently being considered as the country's economic strategy seeks to maximize the extensive marine resources within its territorial waters in keeping with the concept of developing a 'Blue Economy'. As such, the Ministry of Finance and Economic Planning is spearheading an initiative to establish policies and legislation to govern wastewater discharge throughout the state.

Coverage & Quality of Service

Water Supply¹¹⁷

As per CWSA 2018 estimates, water supply coverage was 90% though the main challenge in the potable water delivery is to implement a strategy to provide a more consistent water supply to the smaller Grenadine islands where perennial streams are non-existent.

The CWSA is currently pursuing the option of desalination but issues such as cost of supply and addressing the impact of increased grey water runoff on the fragile coastal environment of these islands are yet to be fully reviewed and resolved.

Sanitation

As per CWSA 2019 figures, sewerage coverage is low at approximately 1%. As 54.3% of the population was urbanised in 2021, there is a significant sewerage gap that will require significant investments to bridge.

Data on I&I levels within the sewerage system have not been communicated.

As previously mentioned, there is no WWTP and untreated sewage is pumped offshore via an outfall where it undergoes dilution. The operational status and efficiency of this outfall is unknown.

¹¹⁶ CWWA Country Profile – St. Vincent and the Grenadines – 2019

¹¹⁷ CWWA Country Profile – St. Vincent and the Grenadines – 2019

Operational and Financial Performance

Operational Performance (Water Supply & Sanitation)

According to CWWA data¹¹⁸, NRW = 11%. This is a surprisingly low NRW figure and during subsequent interviews, the updated NRW figure of 40% was mentioned. The latter figure seems more realistic given the NRW challenges faced by CWSA (ageing network, high pressures, etc.) and the regional NRW average of 45%. It is worthwhile noting that the best performing utility in the Caribbean Region (BWS, Belize) has a NRW figure of 25%¹¹⁹.

Financial Performance (Water Supply and Sanitation)¹²⁰

Following an island wide metering system of most domestic and commercial customers, the CWSA achieved financial sustainability in 1988 and has managed to derive a surplus from its revenues ever since. Production costs are low because of CWSA's reliance on simple treatment of mountain stream water and gravity distribution. The current billing system

charges all domestic consumers a fixed monthly basic charge, a portion of which is an environmental levy for the management of solid waste. In addition to this fixed charge, consumers pay for the water consumed on a tiered system, where the higher the consumption bands the higher the unit cost. Commercial customers are also required to pay a basic charge and a fixed consumption fee per unit based on the size of their business.

Domestic and commercial sewerage customers are charged fixed monthly rates in three different categories respectively. Commercial enterprises are expected to outsource the collection of their solid waste to private contractors but are charged a fixed rate for accessing the disposal services offered by the CWSA at the landfills.

Most government accounts are not metered as these institutions do not pay directly for water consumption, sewerage and solid waste services. Instead the government makes an annual payment to the authority to cover the cost of providing these services to all state-owned schools, administrative centers, medical facilities and other government institutions.

Vulnerability to Extreme Weather Events - Adaptation & Mitigation

Like many other island nations in the Caribbean, St Vincent & the Grenadines is highly susceptible to the impacts of extreme weather events. Its geographical location in the hurricane-prone Atlantic Basin, coupled with factors such as topography, population density, and socio-economic conditions, make it particularly vulnerable to hurricanes, tropical storms, and other climate-related disasters.

In April 2021, the La Soufrière volcano erupted several times with "explosive events" continuing. By 12 April, 16,000 residents had evacuated the area. Assistance and emergency financial support was being provided by several

nearby islands, the United Kingdom, and agencies such as the United Nations. The first significant offer of long-term funding, of US\$20 million, was announced on 13 April 2021 by the World Bank.

The most costly hazard events in St Vincent and the Grenadines (SVG) resulted from Hurricane Tomas in 2010, which cost about EC\$130 million and the 2013 flood in December 2013 which resulted in damage and losses of US\$ 108.4 mil or (EC\$291.4 million). The cost of the 2013 flood is equivalent to 15% of the country's gross domestic product (GDP), (GOVSVG, 2014).

118 CWWA Country Profile – St. Vincent and the Grenadines - 2019

119 Governance Position Paper Caribbean Water Sector – IDB – Dec 2019

120 CWWA Country Profile – St. Vincent and the Grenadines - 2019

Status of Hydrometeorological and Climate Monitoring Systems

The Saint Vincent and the Grenadines Meteorological Services, established in 1960, is currently attached to the Aviation Services Department, under the Ministry of National Security, Air and Sea Port Development.

The St. Vincent and the Grenadines Meteorological Service operates the weather station located at the ET Joshua Airport and monitors the rainfall of at least 7 locations on the island of St. Vincent.

As of September 2015, the St. Vincent & the Grenadines Meteorological Office (SVGMO) categorised itself as a Category 2 climate services provider offering a basic range of climate services and products, as well as, climate predictions. The SVGMO provides a monthly weather bulletin, an Agro-Meteorological Bulletin, seasonal rainfall, temperature and drought outlooks, a drought and precipitation statement and wet and extremely wet spells outlooks.

SVGMO recommendations for improving its climate services capability include¹²¹:

1. Building the capacity of the SVG Met Office to be able to provide its own national forecast as an independent forecasting office;
2. Expansion of the observation network with more field equipment to measure a wider range of climatic parameters. In this regard, the setup of the recently acquired equipment at the new airport is desired. New parameters to be measured including soil temperature, solar radiation and sunshine hours;
3. Conducting routine assessments of the network;
4. Increasing routine interaction/feedback between the met office and users of climate information feedback with users as well as greater collaboration needed with sectoral users to better ascertain their needs;
5. A dedicated research division with a clear long-term strategy, funding to conduct research, and also the capacity to establish collaborative relationship with tertiary institutions for the conduct of applied research;
6. Training and capacity building in the development of climate products, as well as, the interpretation of climate information; and
7. Setting up a dedicated website.

Emergency Response Plans and Disaster Preparedness

The National Emergency and Disaster Management Act 2006 lays down rules for the effective management and control of disasters as well as mitigation of, preparedness for, response to, and recovery from disasters and emergencies.

The Act establishes various entities such as:

1. National Emergency Council, chaired by the Prime Minister, which has overall responsibility for disaster control and management in St Vincent;
2. The National Emergency Executive Committee (NEEC), which reports to the Council and which is responsible for coordinating efforts related to disaster management, including preparedness, mitigation, response, and recovery. The NEEC has established subcommittees to execute/manage various functions under the purview of the NEEC;

¹²¹ <https://rcc.cimh.edu.bb/files/2018/06/Country-Profile-St.-Vincent-and-the-Grenadines.pdf>

3. The National Emergency Operation Centre (NEOC), which is activated during an emergency. The NEOC is the centre from which all commands are issued and to which all demands are made. It is the seat of control for the Prime Minister as Chairman of the NEOC and as leader of the State;
4. District Disaster Management Committees, under NEMO, that are involved in the planning and response against disasters.

St Vincent has:

5. A Comprehensive Disaster Management Policy (2014);
6. A National Disaster Plan, the revised version of which was developed by NEMO in 2005.

In 1991, the Caribbean took ownership of Disaster Management in the region through the formation of CDERA, which has since been renamed the Caribbean Disaster Emergency Management Agency (CDEMA). That same year, four sub-regional focal points were established – Antigua and Barbuda, Jamaica, Barbados and Trinidad and Tobago.

Antigua and Barbuda has focal point responsibility for Anguilla, the British Virgin Islands, Montserrat and St Kitts/Nevis.

Other focal points and their assigned islands:

1. Barbados: Dominica, St Lucia, St Vincent;
2. Trinidad: Tobago, Guyana, Grenada, Suriname;
3. Jamaica: Belize, Bahamas, Turks and Caicos and Haiti.

Asset Planning & Development

CWSA, under supervision of its line Ministry, is responsible for asset planning and renewal in the water supply and sanitation sub-sector.

If water supply coverage is close to 90%, the Grenadines lack a proper water supply system, the network is old and there is insufficient renewal of ageing water supply assets (the required minimum percentage is 2% for assets with a 50-year life cycle and higher percentages are required for assets with a lower life cycle). Reportedly, annual CWSA investments in asset expansion and renewal does not exceed 1.5 MUSD/year which is below the 2% threshold¹²².

CWSA is also considering the refurbishment of some of its larger and smaller water treatment plants (between three and five) to introduce a full treatment process including sedimentation, settling and disinfection (chlorination).

There is therefore need for significant investments in water supply system renewal/upgrades. NRW management and reduction is also high on CWSA's agenda including network zoning, pressure management, leakage management, network renewal and the gradual replacement of the ageing mechanical water meters with static meters.

¹²² Consultant's gross estimate of CWSA's water assets Gross Book Value (GBV) = 35,000 customers x 3,200 USD/customer (average Caribbean - IDB 2019 figure) = 112 MUSD. Thus, yearly CWSA CAPEX of 1.5 MUSD/year represents 1.3% of GBV estimates.

There is a significant gap in sewerage coverage as 1% only of the population is sewered whilst the urbanization ratio is 54.3%. Significant investments are thus required to close that gap though there are currently no significant wastewater projects in CWSA's investment pipeline.

Investments in household sanitation system upgrades (including for example systematic installation of coconut chip filters after the septic tank) are also required to mitigate aquifer and surface water contamination. This will be particularly relevant for the Grenadines after the future implementation of water supply systems (based on package desalination plants and associated water networks) and the consequential increase of effluent flows (both black and grey water) from customer premises.

