Caribbean Water Study

Water and Sanitation Division

Authors:
Nils Janson
Lindsay N. Burkhard
Sara Jones

Editors:
Evan S. Cayetano
Corinne Cathala

TECHNICAL NOTE Nº
IDB-TN-2320

November 2021

Inter-American Development Bank

Caribbean Water Study

Authors:
Nils Janson
Lindsay N. Burkhard
Sara Jones

Editors:
Evan S. Cayetano
Corinne Cathala

Inter-American Development Bank
Water and Sanitation Division

November 2021

Cataloging-in-Publication data provided by the
Inter-American Development Bank
Felipe Herrera Library
Janson, Nils.
Caribbean water study / Nils Janson, Lindsay N. Burkhard, Sara Jones; editors, Evan S. Cayetano, Corinne Cathala.
p. cm. — (IDB Technical Note; 2320)
1. Water utilities-Caribbean Area. 2. Sanitation-Caribbean Area. 3. Coronavirus infections-Caribbean Area. I. Janson, Nils. II. Burkhard, Lindsay N. III. Jones, Sara. IV. Cayetano, Evan S., editor. V. Cathala, Corinee, editor. VI. Inter-American Development Bank. Water and Sanitation Division. VII. Title. VIII. Series.
IDB-TN-2320

Keywords: Caribbean water study, Caribbean water and sanitation, Caribbean water utilities

JEL Codes: Q25, Q54

http://www.iadb.org

K&M ADVISORS
a Dorado Group Company

Caribbean Water Study

October 2021

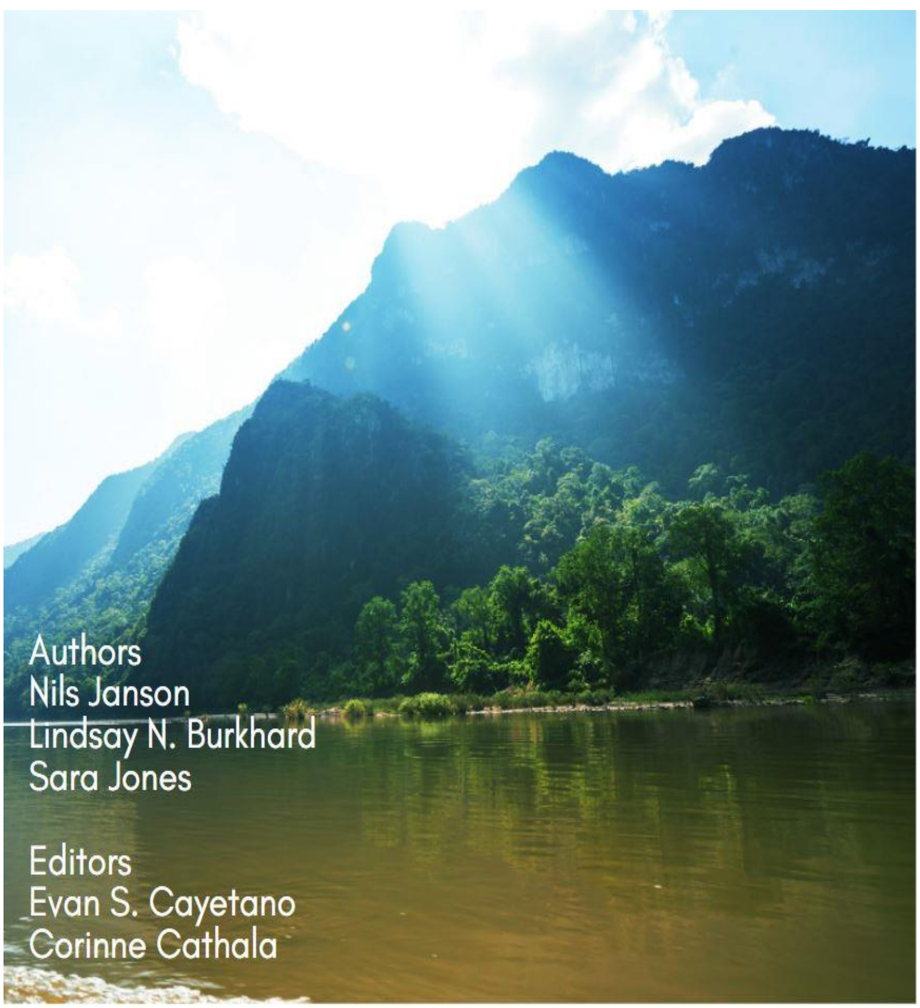


Table of Contents

K&M ADVISORS
a Dorado Group Company

Appendices

List of Tables

List of Figures

List of Boxes

Acronyms and Abbreviations

APUA	Antigua & Barbuda Public Utilities Authority
AQUA	Curacao Water Company
BWA	Barbados Water Authority
BWS	Belize Water Services
CAPEX	Capital Expenditures
CARICOM	Caribbean Community
CARILEC	Caribbean Electric Utility Services Corporation
CAWASA	Caribbean Water and Sewerage Association Inc.
CCCCC	Caribbean Community Climate Change Centre
CDB	Caribbean Development Bank
CREAD	Climate Resilience Execution Agency of Dominica
CCRIF	Caribbean Catastrophe Risk Insurance Facility
CWSA	Central Water and Sewerage Authority, St Vincent & the Grenadines
CWUIC	Caribbean Water Utility Insurance Company
CWWA	Caribbean Water and Wastewater Association
DNWS	Decentralized Nonpotable Water Systems
DOWASCO	Dominica Water and Sewerage Company
EBITDA	Earnings before interest, tax, depreciation, and amortization
EIB	European Investment Bank
EU	European Union
FEMA	Federal Emergency Management Agency
GDP	Gross Domestic Product
GIZ	Gesellschaft für Internationale Zusammenarbeit
GWI	Guyana Water Incorporated
GWP	Global Water Partnership
ICT	Information and Communications Technology
IDB	Inter-American Development Bank
IDB Invest	Inter-American Investment Corporation
IFI	International Financial Institutions
IPCC	Intergovernmental Panel on Climate Change
LAC	Latin America and the Caribbean

NAWASA	National Water and Sewerage Authority, Grenada
NGO	Non-Governmental Organization
NWC	National Water Commission, Jamaica
OPEX	Operating Expenses
PPE	Plant, Property and Equipment
PRASA	Puerto Rico Aqueducts and Sewers Authority
RSAP	Regional Strategic Action Plan
RLSF	Regional Liquidity Support Facility
SOP	Standard Operating Procedure
SWM	N.V. Surinaamsche Waterleiding Maatschappij
TBD	To be determined
VIWAPA	The U.S. Virgin Islands Water and Power Authority
WAC	Water Authority Cayman Islands
WARN	Water/Wastewater Agency Response Network
WASA	Water and Sewerage Authority Trinidad and Tobago
WASCO	Water and Sewerage Company Saint Lucia
WEBA	Water and Energy Company Aruba
WGS	Water Guaranteed Standards
WSC	The Water & Sewerage Corporation of the Bahamas
WTP	Wastewater Treatment Plant

1 Introduction

The Inter-American Development Bank (IDB) is a champion of the Regional Strategic Action Plan for Governance and Building Climate Resilience in the Water Sector in the Caribbean (RSAP). In support of the implementation of the RSAP, the IDB has contracted K&M to provide a report for publication on water utilities in the Caribbean. This report will serve as a reference document and as a key guide for prioritizing improvements needed by water utilities in the Caribbean. This report includes benchmarking of the key operational and financial indicators for a number of water utilities in the Caribbean using the most current data available, exploring the scope of benefits of implementing Non-Revenue Water (NRW) reduction projects, assessing the impact of COVID-19 on the water utilities, and identifying levels of resilience to natural disasters. This section provides high level summaries from the report, including an:

- Overview of the results of the benchmarking of water utilities in the Caribbean (Section 1.1)
- Brief on one of the biggest challenges for water utilities in the Caribbean: Non-Revenue Water (NRW) (Section1.2)
- Summary of the impacts of COVID-19 on water utilities in the Caribbean (Section 1.3)
- Overview of the levels of resilience of water utilities in the Caribbean (Section 1.4)
- Information gaps for water utilities in the Caribbean (Section 1.5)
- Structure of the report (Section 1.6).

1.1 Overview of the results of the benchmarking of water utilities in the Caribbean

Benchmarking the key performance indicators for water utilities in the Caribbean shows how utilities are performing in relation to their peers across time. Eleven water utilities in the Caribbean were included in this study, each from a separate jurisdiction. Figure 1.1 presents the Caribbean jurisdictions included in the benchmarking.

Figure 1.1: Countries Included in the Benchmarking

1.1.1 Water utilities included in the benchmarking

While all utilities that were contacted for the purposes of the benchmarking received the same data requests, the information provided by the utilities varied widely. In general, those utilities that provided more and better data perform better. Table 1.1 identifies the 11 water utilities included in the study and presents key attributes including information regarding service provision, annual revenues, number of water customers, and volumes of water billed. Apart from BWS, all water utilities are 100 percent government owned.[1]

Table 1.1: Utilities Included in the Benchmarking

Utility	Jurisdiction	Sole Provider of Piped Water	Annual Revenues in USD million	Number of Water Customers	Annual Volume of Water Billed in m3 x '000
WSC (2015)	Bahamas	No	46	59,001	14,343
BWA (2018)	Barbados	Yes	66	110,855	144,128

1 The Government of Belize (GOB), the majority shareholder, owning approximately 82.6% of the total shares in BWS; the Social Security Board holds 10% and minority shareholders the remainder. Accessed on 2 March 2021, retrieved from: https://www.bws.bz/about.html.

BWS (2020)	Belize	No	25	62,104	12,595
WAC (2019)	Cayman	No	42	N/A	N/A
DOWASCO (2020)	Dominica	Yes	8	23,821	6,138
NAWASA (2018)	Grenada	Yes	13	N/A	N/A
GWI (2020)	Guyana	Yes	37	174,496	52,000
NWC (2020)	Jamaica	No	218	380,478	79,600
WASCO (2016)	Saint Lucia	Yes	21	47,917	8,456
SWM (2017)	Suriname	No	19	131,711	28,442
WASA (2020)	Trinidad and Tobago	Yes	104	387,178	187,656

Source: K&M's Caribbean Water Utility Database

Below, we present the utilities included in the benchmarking:

Water and Sewerage Corporation (WSC)

WSC is a wholly government-owned water utility in the Bahamas. WSC has 59,001 water connections. In 2015, WSC had USD46 million in annual revenue and a volume of 14 million cubic meters in water billed.

In 2015, WSC had an EBITDA margin of negative 46 percent, a net income margin of negative 80 percent and a return on assets of negative 11 percent. In 2015, WSC reported NRW at 37 percent (equivalent to 391 liters per connection per day) and had 7.4 staff per 1,000 water connections. WSC did not provide information on quality of service.[2]

Barbados Water Authority (BWA)

BWA is the sole water utility in Barbados. The wholly government-owned water utility has 110,855 water connections. In 2018, BWA had USD66 million in annual revenue and a volume of 144 million cubic meters in water billed.

In 2018, BWA had an EBITDA margin of 16 percent, a net income margin of negative 11 percent and a return on assets of negative 2 percent.[3] In 2018, BWA had 6.7 staff per 1,000 water connections and a reported NRW of 45 percent. BWA did not provide information regarding quality of service.

Belize Water Services Limited (BWS)

BWS is a majority government-owned water utility in Belize. BWS has 62,104 water connections. In 2020, BWS had USD25 million in annual revenue and a volume of 12 million cubic meters in water billed.

In 2021, BWS had an EBITDA margin of 34 percent, a net income margin of 7 percent and a return on assets of 1 percent. In 2021, BWS reported NRW of 20 percent (equivalent to 113 liters per

[2] Information publicly available for WSC.

[3] Information provided by BWA.

connection per day), 4.4 staff per 1,000 water connections. In 2019, BWS reported 23.98 hours of continuity of service per day and 99 percent of water tests passed quality standards.[4]

The Water Authority of the Cayman Islands (WAC)
WAC is a wholly government-owned water utility in the Cayman Islands. In 2019, WAC had USD42 million in annual revenue.

In 2019, WAC had an EBITDA margin of 33 percent, a net income margin of 26 percent and a return on assets of 9 percent. Information regarding NRW, staff per 1,000 water connections, and quality of service is not publicly available.

Dominica Water and Sewerage Company Limited (DOWASCO)
DOWASCO is the sole water utility in Dominica. The wholly government-owned water utility has 23,821 water connections. In 2020, DOWASCO had USD8 million in annual revenue and a volume of 6 million cubic meters in water billed.

In 2020, DOWASCO had an EBITDA margin of 25 percent, a net income margin of negative 11 percent and a return on assets of negative 1 percent. In 2019, DOWASCO had an estimated NRW of 53 percent (equivalent to 744 liters per connection per day) and 6.7 staff per 1,000 water connections. DOWASCO did not provide information regarding qualify of service.[5]

National Water and Sewerage Authority (NAWASA)
NAWASA is the sole water utility in Grenada. In 2018, NAWASA had USD13 million in annual revenue.

In 2018, NAWASA had an EBITDA margin of 19 percent, a net income margin of 22 percent and a return on assets of 7 percent. In 2018, NAWASA reported NRW of 26 percent and 5.3 staff per 1,000 water connections.[6] NAWASA did not provide information regarding quality of service.

Guyana Water Incorporated (GWI)
GWI is the sole water utility in Guyana. The wholly government-owned water utility has 174,496 water connections. In 2020, its annual revenue was USD37 million.

In 2020, GWI had an EBITDA margin of 11 percent, a net income margin of 8 percent and a return on assets of 2 percent. In 2020, GWI had 7.1 staff per 1,000 water connections[7] and reported NRW of 68 percent (equivalent to 1,740 liters per connection per day).[8] GWI did not provide information regarding quality of service.

National Water Commission (NWC)
NWC is the largest water utility in Jamaica. The wholly government-owned water utility has 380,478 water connections. In 2020, NWC had USD218 million in annual revenue and a volume of 80 million cubic meters in water billed.

---

4 Information provided by BWS.

5 Information provided by DOWASCO.

6 Information provided by NAWASA.

7 Information publicly available for GWI.

8 Thornton, J., Aguiar, M., Wyatt, A., "NRW Training Modules: Regional strategic action plan for governance and building climate resilience in the water sector in the Caribbean" October 2020.

In 2020, NWC had an EBITDA margin of negative 2 percent, a net income margin of negative 19 percent and a return on assets of negative 7 percent. In 2021, NWC reported NRW of 73 percent (equivalent to 1,729 liters per connection per day) and 4.8 staff per 1,000 water connections.

Water and Sewerage Company (WASCO)
WASCO is the sole water utility in St. Lucia. The wholly government-owned water utility has 47,917 water connections. In 2016, WASCO had USD21 million in annual revenue and a volume of 8 million cubic meters in water billed.

In 2016, WASCO had an EBITDA margin of 22 percent, a net income margin of 8 percent and a return on equity of 5 percent.[9] In 2014, WASCO reported NRW of 56 percent (equivalent to 314 liters per connection per day) and 6.1 staff per 1,000 water connections. WASCO did not provide data regarding qualify of service.[10]

Surinaamsche Waterleiding Maatschappij (SWM)
SWM is the sole water utility in Suriname. The wholly government-owned water utility has 131,711 water connections. In 2017, SWM had USD19 million in annual revenue and a volume of 28 million cubic meters in water billed.

In 2017, SWM had an EBITDA margin of 12 percent, a net income margin of negative 4 percent and a return on assets of negative 1 percent. In 2019, SWM reported NRW of 31 percent (equivalent to 241 liters per connection per day) and 6.5 staff per 1,000 water connections.[11]

Water and Sewerage Authority (WASA)
WASA is the sole water utility in Trinidad and Tobago. The wholly government-owned water utility has 387,178 water connections. In 2020, WASA had USD104 million in annual revenue and a volume of 187 million cubic meters in water billed.

In 2020, WASA had an EBITDA margin of negative 237 percent, a net income margin of negative 111 percent and a return on assets of negative 6 percent. In 2020, WASA reported an NRW of 50 percent (equivalent to 1,331 liters per connection per day) and 12.5 staff per 1,000 water connections. WASA did not provide information regarding qualify of service.[12]

1.1.2 Key Findings of the Benchmarking

There is a wide range of performance across water utilities in the Caribbean. The benchmarking study considered four major performance areas:

- **Access to water and wastewater service:** In the Caribbean, access to piped water is high, but access to sewerage connection is low. The percent of wastewater that is treated in the Caribbean is even lower.

[9] Burdescu, R.; van den Berg, C.; Janson, N.; Alvarado, O., 2020. A Benchmark for the Performance of State-Owned Water Utilities in the Caribbean. Development Knowledge and Learning; Washington, DC: World Bank. Retrieved from: https://openknowledge.worldbank.org/handle/10986/33251?locale-attribute=es

[10] Information publicly available for WASCO.

[11] Thornton, J., Aguiar, M., Wyatt, A., "NRW Training Modules: Regional strategic action plan for governance and building climate resilience in the water sector in the Caribbean" October 2020.

[12] Information provided by WASA.

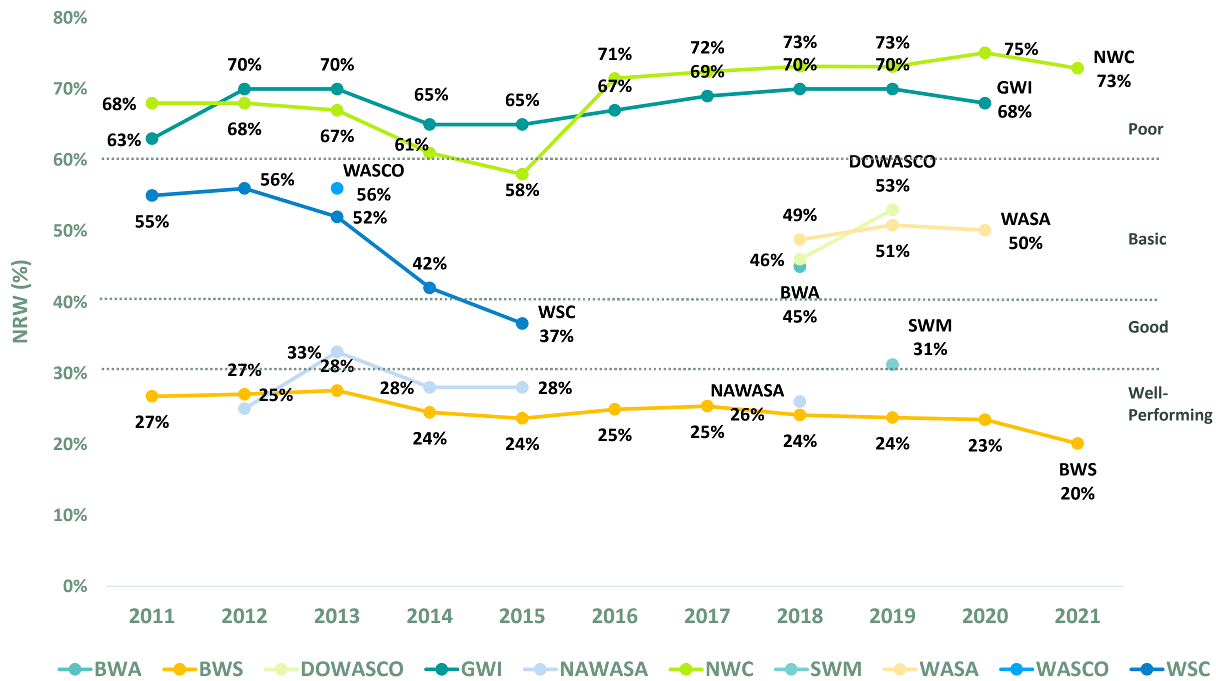
- **Quality of Service:** Generally, the quality of services provided, such as continuity of service and the quality of water supplied by water utilities in the Caribbean is low. BWS reported high quality of service in 2019. While SWM and NWC provided some recent quality of service information, no other water utilities provided this information. This indicates that most water utilities included in the benchmarking may not place sufficient emphasis on quality of service.
- **Financial Performance:** Profitability and financial capacity are low for most water utilities included in the benchmarking. Many utilities in the benchmarking have EBITDA margins well below what is required for financial sustainability. EBITDA margins for the benchmarked utilities ranged from -237 to 34 percent. Seven of the 11 utilities had EBITDA margins at or below 19 percent, of which three were negative. It is commonly accepted that a well-performing water utility has an EBITDA margin above 30 percent. The main reasons for the inadequate levels of EBITDA margins are that operating efficiency needs to be increased and tariffs are below cost recovery levels.
- **Operating Efficiency:** In general, most water utilities in the Caribbean have scope to improve their operating efficiency. Non-Revenue Water (NRW), one key indicator of operating efficiency, for the benchmarked utilities ranges from 20 to 75 percent in the study. For the utilities included in the benchmarking, the average percent of NRW is estimated at 46 percent (equivalent to an average of 825 liters per connections per day). It is commonly accepted that a well-performing water utility should have NRW below 30 percent. Some reasons for the high levels, and estimates, of NRW in the Caribbean are the lack of required resources, incentives, proper operational practices, specialized knowledge, and information necessary to address NRW.

1.2 Brief on one of the biggest challenges for water utilities in the Caribbean: Non-Revenue Water (NRW)

Non-revenue water (NRW)—the difference between the amount of water that enters the distribution system and the amount of water billed to consumers[13]—is simultaneously one of the most pervasive challenges for water utilities in the Caribbean and one of the most direct ways to improve a utility's efficiency, financial performance, and quality of service. In addition, reducing NRW contributes significantly to climate change adaptation. Figure 1.2 shows that most utilities in the Caribbean have NRW levels over 40 percent (in some cases as high as 75 percent). Well-structured NRW reduction projects, with support from governments and international financial institutions, can bring substantial benefits to utilities, customers, governments, the environment, and society as a whole.

[13] IWA, accessed on 16 February 2021 from: https://iwa-network.org/projects/performance-based-contracts-for-non-revenue-water-market-development/

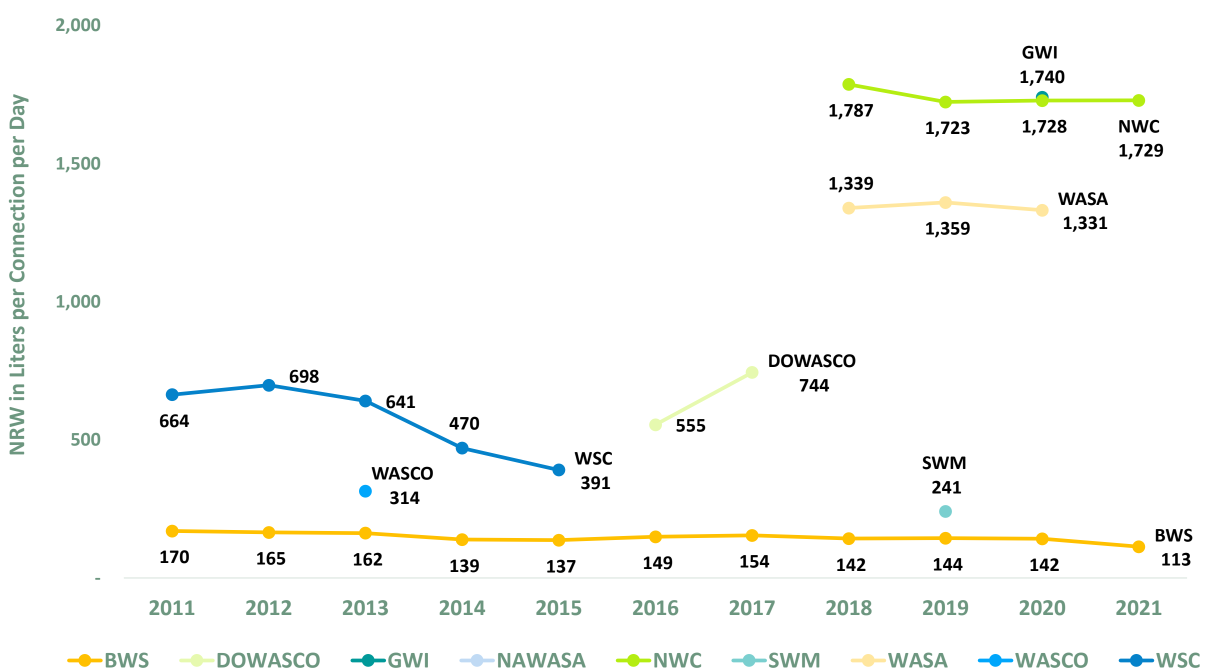
Figure 1.2: NRW for Water Utilities from 2011 to 2021 in Percent



Source: Information provided by utilities.

In addition, Figure 1.3 presents the level of NRW for each utility in liters per connection per day for the utilities for which we have this information.

Figure 1.3: NRW for Water Utilities from 2011 to 2021 in Liters per Connection per Day



Source: Information provided by utilities.

1.3 Summary of the impacts of COVID-19 on water utilities in the Caribbean

COVID-19 has impacted the financial and operational performance of water utilities in Latin America and the Caribbean (LAC). We surveyed 11 water utilities from 9 countries in LAC to identify the impacts of COVID-19 on consumption, water supplied, NRW, average tariffs, revenues, collections, OPEX, profitability, liquidity, and CAPEX.

Based on the evidence from the surveyed utilities, total consumption increased in most Caribbean utilities. Residential consumption increased for all Caribbean utilities for which we have relevant data, but in most cases these increases were offset by large decreases in non-residential consumption. Overall, these changes in consumption patterns led to an increase in the residential share of demand. Due to the large decreases in non-residential consumption, most utilities registered a fall in revenues and in average tariffs. All the utilities surveyed also registered a decrease in collections, while the impact on liquidity varied among them.

The Caribbean utilities surveyed, also had decreases in profitability as measured by EBITDA and net income, which are due to the decreases in revenues. On average, both Caribbean and Latin American utilities registered decreases in OPEX. However, these reductions in OPEX are not the result of improved efficiency, but, rather, results of the utilities foregoing essential activities such as repair and maintenance of their assets. The CAPEX for most Caribbean utilities surveyed also decreased, which, together with the reductions in OPEX, may deteriorate operating efficiency, quality of service and access.

1.4 Overview of the levels of resilience of water utilities in the Caribbean

The Caribbean is one of the most vulnerable regions in the world to natural disasters.[14] Water utilities, which already face financial constraints, have faced tremendous losses in recent decades due to high intensity hurricanes and other natural disasters. A hurricane can cause tens of millions of dollars in damages to utilities, including damages to physical assets and losses due to business interruptions. This poses a threat to people's access to water (at a time of particular need) and to the water and sanitation sector as a whole. Due to the small size and limited resources of water utilities, it is difficult for them to recover from the devastation of a storm on their own. The impact of natural disasters on utilities in recent decades reveal the importance of post-disaster response, natural disaster preparedness, investments to increase resiliency, and access to funds. Many utilities do not have insurance for natural disasters, which limits their ability to recover their losses in the aftermath of a storm and constrains their financial resilience to natural disasters.

1.5 Information Gaps for Water Utilities in the Caribbean

Many water utilities in the Caribbean do not have and use accurate information for their management, operations, and investment planning, as evidenced by the information submitted for this study. The lack of information is one of the reasons many of these utilities are not meeting adequate levels in the performance areas where water utilities should be assessed: access, quality

[14] "Effects of 2017 Hurricanes Still a Reality for Some Families in the Caribbean," February 6, 2020. https://www.unicef.org/easterncaribbean/stories/effects-2017-hurricanes-still-reality-some-families-caribbean.

of service, operating efficiency, financial performance, and affordability. Due to the lack of information, many of the utilities are not able to:

- Determine the quality of service being provided and what measures or investments are required to improve that quality
- Assess operating efficiency and establish realistic targets for increasing operating efficiency
- Determine required investments in the network to reduce non-revenue water or expand access
- Identify needs to expand the capacity of water supply to meet forecast demand
- Bill customers based on the volumes of water they are consuming
- Determine the tariffs required to recover the cost of providing service
- Assess the economic and financial viability of capital investment projects

In addition, with this information gap, governments, regulators, customers, and development partners like the IDB, are not able to adequately assess the performance of the utilities, establish realistic expectations, and hold the utilities accountable.

In the face of this challenge, the availability of information and communication technologies ("ICT") and solutions that are cheaper and easier to implement can offer a practical approach for water utilities to reduce much of their information gaps.[15] These technologies and solutions would also enable a more dynamic and streamlined exchange of information between utility employees, management, board members, regulatory authorities, shareholders, customers, and other stakeholders. Developing and maintaining complete and integrated information systems requires time, knowledge, a disciplined approach, and investment.

Those utilities that have been able to develop and maintain complete and integrated information systems are among the best performers in LAC. Some examples of the best performers in LAC include Empresas Públicas de Medellin (EPM) in Colombia, Aguas Andinas in Chile, and Belize Water Services (BWS) in Belize. Why do well-performing water utilities like EPM, Aguas Andinas, and BWS have and use the necessary information systems while many others do not? The reasons are most likely that other utilities have not had the incentives, understanding of the value of the information, internal capacity, and funding needed to develop those information systems.

1.6 Structure of the report

The report is organized into the following four sections:

- **Benchmarking water utilities in the Caribbean (Section 2):** This section describes the results of the benchmarking study and presents the findings regarding access to potable water and sanitation, quality of service, financial performance, operating efficiency, tariffs, and financing CAPEX.

15 While some utilities may use some form of ICT to collect department specific information, this information may not be shared across the utility. Therefore, with no central ICT system, complete, precise, and up to date aggregated performance data may not for to utility-wide decision-making processes.

- **Reducing Non-Revenue Water (Section 3):** This section describes the context of NRW in the Caribbean, the benefits of reducing NRW, and considerations for structuring a comprehensive NRW reduction program.
- **Impacts of COVID-19 on water utilities (Section 4):** This section presents the findings of the assessment of the impacts of COVID-19 on 11 water utilities in LAC, with a focus on those in the Caribbean
- **Levels of resilience of water utilities in the Caribbean (Section 5):** This section describes the vulnerability of water utilities in the Caribbean to natural disasters, the impact natural disasters have on utilities, the post-disaster needs of water utilities, and how utilities' lack of natural disaster insurance constrains their financial resilience to natural disasters

There are three appendices included in the report:

- Health and Economic Impacts of COVID-19 in LAC (Appendix A)
- Vulnerability of Jurisdictions to Natural Disasters (Appendix B)
- Vulnerability of Water and Wastewater Infrastructure to Natural Disasters (Appendix C)

2 Benchmarking Water Utilities in the Caribbean

Benchmarking the performance of water utilities in the Caribbean is critical to identifying relative performance, setting realistic targets for improved performance, and identifying critical gaps in information. It assists development agencies in targeting their interventions and water utilities to twin engagements and learn from each other. This section describes the findings and results of the benchmarking for the following key performance indicators:

- Access to potable water and sanitation (Section 2.1)
- Quality of service (Section 2.2)
- Financial performance (Section 2.3)
- Operating efficiency (Section 2.4)
- Tariffs (Section 2.5)
- Financing capital expenditures (Section 2.6)

2.1 Access to potable water and sanitation

In the Caribbean, piped water coverage is high. However, access to wastewater services, especially through a centralized piped system, remains low.[16] Table 2.1 shows the average national piped water coverage, sewer connection, and wastewater treated for the jurisdictions included in the benchmark. The average percent of national piped water coverage for this sample is 91 percent. Barbados, Bahamas, Saint Lucia, Dominica, Trinidad and Tobago, Grenada, and Guyana have national piped water coverage above 90 percent. In contrast, the average percent of sewer connection for this sample is 12 percent. Three jurisdictions, Bahamas, Jamaica, and Trinidad and Tobago are at or above 20 percent for sewer connections. Barbados and Jamaica are the only countries with the percent of wastewater treated reported, at 3 and 8 percent, respectively.

Table 2.1: Access to Water and Sanitation Services

Jurisdiction	National Piped Water Coverage	Sewer Connection	Wastewater Treated
Barbados	99%	3%	3%
Bahamas	97%	21%	N/A
Saint Lucia	96%	5%	N/A
Dominica	95%	15%	N/A
Trinidad and Tobago	94%	20%	N/A
Grenada	92%	7%	N/A
Guyana[17]	92%	8%	N/A
Cayman	86%	19%	N/A

16 World Bank, A Benchmark for the Performance of State-Owned Water Utilities in the Caribbean (2018) pg. 7.

17 This data was provided by GWI.

Belize	86%	9%	N/A
Jamaica	84%	23%	8%
Suriname	79%	1%	N/A
Average	**91%**	**12%**	**6%**

WHO/UNICEF Joint Monitoring Programme (JMP) Database, accessed on 6 January 2021 from https://washdata.org/data. Values presented for Dominica are from 2015. Cayman values are from 2016. All other values presented are from 2017. 'N/A" indicates the data is not available. Some peer reviewers of this document indicated that the values for some countries seem imprecise.

2.1.1 Access to potable water

Table 2.2 shows that across the benchmarked jurisdictions, the percentage of urban water coverage is higher than that of rural water coverage. Of the eleven countries included in the benchmarking, five jurisdictions in this sample have data disaggregated by area. These jurisdictions include Saint Lucia, Belize, Jamaica, Suriname, and Guyana. At 94 percent, the average percentage of urban coverage is 20 percent higher than rural coverage in this sample.

Table 2.2: Access to Potable Water

Jurisdiction	National Piped Water Coverage	Urban Water Coverage	Rural Water Coverage
Barbados	99%	N/A	N/A
Bahamas	97%	N/A	N/A
Saint Lucia	96%	100%	95%
Dominica	95%	N/A	N/A
Trinidad and Tobago	94%	N/A	N/A
Grenada	92%	N/A	N/A
Guyana[18]	92%	96%	65%
Cayman	86%	N/A	N/A
Belize	86%	95%	78%
Jamaica	84%	93%	72%
Suriname	79%	88%	61%
Average	**91%**	**94.4%**	**74.2%**

Source: WHO/UNICEF Joint Monitoring Programme (JMP) Database, accessed on 6 January 2021 from https://washdata.org/data. Values presented for Dominica are from 2015. Cayman values are from 2016. All other values presented are from 2017. 'N/A" indicates the data is not available.

2.1.2 Access to sanitation

While the World Health Organization (WHO) and United Nations International Children's Fund's (UNICEF) Joint Monitoring Programme (JMP) estimates an average of 96 percent improved sanitation for the benchmarked jurisdiction, wastewater treatment in the Caribbean is low. Table 2.3 shows the percentage for improved sanitation and the percent of wastewater treated. Of the jurisdictions included in the benchmark, Barbados and Jamaica are the only two

[18] This data was provided by GWI.

jurisdictions for which JMP has data for the percent of wastewater treated, at 3 and 8 percent respectively. For jurisdictions without wastewater treatment data, it can be assumed that treatment is also under 10 percent or non-existent.

Table 2.3: Access to Sanitation

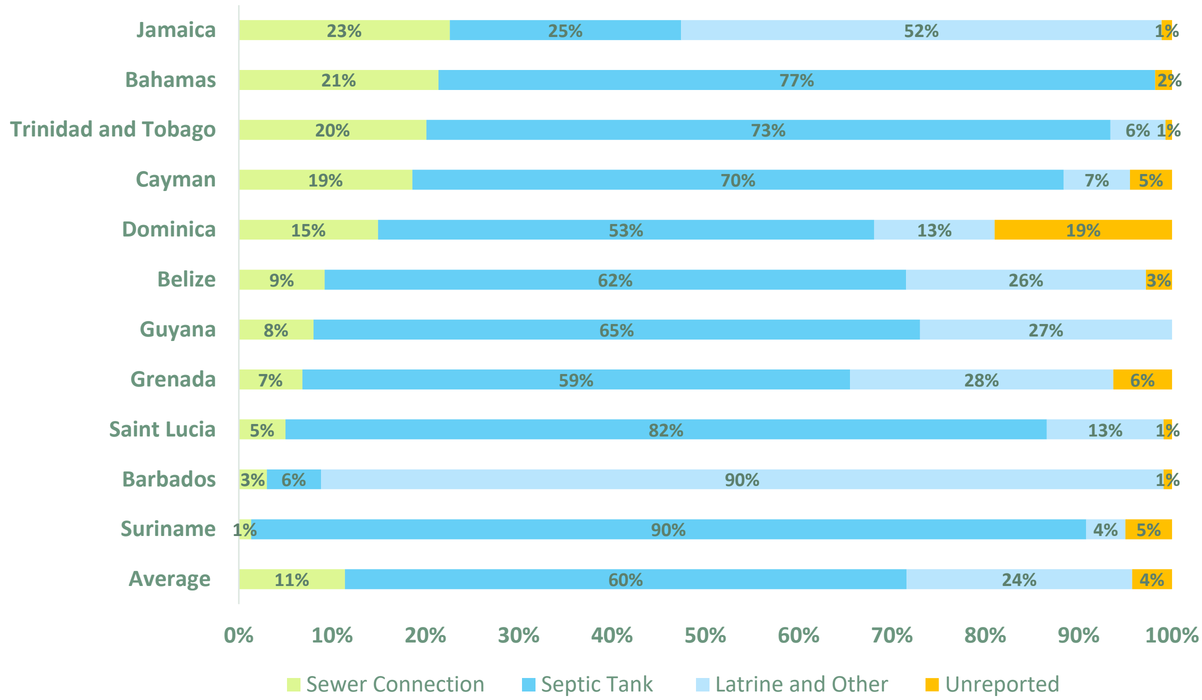
Jurisdiction	Improved Sanitation	Wastewater Treated
Bahamas	98.%	N/A
Barbados	99%	3%
Belize	97%	N/A
Cayman	96%	N/A
Dominica	81%	N/A
Grenada	94%	N/A
Guyana	96%	N/A
Jamaica	99%	8%
Saint Lucia	99%	N/A
Suriname	95%	N/A
Trinidad and Tobago	99%	N/A
Average	**96%**	**6%**

Source: WHO/UNICEF Joint Monitoring Programme (JMP) Database, accessed on 6 January 2021 from https://washdata.org/data. Values presented for Dominica are from 2015. Cayman values are from 2016. GWI values are from 2020 and provided directly by the utility. All other values presented are from 2017. 'N/A" indicates the data is not available.

Notes: Citing a 2014 report from WRI, one of the peer reviewers noted that "20% of domestic wastewater produced in Trinidad and Tobago is collected and from that only 5% of total domestic wastewater is treated and disposed of."

Figure 2.1 shows the percent of wastewater collection disaggregated by type for each of the jurisdictions included in the benchmarking. Saint Lucia, Barbados, Guyana, and Suriname have the lowest percent of sewerage connection, at or below 5 percent for each jurisdiction. The average percent of sewer connections for the benchmarked countries is 11 percent. With an average of 60 percent, septic tanks are the most prevalent type of sanitation for the jurisdictions included in the benchmark. This is followed by latrines and other rudimentary sanitation means at 24 percent.

Figure 2.1: Percent of Wastewater Collection Type by Category



Source: WHO/UNICEF Joint Monitoring Programme (JMP) Database, accessed on 6 January 2021 from https://washdata.org/data. Values presented for Dominica are from 2015. Cayman values are from 2016. GWI values are from 2020 and provided directly by the utility. All other values presented are from 2017. 'N/A" indicates the data is not available. The unreported category is K&M's calculation based on the percentage required for the total to equal 100 percent.

Note: Citing a 2014 report from WRI, one of the peer reviewers noted that "20% of domestic wastewater produced in Trinidad and Tobago is collected and from that only 5% of total domestic wastewater is treated and disposed of."

2.2 Quality of Service

Quality of service refers to the reliability, continuity, and responsiveness of the services provided by the utility to its customers. Quality of service also includes the quality of water provided and the quality of wastewater that is collected and disposed.[19] Apart from BWS, SWM, and NWC water utilities did not provide data that indicated the level of quality of service provided to customers. These indicators include:

- Number of water pipe breaks
- Number of sewer blockages
- Continuity of service (average hours of service per day)
- Quality of water supplied (as a percentage of water testing meeting standards)
- Number of complaints per 1,000 customers.

The lack of data provided may indicate that either many water utilities did not have much data on quality of service—or for utilities that do have data, it was not consolidated and made publicly

19 In many jurisdictions, water utilities and regulators have agreed upon standards of service. This study did not include a benchmarking of the required standards of service as set by regulatory bodies in each jurisdiction.

available. In either case, it can be assumed that most water utilities included in the benchmarking do not place sufficient emphasis on quality of service. If water utilities did place sufficient emphasis, quality of service data would be collected, made publicly available, and show that the quality of service is improving.

BWS is a notable exception. Table 2.4 shows quality of service indicators for BWS in 2019 and SWM in 2020. BWS reported five water pipe breaks per km, five sewer blockages per km, 23.98 hours of continuous service per day, and reported 159 complaints per 1,000 customers. In comparison, SWM reported 22.54 hours of continuous service per day and 333 complaints per 1,000 customers.

Table 2.4: Quality of Service Indicators for BWS, NWC, and SWM

Quality of Service Indicator	BWS (2019)	SWM (2020)
Number of water pipe breaks per km	5 breaks	N/A[20]
Number of sewer blockages per km	5 blockages	N/A[21]
Continuity of service (average hours of service per day)	23.98 hours	22.54 hours
Quality of water supplied (as a percentage of water testing meeting standards)	99% of water tests passed standards	N/A[22]
Number of complaints per 1,000 customers	159 complaints	333 complaints

Source: Data provided by BWS.

NWC is required to submit quarterly reports on its performance against the set quality of service standards to the Consumer Affairs Unit (CAU) of the Office of Utilities Regulation (OUR). While these reports are not publicly available, the OUR publishes its analysis of reports from NWC and other

20 SWM indicated it had a total of 8,485 water pipe breaks from December 2019 to June 2020.

21 SWM is a water supply company and does not provide sanitation services.

22 SWM indicated that lab testing is done at the supply area, however the data is not aggregated.

service providers. According to the OUR, in 2021[23], NWC reported 2,442 breaches of standards[24] and recorded a total of 1,130 complaints from customers.[25] [26] [27]

2.3 Financial Performance

Financial performance for a water utility is usually measured with indicators for profitability, liquidity, and efficiency of the capital structure. Table 2.5 presents key financial indicators for the utilities included in the benchmarking. These indicators include, EBITDA margin, net income margin, return on equity, return on assets, and cash from operations. Utilities are organized in Table 2.5 starting with the utility with the highest EBITDA margin (BWS) in descending order. There are eight utilities with a positive EBITDA Margin. These include BWS, WAC, DOWASCO, WASCO, NAWASA, BWA, SWM, and GWI. WASA is an outlier in this sample with negative financial performance indicators, including a negative 237 percent EBITDA margin and a negative 111 percent net income margin. When WASA is excluded from this sample, the average EBITDA margin is 12 percent and net income margin is a negative 5 percent.

Table 2.5: Key Financial Performance Indicators

Utility	EBITDA Margin	Net income Margin	Return on Assets	Return on Equity	Cash from Operations in USD'000
BWS (2021)	34%	7%	1%	2%	4,144
WAC[28] (2019)	33%	26%	9%	12%	16,344
DOWASCO (2020)	25%	-11%	-1%	-3%	3,690
WASCO (2016)	22%	8%	N/A	5%	N/A
NAWASA (2018)	19%	22%	7%	10%	4,878
BWA (2018)	16%	-11%	-2%	-4%	12,543

23 NWC's fiscal year 2021 runs from April 2020 to March 2021.

24 The reports indicates that in FY2021, the majority of breaches that the NWC were related to Meter Installation (Water Guaranteed Standards (WSG) 7), Meter Reading (WGS10(a)), Connection to Supply (WGS1), and Repair of Faulty Meters (WGS8)).

25 Office of Utilities Regulation, Consumer Affairs Unit. "Quarterly Performance Report: 2020 April-June." 24, September 2020.

Office of Utilities Regulation, Consumer Affairs Unit. "Quarterly Performance Report: 2020 July-September." 29 December 2020.

Office of Utilities Regulation, Consumer Affairs Unit. "Quarterly Performance Report: 2020 October-December." April 14, 2021.

Office of Utilities Regulation, Consumer Affairs Unit. "Quarterly Performance Report: 2021 January-March." June 17, 2021.

26 Complaints include what the CAU's Quarterly Reports term as "Appeals," "Complaints," and "Referrals."

27 Additionally, the CAU received a total of 21 allegations in FY2021 from customers that alleged NWC breached its standards of service.

28 From 2018 to 2019, WAC reported financial data for a 12-month period. In 2017, however, WAC reported financial data for an 18-month period.

SWM (2017)	12%	-4%	-1%	N/A	N/A
GWI (2020)	11%	8%	2%	3%	13,457
NWC (2020)	-2%	-19%	-7%	N/A	26,270
WSC (2015)	-46%	-80%	-11%	-26%	9,575
WASA (2020)	-237%	-111%	-6%	-70%	(77,931)
Average including WASA	**-10%**	**-15%**	**-1%**	**-8%**	**1,441**
Average excluding WASA	**12%**	**-5%**	**0%**	**0%**	**11,362**

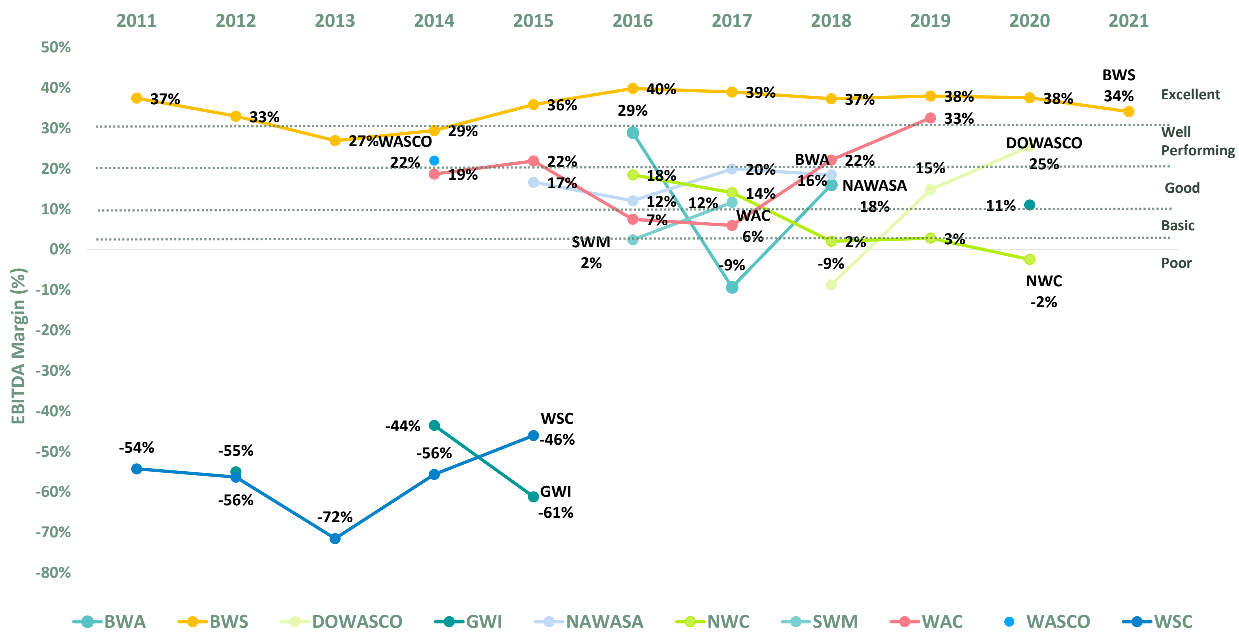
Source: Utility financial statements. WASCO's EBITDA Margin and Return on Equity was calculated using 2014 data. In 2020, NWC had a negative net income and negative shareholder equity, therefore Return on Equity should not be calculated. WASA's Return on Equity was calculated using 2018 data.

2.3.1 EBITDA Margin

EBITDA margin is a measure of a utility's profitability that is calculated as revenues minus OPEX, divided by revenues. This margin provides a good idea of profitability of a utility's operations. The main factors that determine this margin are the tariffs, operating efficiency, and the unit cost of its key inputs. Figure 2.2 illustrates EBITDA margin across time and indicates which ranges are commonly considered "Excellent" (30 percent and above), "Well Performing" (20 to 30 percent), "Good" (5 to 20 percent), "Basic" (under 5 percent and positive), and "Poor" (negative). These are generally recognized standards of performance as reflected in the World Bank's Water Utility Turnaround Framework.[29] BWS has the most complete dataset, with an EBITDA margin range of 27 percent at its lowest point to 40 percent at its highest between 2011 and 2020. In this sample, DOWASCO has seen the most improved EBITDA margin, starting at negative nine percent ("Poor" performance) in 2018—following hurricane Maria in 2017—up to 25 percent ("Well Performing") in 2020.

29 Soppe, Gerard, Nils Janson, and Scarlett Piantini. 2018. "Water Utility Turnaround Framework: A Guide for Improving Performance." World Bank, Washington, DC.

Figure 2.2: EBITDA Margin

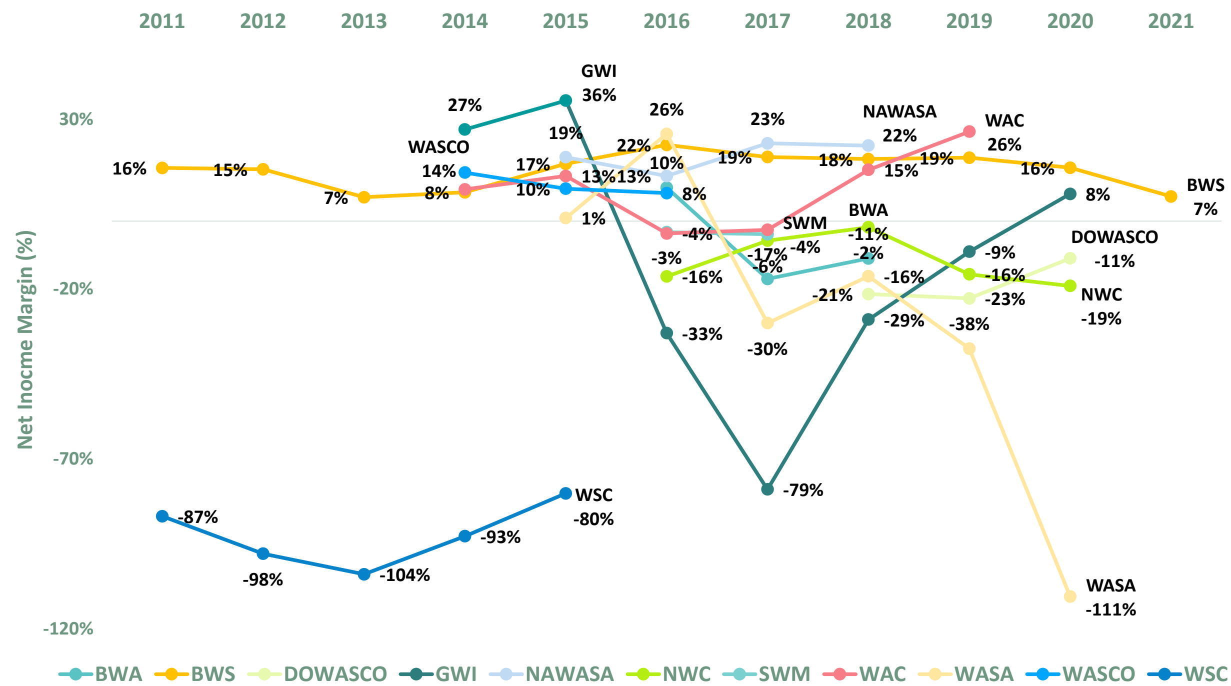


Source: Utility financial statements. WASA is an outlier and is not included in the chart. WASA's EDBITDA Margin decreased from -182% in 2015 to -237% in 2020.

2.3.2 Net Income Margin

Net income margin measures the comprehensive profitability of a water utility. It is calculated as net income divided by revenues. Net income margin is a broader measure of profitability because, in contrast with EBITDA margin, it includes depreciation, interest expense, non-operating income and expenses, government subsidies (if any), and taxes. In 2020, BWS had a positive net income margin of 16 percent, the highest value for all the utilities in that year, although this dropped to 7 percent in 2021. The other utilities for which we have financial information for 2020 are DOWASCO, NWC, WASA, and GWI. DOWASCO, NWC, and WASA had a negative net income margin of -11, -19, and -111 percent, respectively, while GWI had a net income margin of 8 percent. Figure 2.3 shows net income margin across time for each of the utilities for which we have financial information.

Figure 2.3: Net Income Margin



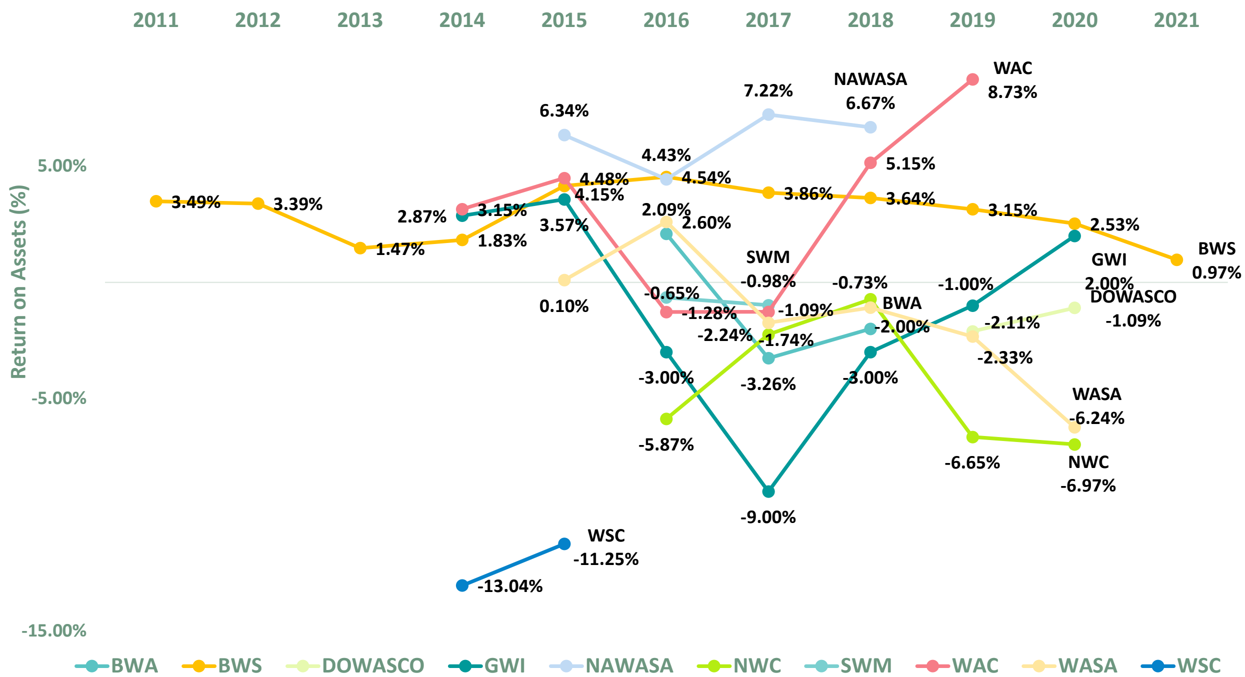
Source: Utility financial statements.

2.3.3 Return on Assets

Return on assets measures the return obtained on all the assets entrusted to the enterprise.[30] This is calculated by dividing net income by total assets. Figure 2.4 shows the return on assets over time. In this sample, WAC has the highest return on asset of 8.7 percent in 2019, a large increase after its return on assets of negative 1.1 percent in 2017. WAC is followed by NAWASA, with a return on assets ranging from 4.4 to 6.7 percent between 2015 to 2018. Between 2016 and 2020, NWC's return on asset is negative ranging from negative seven to negative one percent.

[30] Bernstein, L., Wild, J., Subramanyam, K.R. "Financial Statement Analysis" (2000)

Figure 2.4: Return on Assets

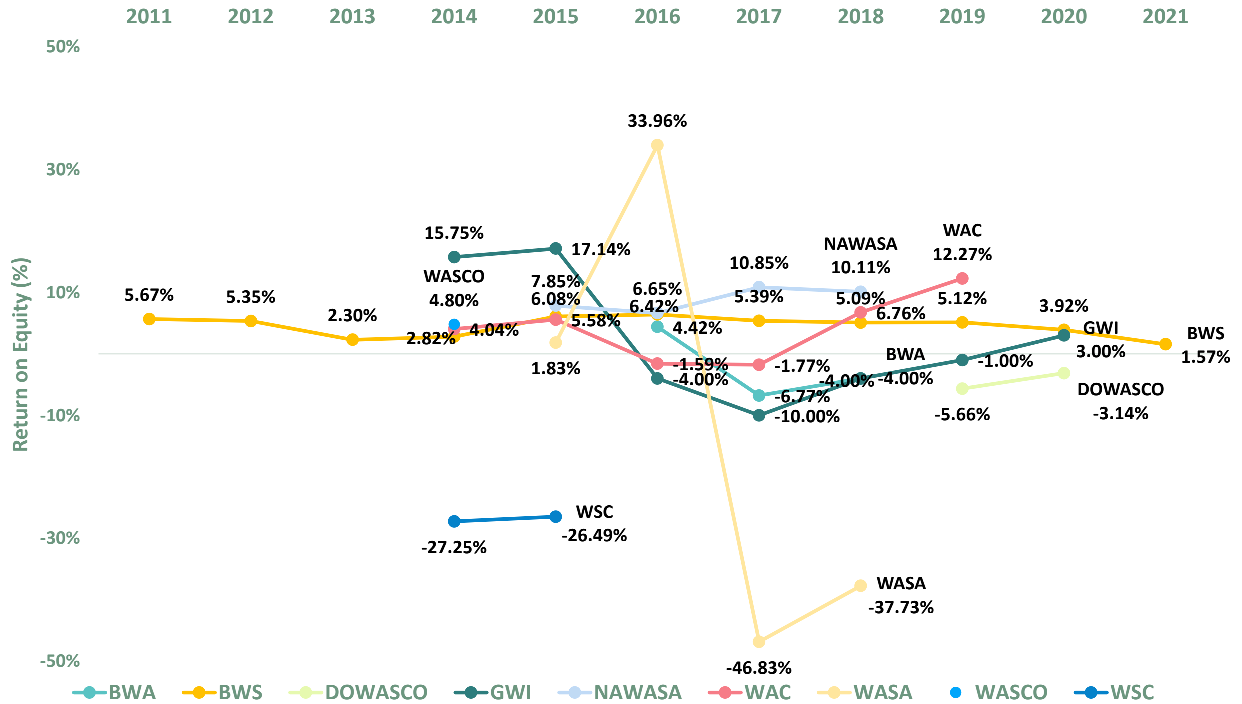


Source: Utility financial statements. WASCO did not provide the financial data required to calculate a return on assets.

2.3.4 Return on Equity

Return on equity measures the profits earned from shareholder's equity contributions. Return on equity is calculated by dividing the net income by equity. However, if net income and equity are both negative, as is the case with NWC, return on equity cannot be calculated. Figure 2.5 presents the return on equity across time. Between 2016 and 2017, WASA saw a decrease in its return on equity from 34 percent down to negative 47 percent. The return on equity for BWS remained stable from 2011 to 2021, ranging from two to seven percent.

Figure 2.5: Return on Equity

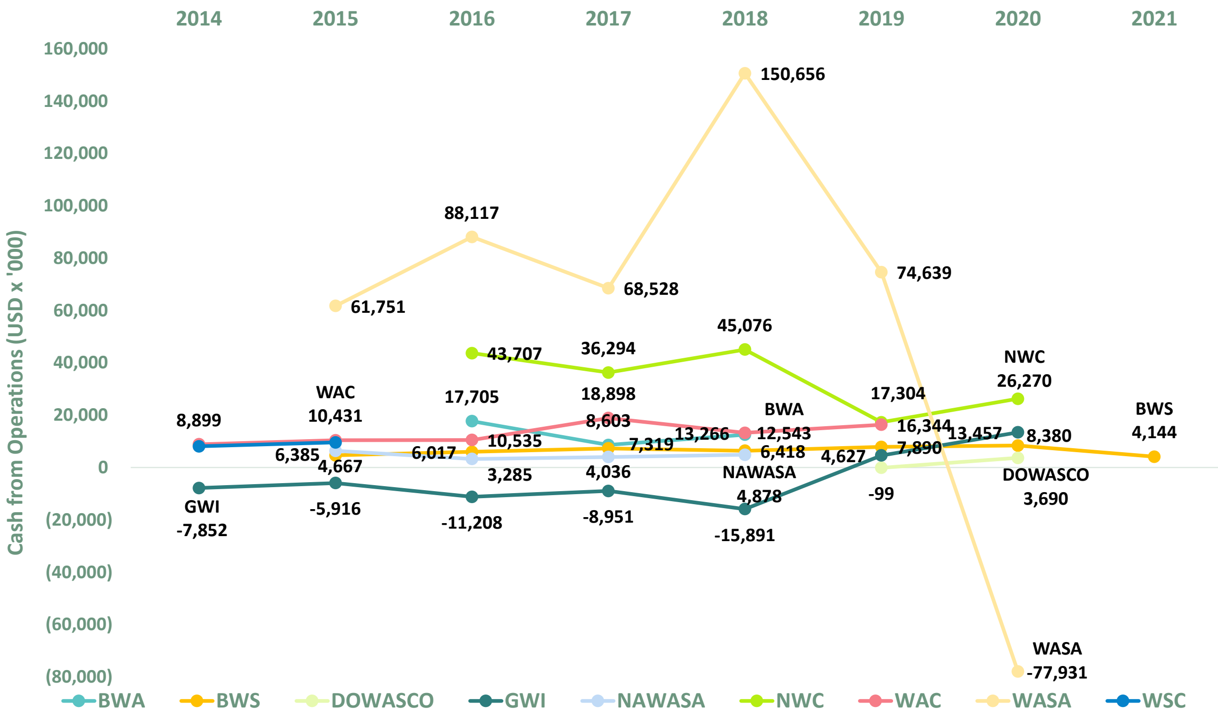


Source: Utility financial statements. SWM not provide the financial data required to calculate a return on equity. NWC had a negative net income and negative shareholder equity, therefore Return on Equity could not be calculated.

2.3.5 Cash from Operations

Cash from operations is the amount of cash that the utility generates from operating activities. Figure 2.6 shows the cash from operations for each utility across time. With the exception of GWI (between 2014 and 2019) and WASA (2020), all of the utilities generated positive cash from operations. In 2020, GWI generated cash from operations. With the exception of WASA, most water utilities included in the study show relatively consistent cash generated from operations each year between 2014 to 2020.

Figure 2.6: Cash from Operations in USD'000



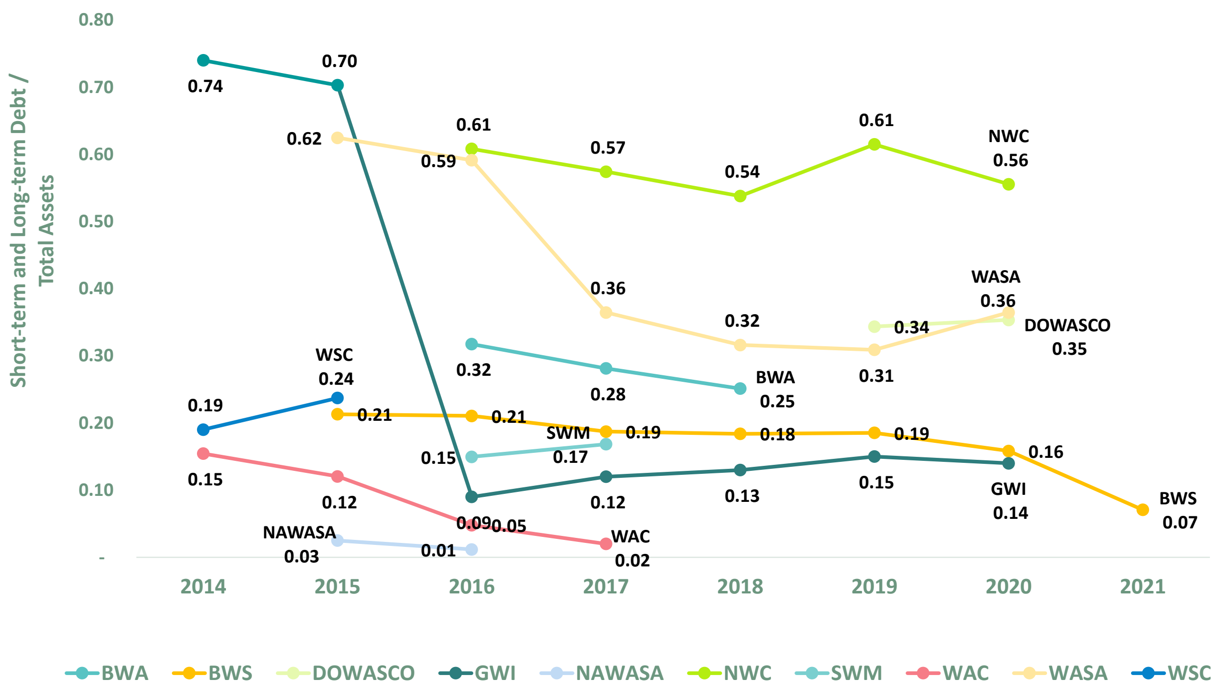
Source: Utility financial statements. SWM and WASCO did not provide the financial data required to determine cash from operations. From 2018 to 2020, WASA's cash from operations decreased from USD150 million to negative USD78 million. This was due to a range of factors including, adjustments for interest income, decreases in accounts receivable and inventories, and decreases in trade accounts payable.

2.3.6 Debt to Assets Ratio

The debt to assets ratio indicates how much of a utility's assets are financed with debt.[31] This is calculated by dividing total debt by total assets. Figure 2.7 shows the debt to asset ratio across time. With the exception of NWC, utilities in this sample tend to have a debt to asset ratio below 40 percent. This is low for water utilities and indicates that they may be able to take on more debt to finance fixed assets.

[31] Another indicator used to measure the capital structure of a company is the debt to equity ratio. We did not use the debt to equity ratio because some of the utilities have negative equity, and, therefore, for those companies, the calculation yields negative values.

Figure 2.7: Debt to Asset Ratio



Source: Utility financial statements. WASCO did not provide the financial data required to debt to asset ratio.

2.4 Operating Efficiency

Most water utilities in the Caribbean need to improve their operating efficiency. In this section, we describe the findings and results of key indicators that reflect the operating efficiency for a utility. These indicators include[32]:

- NRW
- Staff productivity
- Gross accounts receivable days
- Collection rate

Table 2.6 shows the percent of NRW, the number of staff per 1,000 water connections and the gross accounts receivable days for the utilities included in the benchmark. The average level of NRW for this sample is 46 percent. NRW levels between 30 and 40 percent can be categorized as "good performance." The average number of staff per 1,000 water connections is 6.8. Between 5.0 and 6.5 staff per 1,000 water connections is commonly accepted as "good performance." The average number of gross accounts receivable days for this sample is 201. Commonly accepted "good performance" for gross receivable days would be 60 days or less.

32 We were not able to provide an analysis on another key indicator: energy efficiency since the surveyed utilities did not provide sufficient information for this indicator.

Table 2.6: Operating Efficiency Summary Table

Utility	Percent of NRW	Liters per Connection per Day of NRW	Staff per 1,000 Water Connections	Gross Accounts Receivable Days
NWC (2021)	73%	1,729	4.8	446
GWI (2020)	68%	1,740	7.1	214
WASCO (2014)	56%	314	6.1	N/A
DOWASCO (2020)	53%	744	6.7	145
WASA (2020)	50%	1,331	12.5	424
BWA (2018)	45%	N/A	6.7	208
WSC (2015)	37%	391	7.4	325
SWM (2019)	31%	241	6.5	110
NAWASA (2018)	26%	N/A	5.3	46
BWS (2021)	20%	113	4.4	49
WAC (2017)	N/A	N/A	N/A	47
Average	**46%**	**825**	**6.8**	**210**
Commonly Accepted as Good Performance	**Between 30% to 40%**		**Between 5.0 and 6.5**	**Less than 60**

Source: Data provided by utilities. The data required to calculate the number of staff per 1,000 water connections for WAC is not publicly available. BWA and WASCO did not provide data for staff productivity calculations. WASA's average cost per employee is from 2019, and percent of NRW is an estimate. DOWASCO's staff per thousand water connections and average cost per employee values are from 2018. NAWASA's staff cost as a percent of OEPX value is from 2018. SWM's gross accounts receivable days is from 2017. "N/A" indicates the data is not available.

In this section, we also include an analysis of two main components of OPEX: staff costs and electricity costs. For many water utilities in the Caribbean, staff costs and electricity costs make up a large portion of OPEX.

2.4.1 NRW in the Caribbean

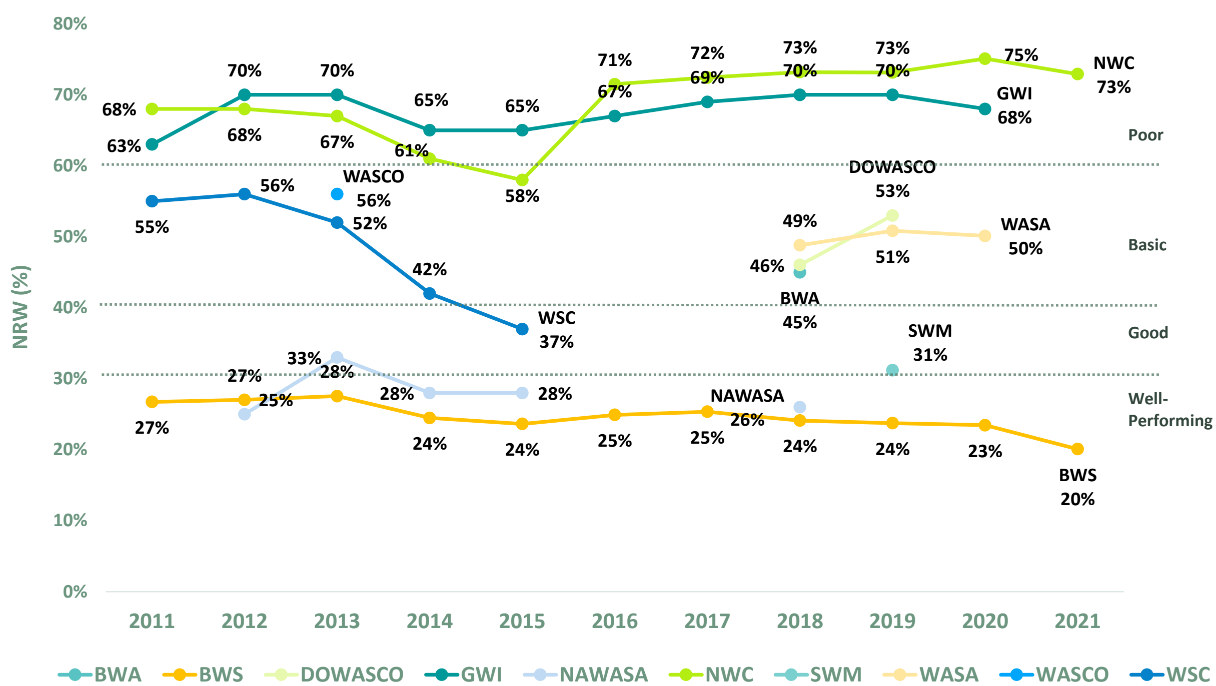
NRW refers to the difference between the amount of water that enters the distribution system and the amount of water billed to consumers.[33] Reflective of the general lack of information in many water utilities in the Caribbean, some utilities included in the benchmarking did not provide estimates for NRW. Figure 2.8 shows NRW across time and indicates which ranges are commonly considered "Well Performing" (30 percent and below), "Good" (30 to 40 percent), "Basic" (40 to 60 percent), and "Poor" (above 60 percent or 'unavailable').[34] From 2019 to 2021, NWC and BWS are the only utilities included in the benchmarking with NRW estimates. Notably, NRW levels have

33 IWA, accessed on 16 February 2021 from: https://iwa-network.org/projects/performance-based-contracts-for-non-revenue-water-market-development/

34 These are generally recognized standards of performance as reflected in the World Bank's Water Utility Turnaround Framework. Source: Soppe, Gerard, Nils Janson, and Scarlett Piantini. 2018. "Water Utility Turnaround Framework: A Guide for Improving Performance." World Bank, Washington, DC.

not changed significantly across time and have remained high. This indicates that a stronger emphasis on reducing NRW is critical. WSC is an exception to this trend, showing a decrease in NRW between 2012 and 2015 following the implementation of a comprehensive project to reduce NRW.[35] However, since WSC did not provide information for 2016 through 2020, we cannot determine if that reduction in NRW has been sustained, increased, or decreased. WASA, for example, estimates NRW to be 50 percent. None of the utilities provided the information necessary to disaggregate NRW into its parts. This suggests that their estimates of NRW may not have been carried out rigorously according to accepted methodologies.

Figure 2.8: Non-Revenue Water



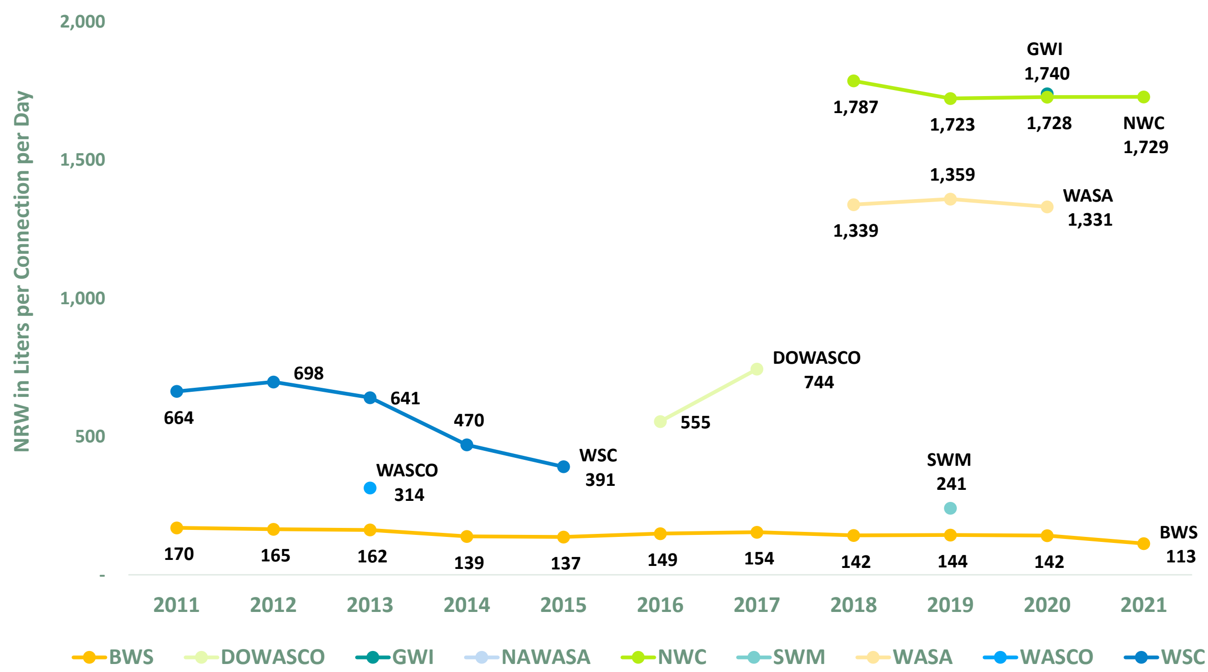
Source: Information provided by utilities. BWA did not provide estimates for NRW. Estimates for NRW for WAC are not publicly available.

Figure 2.9 shows the level of NRW for each utility, measured in liters per connection per day. While the percentage of NRW is useful in demonstrating the relative impact that NRW has on each utility, measuring in liters per connection per day demonstrates the exact magnitude of NRW. For example, when measured in percentage, WASA and DOWASCO are in the same range (46 to 53 percent from 2018 to 2020). Whereas the volume of NRW demonstrates that WASA has roughly twice the volume of NRW as DOWASCO. Between 2018 and 2020, WASA's NRW ranged from 1,331 to 1,359 liters per connection per day, while DOWASCO's values were much lower at 555 to 744 liters per connection per day.

---

35 Wyatt, A., Riquelme, R., Mellinger, Y., and Cayetano, Evan, (2018) IDB. "Performance based contract for non-revenue water reduction and control: New Providence, Bahamas. "Retrieved from: https://publications.iadb.org/en/case-study-performance-based-contract-nrw-reduction-and-control-new-providence-bahamas

Figure 2.9: NRW for Water Utilities from 2011 to 2021 in Liters per Connection per Day



Source: Information provided by utilities.

2.4.2 Staff productivity in Caribbean water utilities

Staff productivity is an important component of water utility operations. Staff productivity in water utilities is commonly measured as the number of employees per 1,000 water connections. Also important for understanding how staffing contributes to the operating cost of water utilities is the average annual cost per employee in USD and staff costs as a percent of OPEX. Table 2.7 presents key indicators of staff productivity for the utilities included in the benchmarking and shows the utility with the greatest number of staff per thousand water connections (WASA) in descending order. For this sample, WAC has the highest average annual cost per employee at USD57,053.

Table 2.7: Staff Productivity

Utility	Staff per Thousand Water Connections	Average Annual Cost per Employee in USD	Staff Costs as a Percent of OPEX
WASA (2020)	12.5	37,551	53%
WSC (2015)	7.4	16,511	11%
GWI (2020)	7.1	25,377	21%
DOWASCO (2020)	6.7	15,682	41%
BWA (2018)	6.7	N/A	N/A
SWM (2019)	6.5	N/A	62%
WASCO (2014)	6.1	N/A	N/A
NAWASA (2016)	5.3	14,950	30%

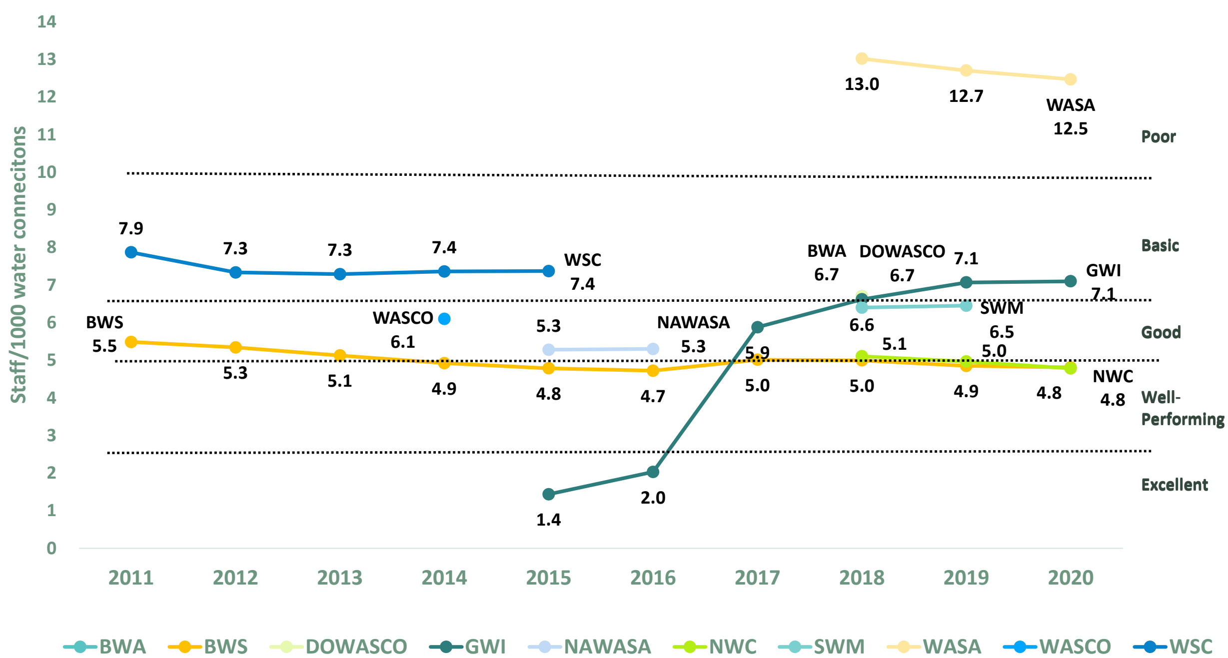
NWC (2020)	4.8	35,382	34%
BWS (2021)	4.4	22,598	43%
WAC (2017)	N/A	57,053	23%
Average	**6.8**	**28,138**	**35%**

Source: Data provided by utilities. The data required to calculate the number of staff per 1,000 water connections for WAC is not publicly available. WASA's average cost per employee is from 2019. DOWASCO staff per thousand water connections and average cost per employee values are from 2018. The value for NAWASA's staff cost as a percent of OPEX from 2018. "N/A" indicates the data is not available.

2.4.3 Staff per 1,000 water connections

A common indication of a utility's operating efficiency is how many staff are employed by the utility for every 1,000 water connections. Figure 2.10 shows the number of staff per 1,000 water connections across time and indicates which ranges are commonly considered "Excellent" (under 2.5), "Well Performing" (between 2.5 and 5.0), "Good" (above 5.0 and below 6.5), "Basic" (between 6.5 and 10.0), and "Poor" (above 10.0).[36] SWM, NAWASA, NWC, BWS, WASCO, and GWI (in 2017) range from "Good" to "Well Performing." WASA has the greatest number of staff per 1,000 connections for this sample.

Figure 2.10: Staff per 1,000 Water Connections



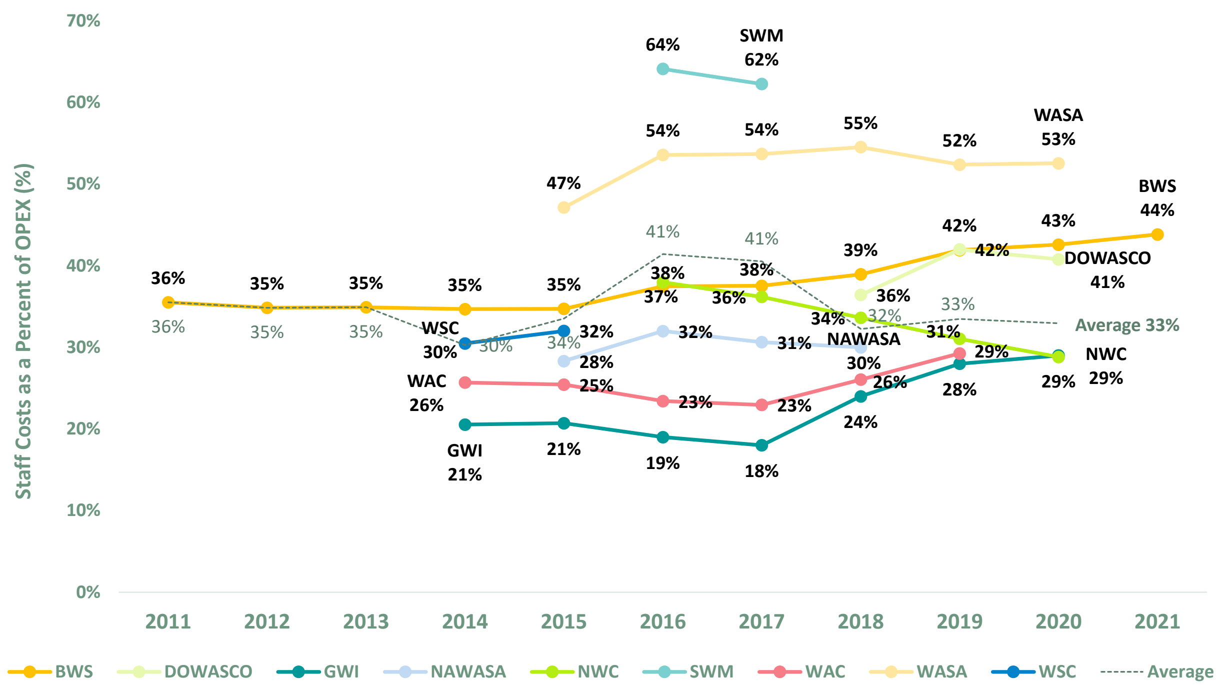
Source: Information provided by utilities.

36 These are generally recognized standards of performance as reflected in the World Bank's Water Utility Turnaround Framework. Source: Soppe, Gerard, Nils Janson, and Scarlett Piantini. 2018. "Water Utility Turnaround Framework: A Guide for Improving Performance." World Bank, Washington, DC.

2.4.4 Staff Costs as a percent of OPEX

For many water utilities in the Caribbean staff costs make up a significant percentage of operating expenses. Figure 2.11 illustrates the staff costs as a percent of OPEX across time. For utilities including SWM and WASA, staff costs are over 50 percent of OPEX. For WAC and GWI, staff costs are less than 30 percent of OPEX.

Figure 2.11: Staff Costs as a Percent of OPEX

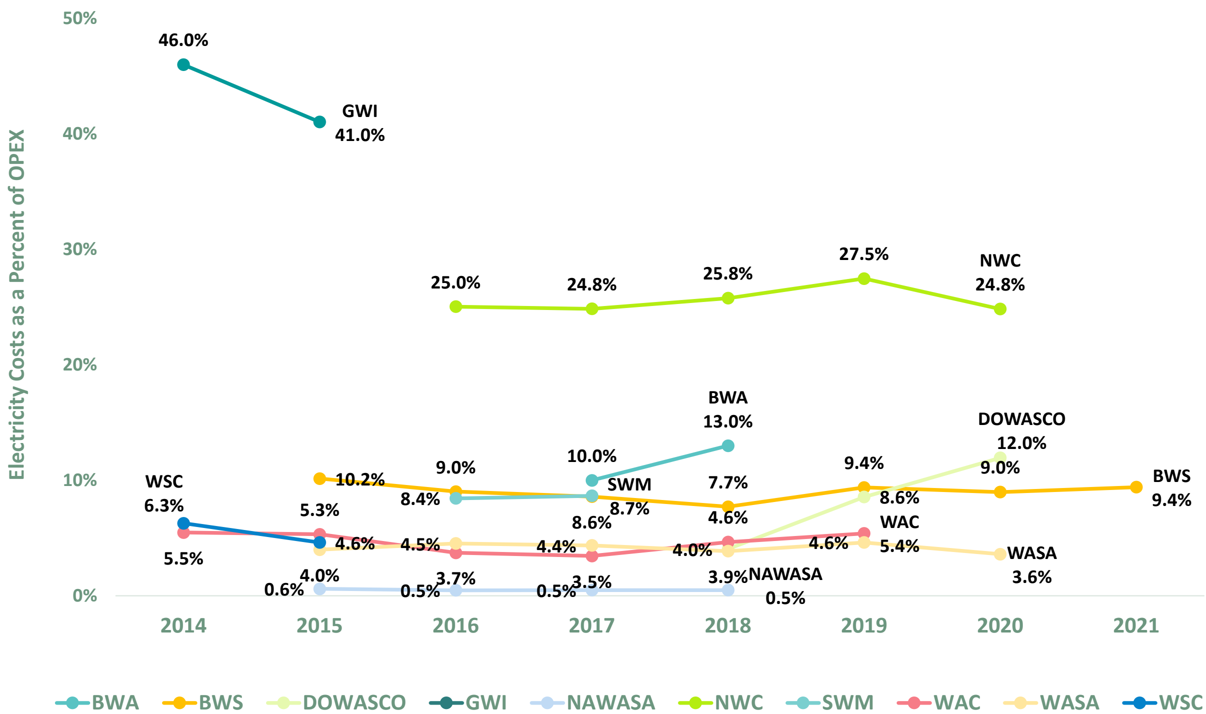


Source: Utility financial statements. BWA and WASCO did not provide the data required to calculate staff costs as a percent of OPEX.

2.4.5 Electricity costs as a percent of OPEX

In addition to staff costs, electricity costs are also a key component of OPEX. Figure 2.12 describes the electricity costs as a percent of OPEX across time. For GWI and NWC, electricity costs make up more than 20 percent of OPEX. The other utilities included in the benchmarking have electricity costs at or below 12 percent of OPEX.

Figure 2.12: Electricity Costs as a Percent of OPEX



Source: Utility financial statements. WASCO and BWA did not provided the data required to calculate electricity costs as a percent of OPEX.

2.4.6 Gross Accounts Receivable Days and Collection Rate

Gross accounts receivable days and collection rates are indicators of a utility's ability to collect from its customers. While GWI, WASA, DOWASCO, NWC, and BWS provided collection rates, we did not receive this information from all utilities. However, a utility's financial statements allow for gross accounts receivable days to be calculated. This is calculated by dividing revenues by gross accounts receivable and multiplying that value by 365. Table 2.8 presents accounts receivable days and the corresponding collection rate, if available. Utilities are organized in Table 2.8 starting with the utility with the highest accounts receivable days (NWC) in descending order. The average accounts receivable days for this sample is 201 days.

Table 2.8: Corresponding Gross Accounts Receivable Days and Collection Rate

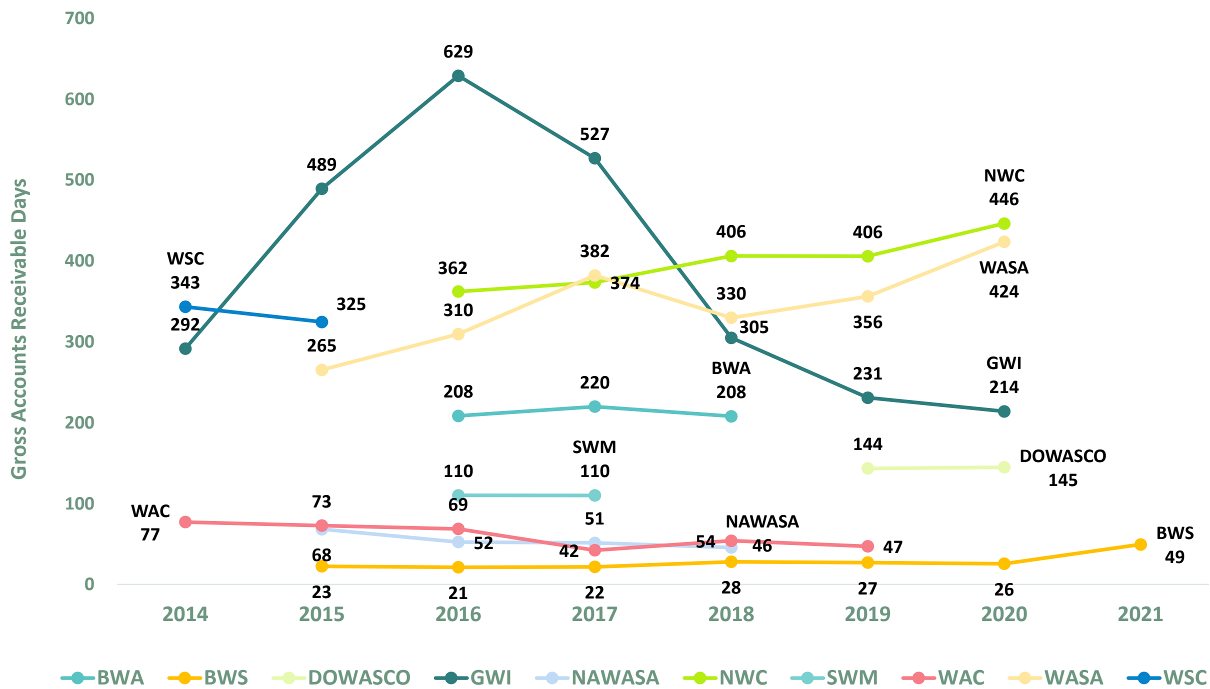
Utility	Accounts Receivable Days	Collection Rate
NWC (2020)	446	41%
WASA (2020)	424	30%
WSC (2015)	325	N/A
GWI (2020)	214	62%
BWA (2018)	208	N/A
DOWASCO (2020)	145	38%
SWM (2017)	110	N/A

BWS (2020)	49	99%
WAC (2017)	47	N/A
NAWASA (2018)	46	N/A
Average	**201**	**54%**

Source: Information provided by utilities. "N/A" indicates the data is not available.

Figure 2.13 shows gross accounts receivable days across time. Generally, gross accounts receivable days above 60 are concerning. BWS has the best performance of this sample, with less than 30 gross accounts receivable days between 2015 and 2020. BWS saw an increase in 2021 to 49 gross accounts receivable days. In 2016, GWI had the highest gross accounts receivable days of 629 and had gross accounts receivable days above 200 from 2014 to 2020.

Figure 2.13: Gross Accounts Receivable Days



Source: Utility financial statements. WASCO did not provide the data required to calculate accounts receivable days.

2.5 Tariffs

For the utilities included in the benchmark, tariffs range from USD0.06 to USD2.35per cubic meter of water. Table 2.9 shows the average water tariff across all customers, the average residential water tariff, and the residential monthly water bill for 15 cubic meters of water in 2019. Utilities are organized in Table 2.9 starting with the utility with the highest average water tariff (NWC) in descending order. The average water tariff in this sample is USD1.08 per cubic meter. The average residential tariff in this sample is USD1.19 per cubic meter.

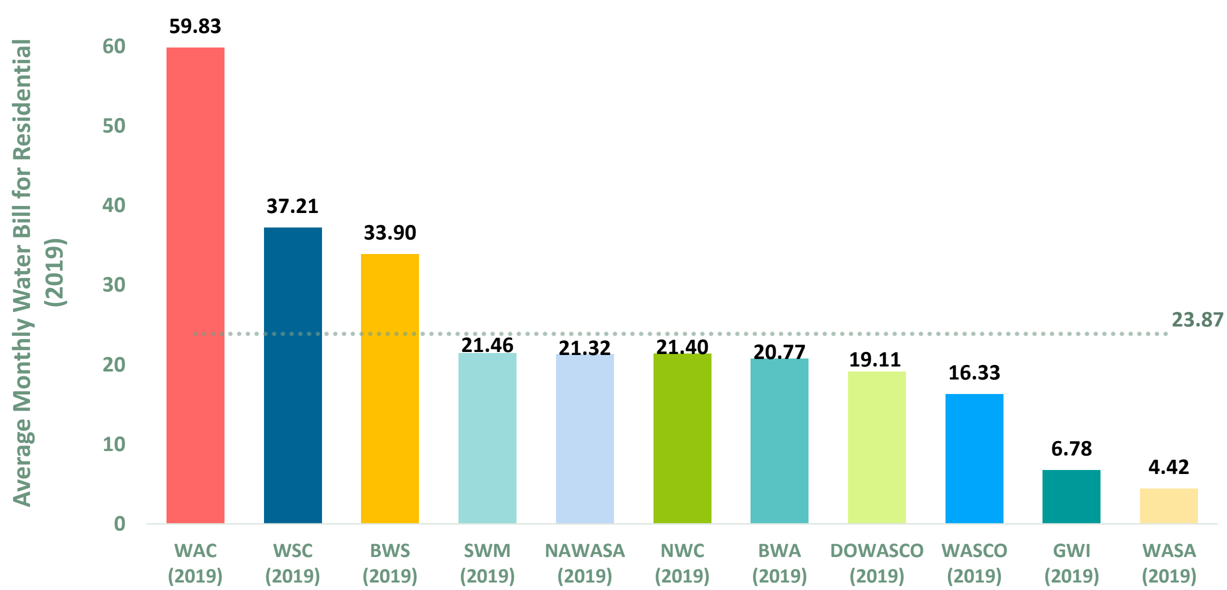
Table 2.9: Affordability of Tariffs of Water Utilities in the Caribbean

Utility	Average Water Tariff (USD/M^3)	Average Residential Water Tariff (USD/M^3)	Residential Monthly Water Bill in 2019 (USD at 15 M^3)
NWC (2020)	2.35	1.92	21.40
BWS (2019)	1.89	2.25	33.90
DOWASCO (2020)	0.89	0.81	19.11
SWM (2018)	0.61	0.61	21.46
GWI (2020)	0.54	N/A	6.78
WASA (2020)	0.51	0.38	4.42
WSC (2015)	0.06	N/A	37.21
WAC (2019)	N/A	N/A	59.83
BWA (2019)	N/A	N/A	20.77
NAWASA (2019)	N/A	N/A	21.32
WASCO (2016)	N/A	N/A	16.33
Average	**1.08**	**1.19**	**23.87**

Source: Information provided by utilities. "N/A" indicates the data is not available.

The average monthly residential water bill for each utility in 2019 is presented in Figure 2.14. USD23.87 is the average monthly water bill for residential consumption of 15 cubic meters per month across water utilities included in the study. At nearly USD60 per month on average, WAC has the highest average monthly residential water bill. WASA has the lowest average in this sample, at USD4 dollars per month.

Figure 2.14: Average Monthly Residential Water Bill for 15 Cubic Meters of Water in 2019

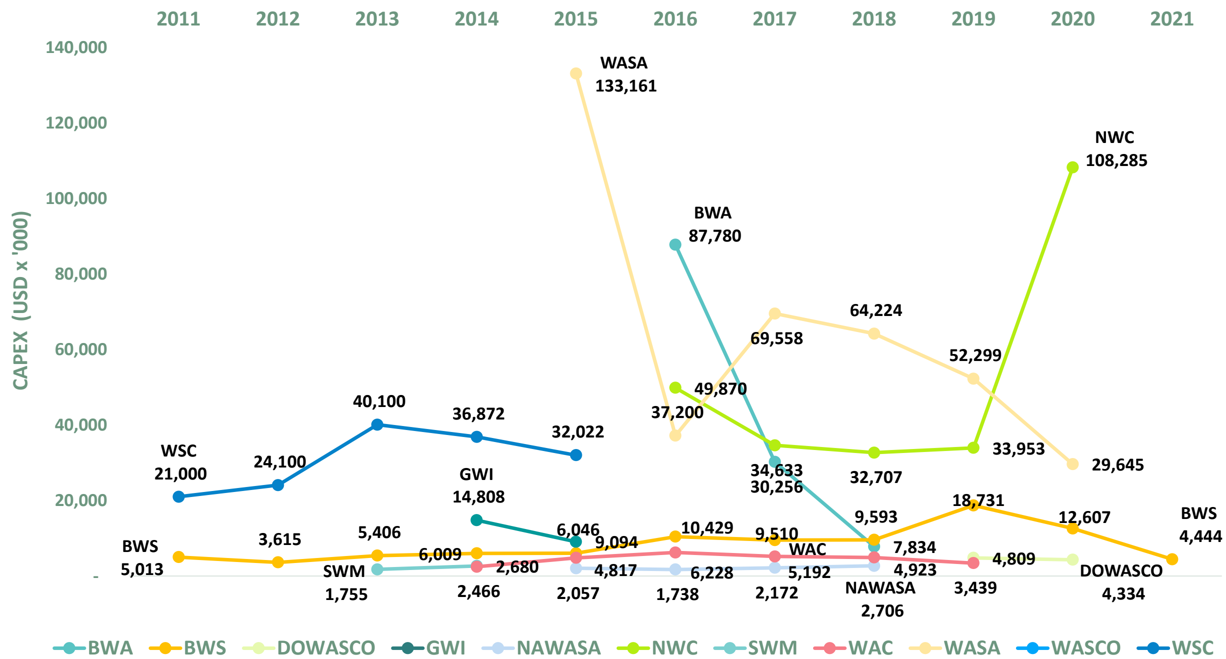


Source: Information provided by utilities.

2.6 Financing CAPEX

A critical component of a utility's performance is its ability to make capital investments. Ongoing capital investments are essential for a water utility's coverage, quality of service, and operating efficiency. Figure 2.15 presents the capital expenditures (CAPEX) made by each utility across time. Some utilities, including BWS, WAC, and NAWASA show similar CAPEX each year. While others, such as WASA, BWA, and NWC see CAPEX change significantly from year to year. For example, in 2019, NWC invested USD34 million and in 2020 invested USD108 million.

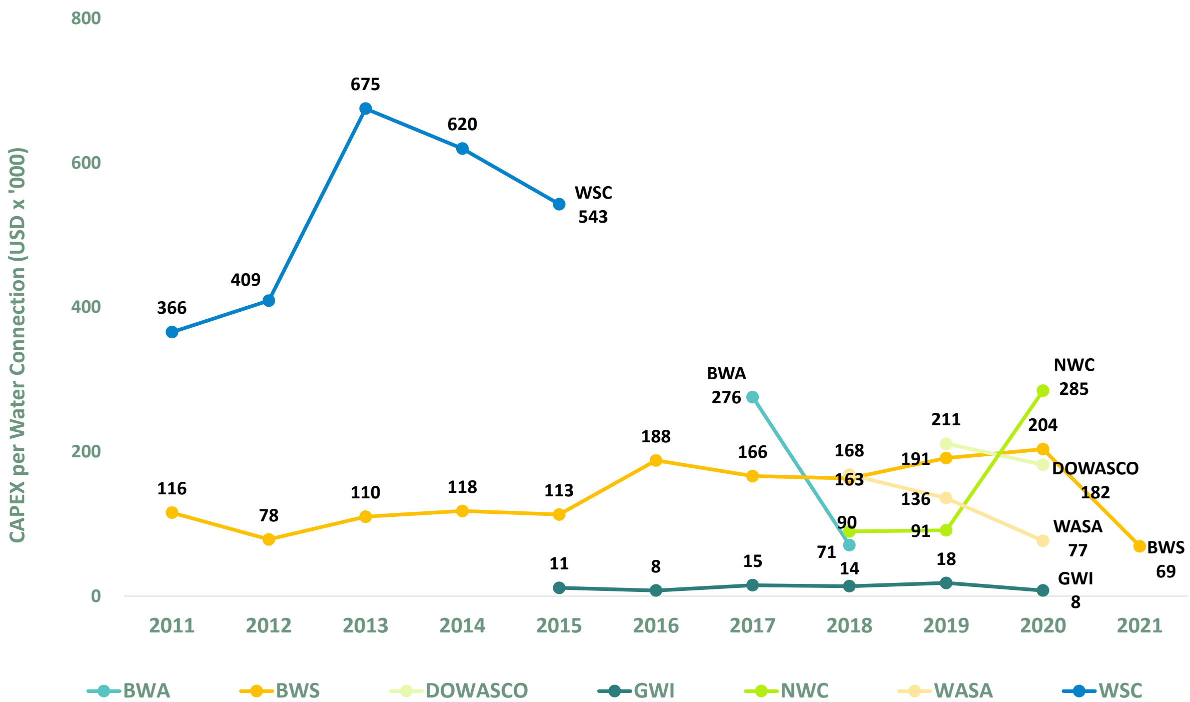
Figure 2.15: Capital Expenditures in USD '000



Source: Information provided by utilities. WASCO did not provide any data for CAPEX.

Figure 2.16 illustrates utilities' CAPEX relative to the number of water connections. BWA, NWC, DOWASCO, and WASA range from around USD100,000 to USD300,000. WSC is an outlier in this sample, ranging from USD366,000 to USD675,000.

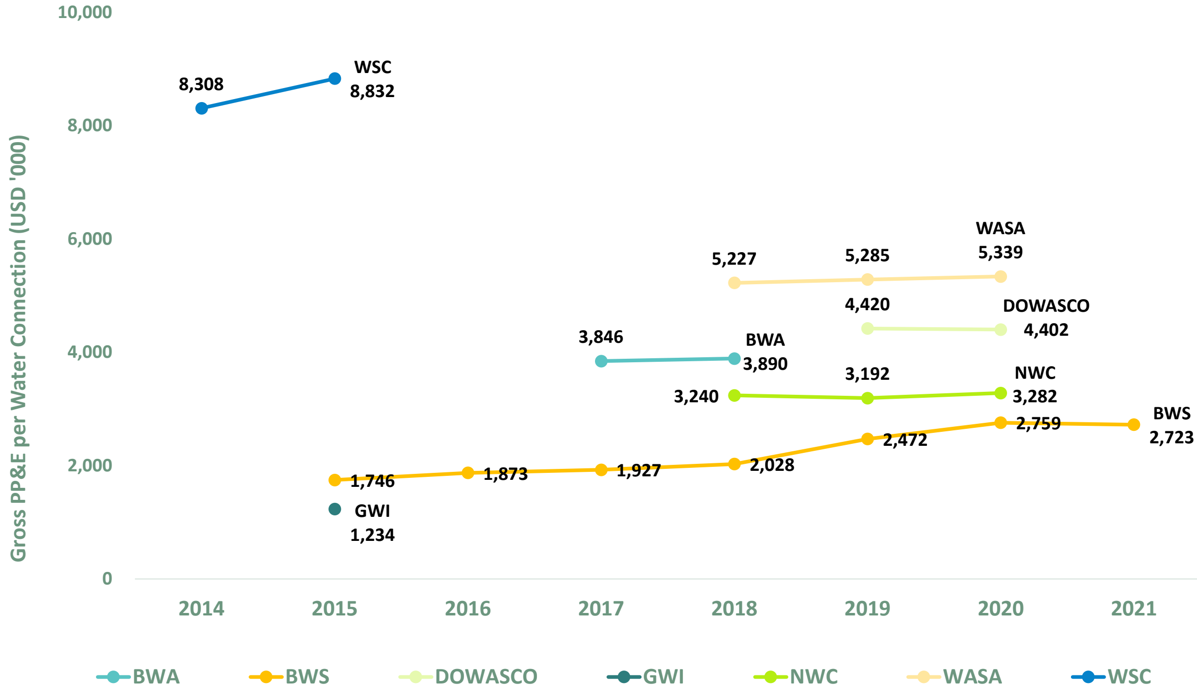
Figure 2.16: CAPEX per Water Connection in USD '000



Source: Information provided by utilities. WAC, NAWASA, SWM, and WASCO did not provide the data required to determine CAPEX per water connections.

Figure 2.17 presents utilities' gross property, plant, and equipment (PP&E) in relation to the number of water connections. A utility with a falling value for this indicator may experience decreases in access, quality of service provided, and/or operating efficiency. BWS shows a slight increase from USD1.7 million in 2015 to USD2.8 in 2020. Similar to CAPEX per water connections, WSC has the highest gross PP&E per water connection in this sample, at USD8.8 million in 2015.

Figure 2.17: Gross PP&E per Water Connection in USD '000



Source: Information provided by utilities. NAWASA, WAC, SWM and WASCO did not provide the data required to calculate Gross PP&E per water connection.

3 Structuring and Financing Non-revenue Water Reduction Projects

NRW is a widespread issue for water utilities in the Caribbean. As discussed in Section 2.4.1, in the past ten years, a majority of water utilities in the Caribbean have had NRW levels of over 40 percent, some reaching as high as 75 percent. The estimated cost of NRW for five utilities in our sample totals USD658 million a year. Although reducing NRW is often considered "one of the lowest hanging fruits"[37] for improving a utility's efficiency, financial performance, and quality of service, many utilities may not have the resources or expertise to reduce NRW on their own. Through well-structured NRW reduction projects, water utilities can take advantage of external expertise and financing to reduce their NRW levels in an effective and cost-efficient manner. Additionally, NRW reduction brings benefits to all involved stakeholders, including utilities, customers, governments, and communities as a whole.

This section describes the following:

- Context of NRW in the Caribbean (Section 3.1)
- Benefits of reducing NRW (Section 3.2)
- Considerations for structuring comprehensive NRW reduction projects (Section 3.3)

3.1 Context of NRW in the Caribbean

Non-revenue water is the difference between water supplied by a utility and the amount that the utility bills its customers.[38] In a study by Roland Liemberger and Alan Wyatt, global NRW amounted to 126 billion m^3/year, which is worth USD39 billion/year.[39] Liemberger and Wyatt estimate that around 30 percent of the global water supply becomes NRW. Fluence Corporation estimates that between 20 and 50 percent of the global water supply becomes NRW, and in emerging markets some countries experience up to 75 percent NRW.[40] Figure 3.1 demonstrates the volume of NRW in liters/capita/day for eleven regions in the world. Latin America and the Caribbean has the third highest volume of NRW, with an average volume of 121 liter/capita/day. This is equivalent to USD8 billion/year.[41]

37 Hvilshoj, Soren. 2015. "Reduction of Non-Revenue Water Around the World." International Water Association. May 20, 2015. https://iwa-network.org/reduction-of-non-revenue-water-around-the-world/.

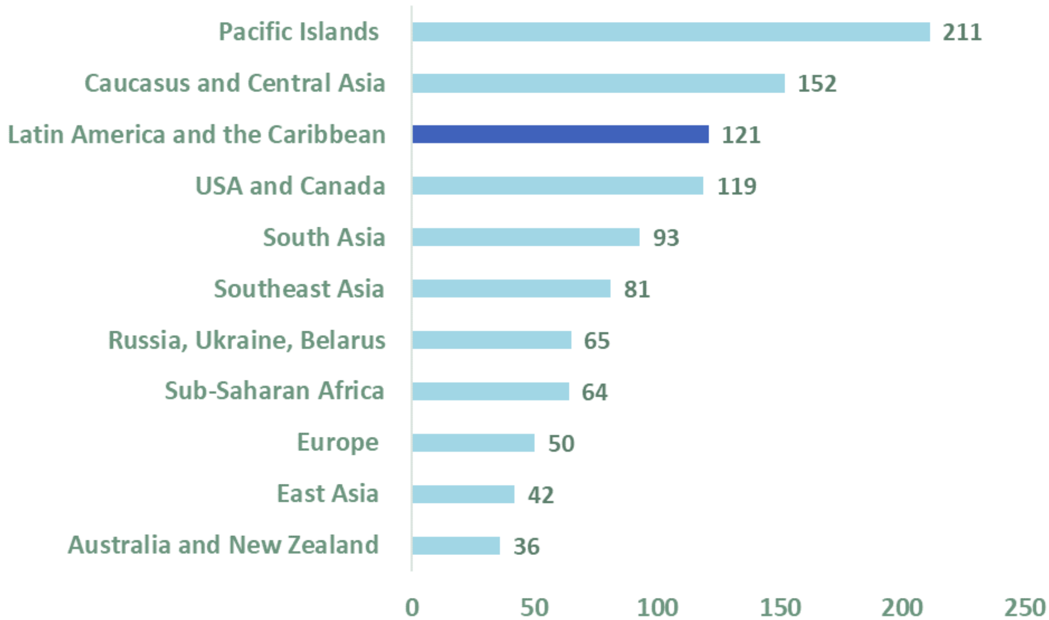
38 Cayetano, Evan, Keisuke Sasaki, and Corinne Cathala. "Non-Revenue Water (NRW) in Caribbean Utilities: A case for Turn-around."

39 Liemberger, R., and A. Wyatt. "Quantifying the Global Non-Revenue Water Problem." *Water Supply* 19, no. 3 (July 6, 2018): 831–37. https://doi.org/10.2166/ws.2018.129.

40 Hvilshoj, Soren. "Reduction of Non-Revenue Water Around the World." International Water Association, May 20, 2015. https://iwa-network.org/reduction-of-non-revenue-water-around-the-world/.

41 Liemberger, R., and A. Wyatt. "Quantifying the Global Non-Revenue Water Problem." *Water Supply* 19, no. 3 (July 6, 2018): 831–37. https://doi.org/10.2166/ws.2018.129.

Figure 3.1: NRW Volume (in liters/capita/day) by Region



Source: Adapted from Liemberger and Wyatt 2018.

For water utilities in the Caribbean, high NRW levels are a widespread issue. **Table 3.1** demonstrates NRW levels for 11 water utilities in the Caribbean, including the percentage, volume in m3/year, and how much utilities would have earned if NRW had been billed to customers. To calculate the cost of NRW, we used an average water tariff based on our available data.[42]

Table 3.1: NRW for Utilities in the Caribbean

Name of Utility	NRW %	Volume of NRW (m3 x '000/year)	Cost of NRW (USD millions/year)
NWC (2020)	75%	240,003	350
GWI (2019)	68%	3,233	5
WASCO (2013)	56%	5,209	8
DOWASCO (2020)	53%	6,191	9
WASA (2020)	50%	188,122	275
BWA (2018)	45%	TBD	N/A
WSC (2015)	37%	8,424	12
SWM (2019)	31%	11,588	17
NAWASA (2018)	26%	TBD	N/A

42 The average tariff for the utilities WSC (2015), NWC (2020), WASCO (2016), BWS (2019), DOWASCO (2020), WASA (2020), and SWM (2018) equals USD1.46/m3.

BWS (2020)	20%	3,833	6
WAC (2017)	N/A	N/A	N/A
Average	**46%**	**58,325**	**85**
Total	**NA**	**466,601**	**682**

Source: Information provided by utilities.

Notes: NRW values are estimates based on the information provided by utilities. Values for NWC are from 2020, values for WASCO are from 2013, values for DOWASCO are from 2019, values for WSC are from 2015, values for GWI are from 2014, values for NAWASA are from 2018, values for BWS are from 2020, and values for WASA are from 2020

On average, the NRW level for these utilities is 46 percent of water supplied. This is higher than the global average from Liemberger and Wyatt's estimate. NWC has the highest level of NRW of 75 percent, while BWS in Belize has the lowest level at 23 percent. The average annual volume of NRW is over 58 million m3 and in total over 450 million m3 of water supply becomes NRW each year. On average, the value of NRW per year for these utilities is over USD85 million, which totals over USD682 million a year.

One of the IDB's key findings of their training webinars delivered to water professionals in the Caribbean in October 2020 was that the success of a NRW project hinged on the availability of reliable data.[43] However, utilities often lack reliable information regarding their level of NRW. Evidence of this is that when we have requested data from utilities, for some of the utilities the NRW value did not match with the volume of water supplied and volume of water billed. Moreover, the higher the percentage of NRW, the higher the margin of error for knowing the true value of NRW. In other words, utilities that report a high level of NRW are more likely to have a higher margin of error.

The reason most Caribbean utilities have insufficient or inaccurate data on NRW is that they do not have sufficient metering throughout their systems (this includes both on the supply and distribution side). For example, customer meter inaccuracies account for 25 percent of NRW in Trinidad and Tobago and 28 percent of NRW in Dominica. [44] During the IDB's training session on NRW, participants acknowledged the importance of water metering for preparing an accurate water balance and discussed the challenges they experienced in preparing their water balance for one of the modules. Participants cited issues with non-existing source meters, meters with no validation, and large numbers of unmetered properties. It is essential that utilities substantially improve the reliability of their meters and increase their metering throughout the system so that they can have more accurate data on their NRW levels.

3.2 Benefits of Reducing NRW

Reducing NRW generates a wide variety of benefits for all stakeholders involved. On a global level, reducing the current level of NRW by half "could generate an estimated additional $2.9 billion in cash every year for the water sector (from both increased revenues and reduced costs) and potentially service an additional 90 million people without any new investments in production

---

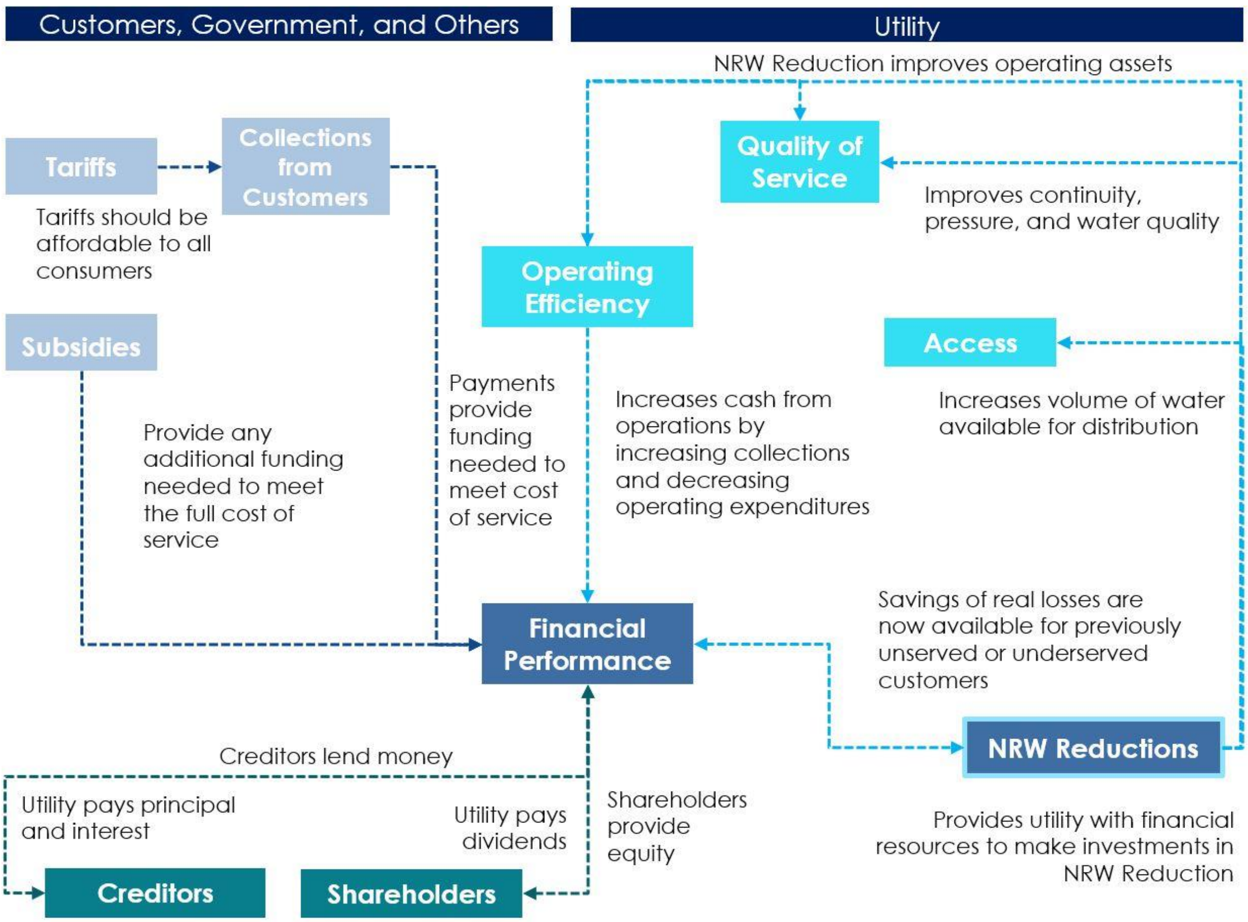
43 Thornton, Julian, Milene Aguiar, and Alan Wyatt. "NRW Training Modules: Regional Strategic Action Plan for Governance and Building Climate Resilience in the Water Sector in the Caribbean." Inter-American Development Bank, October 2020. Pg. 3.

44 Thornton, Julian, Milene Aguiar, Alan Wyatt. 2021. "NRW Training: Non-Revenue Water Training for the national Water Commission in Jamaica November 2020 to January 2021." Inter-American Development Bank. Pg. 20-21.

facilities nor drawing further on scarce water resources."[45] In addition to benefitting water utilities and consumers, NRW reduction can make cities more attractive, improve climate resilience, and reduce energy consumption.[46]

Figure 3.2 demonstrates the benefits generated by NRW reduction projects for utilities, customers, governments, creditors, and shareholders. NRW reduction projects result in improvements in access, quality of service, operating efficiency, and ultimately financial performance for the utility.

Figure 3.2: Benefits of NRW Reduction Projects



Adapted from: "*Burdescu, Ruxandra; van den Berg, Caroline; Janson, Nils; Alvarado, Oscar. 2020. A Benchmark for the Performance of State-Owned Water Utilities in the Caribbean. Development Knowledge and Learning;. Washington, DC: World Bank. © World Bank. https://openknowledge.worldbank.org/handle/10986/33251 License: CC BY 3.0 IGO.*"

[45] Cayetano, Evan, Keisuke Sasaki, and Corinne Cathala. "Non-Revenue Water (NRW) in Caribbean Utilities: A Case for Turnaround." Pg. 3.

[46] Kingdom, Bill, Gerard Soppe, and Jemima Sy. "What Is Non-Revenue Water? How Can We Reduce It for Better Water Service?" *The Water Blog* (blog), August 31, 2016. https://blogs.worldbank.org/water/what-non-revenue-water-how-can-we-reduce-it-better-water-service.

For water utilities with water coverage close to or at 100 percent, NRW reduction projects generate many benefits, including the following:

- **Conserves water resources** through reduction of real losses and water production requirement.
- **Improves resilience to climate change** through increased water reserves and greater allocation options.
- **Reduces water production requirement**, causing reduced energy usage, reduced GHG emissions (if carbon based fuels are used) and reduced energy costs.
- **Reduces other variable operating costs**.
- **Improves water supply services**, through increased continuity, higher pressure, cleaner water, fewer disruptions, and reduced cost to water users. It also reduces health risks.
- **Improves utility revenues**, though the reduction of apparent losses.
- **Reduces CAPEX** for water production facilities either through the cancellation or delay of construction of new facilities.
- **Improves financial condition of the utility** through cost reductions and revenue increases. Note that the increased CAPEX and OPEX expense for a more robust NRW reduction and control program will utilize a portion of the improved operating margin, but experience has shown that in most cases this additional NRW expense is less than the net revenue gains.[47]

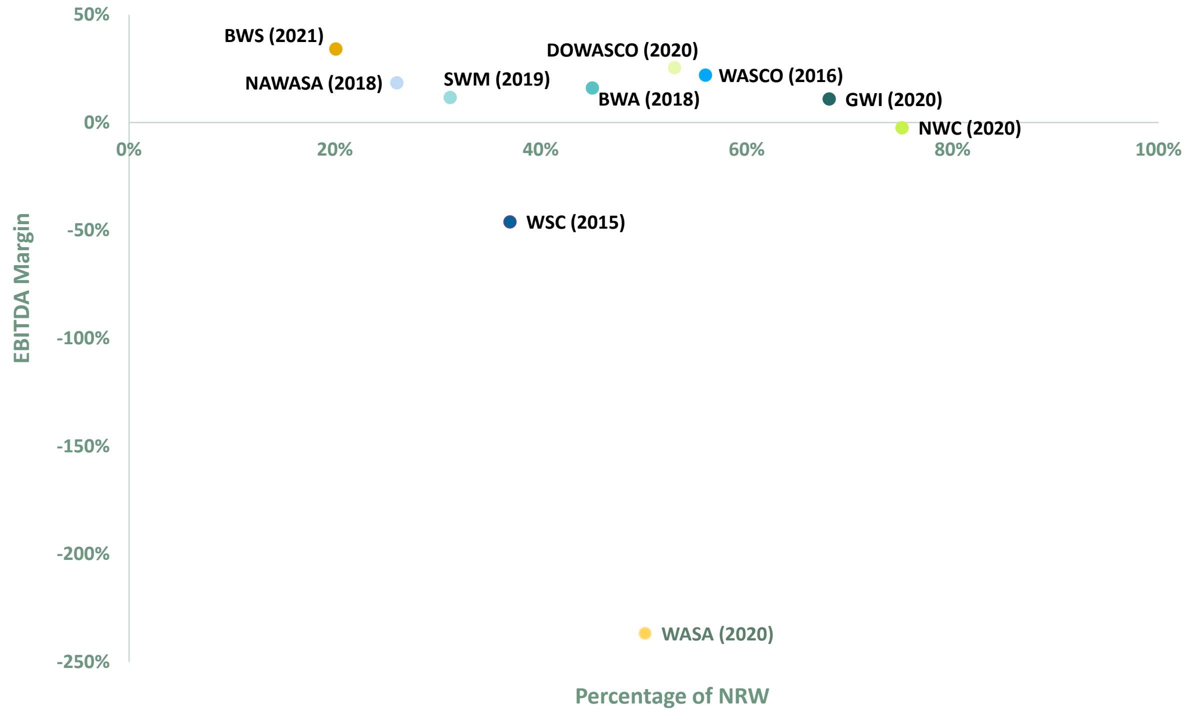
In addition, there is also the benefit from an increase in trust and satisfaction with the service on the part of the customers, which may lead to fewer complaints by customers.

Impact of NRW on financial performance of a water utility

NRW has an impact on a utility's financial performance. Figure 3.3 illustrates the relationship between a utility's financial performance and NRW levels. It shows NRW percentage compared to EBITDA margin for ten utilities in the Caribbean. In general, when NRW decreases, EBITDA margin tends to increase. Conversely, as NRW increases, EBITDA margin tends to decrease. The utility with the highest EBITDA margin, BWS, also has the lowest level of NRW. The utility with the highest NRW level, NWC, has a negative EBITDA margin. These examples show that it is difficult for a utility to achieve satisfactory profitability if it has high levels of NRW.

47 Wyatt, Alan. 2018. "Case Study: Performance-Based Contract for NRW Reduction and Control New Providence, Bahamas | Publications." Inter-American Development Bank. https://publications.iadb.org/publications/english/document/Case-Study-Performance-based-Contract-for-NRW-Reduction-and-Control-New-Providence-Bahamas.pdf. Pg. 20.

Figure 3.3: NRW Compared to EBITDA Margin



Source: Information provided by the utilities.

Potential benefits of NRW reduction projects in Jamaica

As part of the IDB's NRW Reduction Training Webinar Series[48], the IDB delivered an additional training session to mid-level managers from NWC in Jamaica which had a focus on financial modelling. In the session, NWC managers used data analysis to develop strategies and plans for NRW reduction projects. Some key results from the financial model were that all Parishes in Jamaica could implement financially viable NRW reduction projects with an internal rate of return (IRR) between 17 and 84 percent (or 45 to 430 percent if international lending terms were considered).[49]

The NWC team estimated that the total cost for ten-year NRW reduction projects in all Parishes in Jamaica would total JMD71 billion (approximately USD 473 million) with an average IRR of 38 percent. The total volume of reduced NRW would be about 198 million m3 per year, half of which could serve and additional 400,000 new customers and effectively double NWC's total customers. The increase of 48 million m3 per year in billed water would result in an annual increase in revenues of USD82 million and an annual increase of net revenue of USD77 million. Additionally, the NWC team found that NRW savings would result in reducing net demand and increasing the difference between supply and demand from 126,000m3 per day to 619,000 m3 per day from 2020 to 2027. This would allow NWC to conserve resources and be better prepared for droughts and climate

48 Disclaimer: "The results shown are from non-audited estimates and measurements provided by NWC for the purposes of training only. The results shown do not reflect an investment grade study and action plan, which should be undertaken prior investment and implementation."

49 Thornton, Julian, Milene Aguiar, Alan Wyatt. 2021. "NRW Training: Non-Revenue Water Training for the national Water Commission in Jamaica November 2020 to January 2021." Inter-American Development Bank. Pg. 6.

change. NWC noted that the improvements in revenue would also help them maintain low NRW and increase services to new customers.

3.3 Considerations for Structuring a Comprehensive NRW Reduction Project

Investing in NRW reduction projects can provide high economic and financial returns for utilities. Utilities can implement approaches with different levels of capital investments. Higher capital investments will lead to greater reductions in NRW, but even more modest investments (e.g. USD10 million) could lead to reductions with an adequate economic and financial return. This means that NRW reduction projects, large and small, can be worthwhile investments for utilities.

There are two general approaches from which water utilities can choose to reduce NRW. The first option is an in-house approach in which the utility uses its own resources, expertise, and labor to implement a project.[50] The second option is a comprehensive project in which a utility hires a contractor to complete the entire NRW reduction project as part of a single contract. This section demonstrates the types of contractual arrangements that can be used for NRW reduction projects, an indicative investment profile of a comprehensive NRW reduction project, options for financing comprehensive NRW reduction projects, and recommendations for NRW reductions projects in the context of the Caribbean.

Types of NRW reduction projects

There are many approaches a utility can take when implementing NRW reduction projects. These different approaches use different variations of in-house and external resources and different contractual arrangements. Some of the typical contractual arrangements include conventional "works" contracts and performance-based contracts (PBCs). Table 3.2 shows some typical options for approaches for NRW reduction projects.

Table 3.2: Generic Implementation Mechanisms for NRW Projects

Mechanism	Characteristics
In-house with internal NRW expertise	Where the skills are available in-house, it would be very logical to use those skills for project design, implementation, monitoring, and evaluation. Highly specialized functions might still be outsourced. Requires careful coordination of different parts of the utility (engineering, operations, commercial, finance etc.) and strong project management and supervision skills and experience.

50 Wyatt, Alan. 2018. "Case Study: Performance-Based Contract for NRW Reduction and Control New Providence, Bahamas | Publications." Inter-American Development Bank. https://publications.iadb.org/publications/english/document/Case-Study-Performance-based-Contract-for-NRW-Reduction-and-Control-New-Providence-Bahamas.pdf.

In-house with external NRW expertise	Utility staff conducts the program with traditional contracting with experienced consulting engineers to conduct audits and assessments, plan interventions, supervise implementation, and monitor and assess results. Can be started out slowly and expanded as the organization gains experience and confidence. Fosters development of in-house expertise for the "long haul" of NRW reduction. Requires coordination of different parts of the utility (engineering, operations, commercial, finance, etc.)
Conventional NRW contracts	Project design (as described above) could be done in-house or by engineering consultants. Implementation by conventional "works" contracts, or services contracts following standard contracting procedures. Considerable project management experience in the utility required, or a contract for a supervision consultant / contractor. No significant incentives for performance.
Performance-based contracts	A full NRW plan can be outsourced to an experienced PBC contractor, or the NRW program can be conducted in a phased approach with different PBCs for different stages or activities. The latter approach helps the utility to learn step- by-step, but this can take a little longer.
Combinations	A large, mature utility could use a multi-faceted approach where the main planning, monitoring and analysis functions are conducted in-house, while highly specialized technical activities or studies are conducted using traditional contracts, and other specific NRW activities are done via PBCs with reputable local contractors, for maximum efficiency.

Source: Adapted from Wyatt 2018, Pg. 24.

In the Bahamas, in 2012, WSC signed a ten-year PBC with Miya Water, an international company experienced in NRW projects implemented through PBCs, to complete an NRW management project in New Providence.[51] The project has "achieved huge NRW reductions, which could not have been accomplished by WSC alone."[52] In the first year of the PBC, NRW was reduced by 40 percent and in the second year it was reduced by 25 percent. [53] In the first three years of the contract, WSC experienced improvements in revenues and costs. Between 2013 and 2015, WSC's

[51] Wyatt, Alan. 2018. "Case Study: Performance-Based Contract for NRW Reduction and Control New Providence, Bahamas | Publications." Inter-American Development Bank. https://publications.iadb.org/publications/english/document/Case-Study-Performance-based-Contract-for-NRW-Reduction-and-Control-New-Providence-Bahamas.pdf. Pg. 9.

[52] Wyatt, Alan. 2018. "Case Study: Performance-Based Contract for NRW Reduction and Control New Providence, Bahamas | Publications." Inter-American Development Bank. https://publications.iadb.org/publications/english/document/Case-Study-Performance-based-Contract-for-NRW-Reduction-and-Control-New-Providence-Bahamas.pdf. Pg. 8.

[53] Wyatt, Alan. 2018. "Case Study: Performance-Based Contract for NRW Reduction and Control New Providence, Bahamas | Publications." Inter-American Development Bank. https://publications.iadb.org/publications/english/document/Case-Study-Performance-based-Contract-for-NRW-Reduction-and-Control-New-Providence-Bahamas.pdf. Pg. 61.

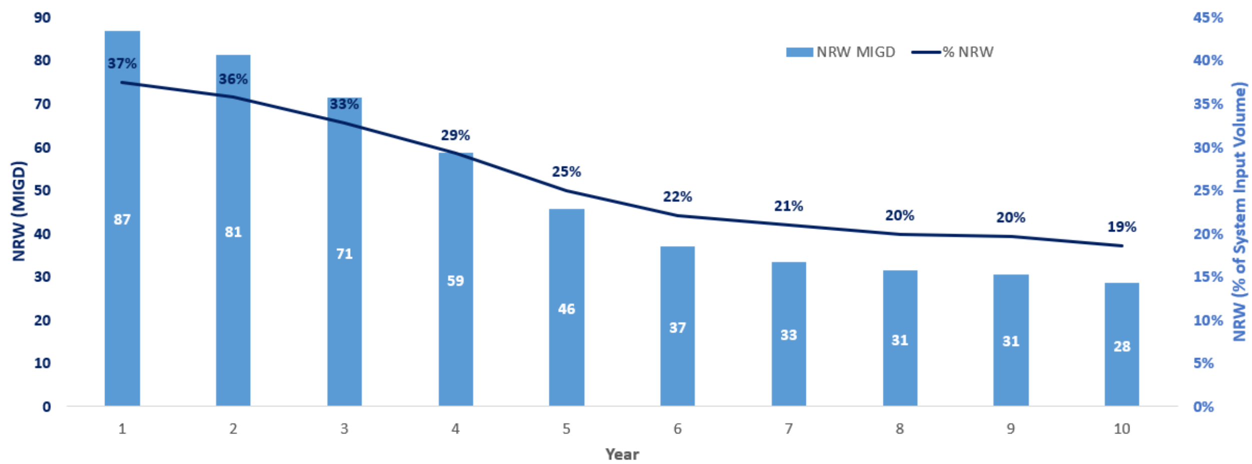
operating cost recovery ratio increased from 0.62 to 0.82 and "EBITDA fell from a loss of B$19 million to $8.8 million over the same period." [54]

Indicative investment profile of a comprehensive NRW reduction project

Typically, comprehensive NRW reduction contracts last about ten years. All the NRW reduction activities will be included in a single contract, including everything from information gathering, capital works, and, in some cases, training.

Figure 3.4 shows an example of a ten-year NRW project, with NRW levels (measured in imperial gallons per day and as a percentage of the system input volume) across time. Most of the CAPEX is completed by year five while NRW reduction activities are carried out throughout the life of the contract. The largest gains in reducing NRW are seen by year six. Payback on a ten-year project usually occurs around year seven.

Figure 3.4: 10-year NRW Reduction Project



CAPEX, which includes materials and civil and installation work, accounts for two thirds of the cost of the NRW project over the ten years. Operating costs, which include NRW reduction activities, account for one third of the total cost over the ten-year period.

As a benchmark for the cost of a comprehensive NRW reduction project, the NRW project PBC for WSC in the Bahamas (which had about 42,000 water connections at the beginning of the contract) included a fixed compensation of USD59 million designed to cover the cost of personnel, travel, materials, equipment, software, and other relevant items. Additionally, it included a performance-based compensation of USD23.8 million. The total compensation for the consultant was USD82.8 million. The cost of a comprehensive NRW reduction project for a utility with fewer connections would most likely be lower.

54 Wyatt, Alan. 2018. "Case Study: Performance-Based Contract for NRW Reduction and Control New Providence, Bahamas | Publications." Inter-American Development Bank. https://publications.iadb.org/publications/english/document/Case-Study-Performance-based-Contract-for-NRW-Reduction-and-Control-New-Providence-Bahamas.pdf. Pg. 67.

Options for financing comprehensive NRW reduction projects

Comprehensive NRW reduction projects often require large capital investments, which requires financing. To finance comprehensive NRW reduction projects, water utilities in the Caribbean have several options. These options for financing comprehensive NRW reduction projects include:

- government capital contributions,
- concessional debt from international financial institutions (IFIs)
- commercial debt from IFIs
- debt from commercial banks
- equity from the NRW contractor
- equity from private shareholders in the utility
- cash generated from operations

The feasibility of these options depends in large part on whether the utility is publicly or privately owned. For example, a public utility may have access to government capital contributions, but a private utility does not. On the other hand, a private utility may receive funding from equity from private shareholders, while this is not a possibility for a public utility.

Figure 3.5 illustrates some potential models for financing CAPEX for a typical ten-year comprehensive NRW reduction project. It demonstrates the different approaches and sources of financing for CAPEX that a public or private utility might choose. For example, in Model 1, a public utility uses 30 percent financing from government capital contributions and 70 percent financing from concessional debt from IFIs.

None of the models for the private utility use financing from government capital contributions or concessional debt from IFIs since these options are not available for a private utility. However, as demonstrated in Model 4, a private utility could choose to finance 60 percent of the project with commercial debt from IFIs, 20 percent from commercial banks, ten percent from equity from private shareholders in the utility, and 10 percent from cash from operations.

Figure 3.5: Models for financing CAPEX of a typical 10 year NRW reduction project

CAPEX Financed by	Utility	Utility	NRW contractor	Utility	Utility	NRW contractor
Ownership of the utility	Public	Public	Public	Private	Private	Private
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Government capital contributions	30%	0%	0%	0%	0%	0%
Concessional debt from IFIs	70%	100%	0%	0%	0%	0%
Commercial debt from IFIs	0%	0%	70%	60%	0%	70%
Debt from commercial banks	0%	0%	20%	20%	70%	20%
Equity from the NRW contractor	0%	0%	10%	0%	0%	10%
Equity from private shareholders in the utility	0%	0%	0%	10%	20%	0%
Cash from operations	0%	0%	0%	10%	10%	0%

When selecting an approach for a NRW project, utilities must consider what options are available to them as a public or private utility. Many public water utilities in the Caribbean may need government guarantees to obtain debt. One important consideration is that a contractor may take on great project risk in exchange for higher returns. The more financial risk the contractor has to accept, the more flexibility is needed in the contract. A full turn-key contract is one way to provide the NRW contractor with that level of flexibility. There are also many hybrid options that utilities may implement.

Recommendations for structuring and financing comprehensive NRW reduction projects

For a comprehensive NRW reduction project, water utilities in the Caribbean will need investments greater than USD10 to 15 million. This estimate is based on the NRW project PBC for WSC in the Bahamas (mentioned above), which was an approximately USD80 million project for a utility with 42,000 connections. A utility with fewer connections could implement a similar project at a lower cost.

IFIs are the best source for financing NRW reduction projects due to their availability and interest rates, their ability to work with both public and private utilities, the fact that they can generally provide debt that is competitive in interest rate and tenor with commercial debt that is available, and they have experience and knowledge regarding NRW reduction projects.

Public utilities need support from governments and IFIs to finance a comprehensive NRW reduction project. IFIs have the financing available, but governments need to provide guarantees for most public utilities or projects to secure financing from IFIs. Therefore, public utilities need to develop NRW reduction projects in close collaboration with governments and IFIs.

Due to the size and complexity of comprehensive NRW reduction projects, specialized NRW contractors are needed for credibility and expected effectiveness. Securing financing from IFIs for this type of project requires well-structured contracts. Scoping, structuring, tendering, and financing the contract can take around two years.

Despite effort and time required to structure NRW reduction projects correctly, the substantial benefits—for utilities, customers, and the environment—should make these projects a priority for both utilities and governments.

4 Impacts of COVID-19 on Water Utilities

COVID has rapidly spread across Latin America and the Caribbean (LAC), reaching 15 million confirmed cases by the end of December 2020. Appendix A shows that the health and economic impacts for the region have been significant. To assess the impacts of COVID on the water and sanitation utilities, K&M conducted a study for the IDB in which 11 water utilities from LAC were surveyed. These utilities provided detailed technical, commercial, and financial information which we used to quantify the impact of COVID on financial and operating elements of water utilities such as demand, non-revenue water, revenues, collections, operating expenses (OPEX), net income, and capital expenditures (CAPEX).

In this section we present an overview of water utilities surveyed for COVID assessment (Section 4.1) and the assessment of the impacts of COVID on the surveyed water utilities (Section 4.2).

4.1 Overview of Water Utilities Surveyed for COVID Assessment

To identify the impacts of COVID on water utilities in LAC, we surveyed 11 water utilities from 9 countries in the region. Table 4.1 lists these 11 utilities, their service areas and number of customers for 2019. We requested financial statements and reports on operating indicators such as volumes of water billed and supplied from these utilities. Most of the utilities provided this information up to September or October 2020, which allows for assessing the impact of COVID on the utilities for at least six months (April 2020 to September 2020).

Table 4.1: Water utilities surveyed for this analysis (2019)

Utility	Service Area	Number of customers
Aguas de Manizales S.A. E.S.P.	Manizales, Colombia	109,382
Aguas y Aguas de Pereira	Pereira, Colombia	156,854
Belize Water Services (BWS)	Belize	60,599
Dominica Water and Sewerage Company (DOWASCO)	Dominica	23,961
Empresa de Acueducto y Alcantarillado de Villavicencio	Villavicencio, Colombia	130,407
Empresa de Servicios Sanitarios del Paraguay S.A.	Paraguay	364,524
Empresa de Telecomunicaciones, Agua Potable, Alcantarillado y Saneamiento de Cuenca	Cuenca, Ecuador	149,076
Instituto de Acueducto y Alcantarillado de Panamá	Panama	672,159
National Water Commission (NWC)	Jamaica	372,275
Suriname Water Company (SWM)	Suriname	131,711
Water and Sewerage Authority (WASA)	Trinidad and Tobago	382,419

Source: Information provided by water utilities.

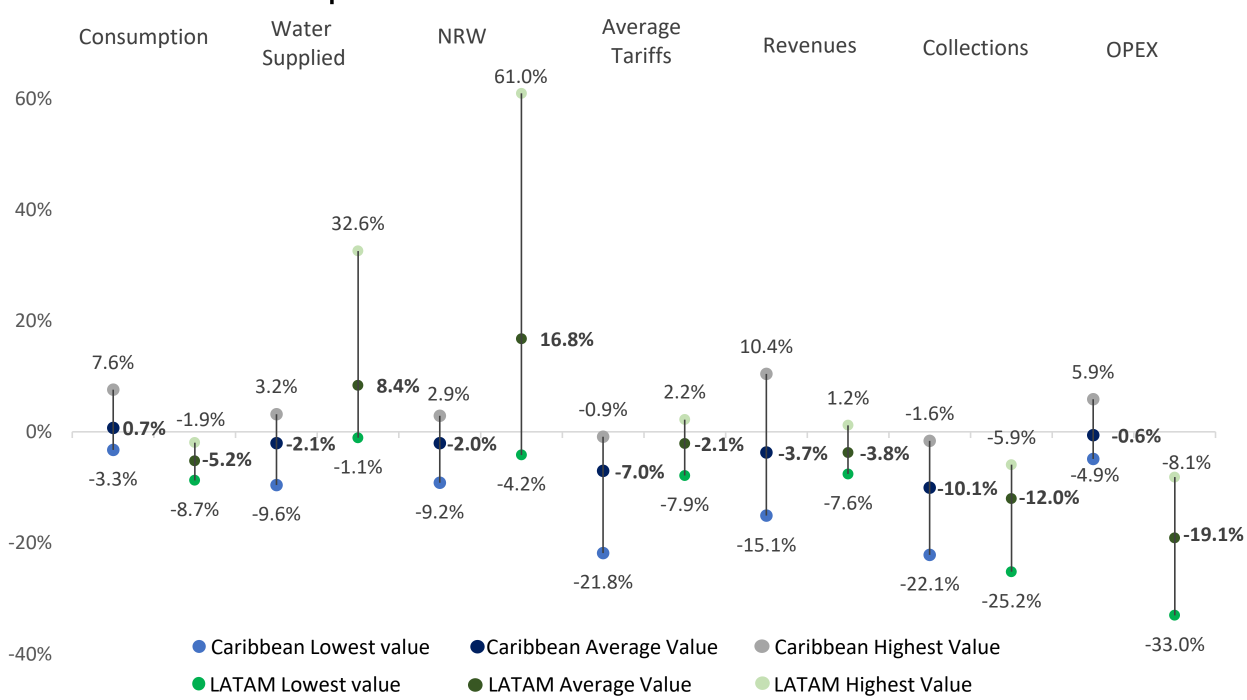
Note: Revenues for SWM are for 2018.

4.2 Assessment of the Impacts of COVID on the Surveyed Water Utilities

Total consumption (measured as water billed to residential and non-residential customers) increased with a marked increase in the share of residential consumption as a result of the decrease in non-residential consumption for three of the five Caribbean utilities we surveyed. The increase in the share of residential consumption (and reduction by non-residential customers) led, on average, to a decrease in revenues and average tariffs. As expected, most Caribbean utilities we surveyed had a decrease in profitability led by a decrease in revenues. In addition to decreases in operating expenditures, several of the utilities reported decreases in CAPEX. The reductions in OPEX and CAPEX will likely adversely impact the quality of service, access, and operating efficiency of the utilities; understanding this impact is necessary for designing effective plans and instruments to strengthen water utilities in the Caribbean.

Figure 4.1 shows the ranges of the impact of COVID on the consumption, water supplied, non-revenue water (NRW), average tariffs, revenues, collections, and operating expenses. disaggregated by Caribbean and Latin American (LATAM) utilities. On average, average tariffs, revenues, collections, and OPEX fell for both Caribbean and LATAM utilities surveyed.

Figure 4.1: Consumption, Water supplied, NRW, Revenues, Collections OPEX, Average tariffs, and CAPEX: pre-COVID vs COVID



Source: K&M's calculations based on information provided by the utilities

Notes: The impact of COVID is measured as the percent change between the pre-COVID and COVID periods.

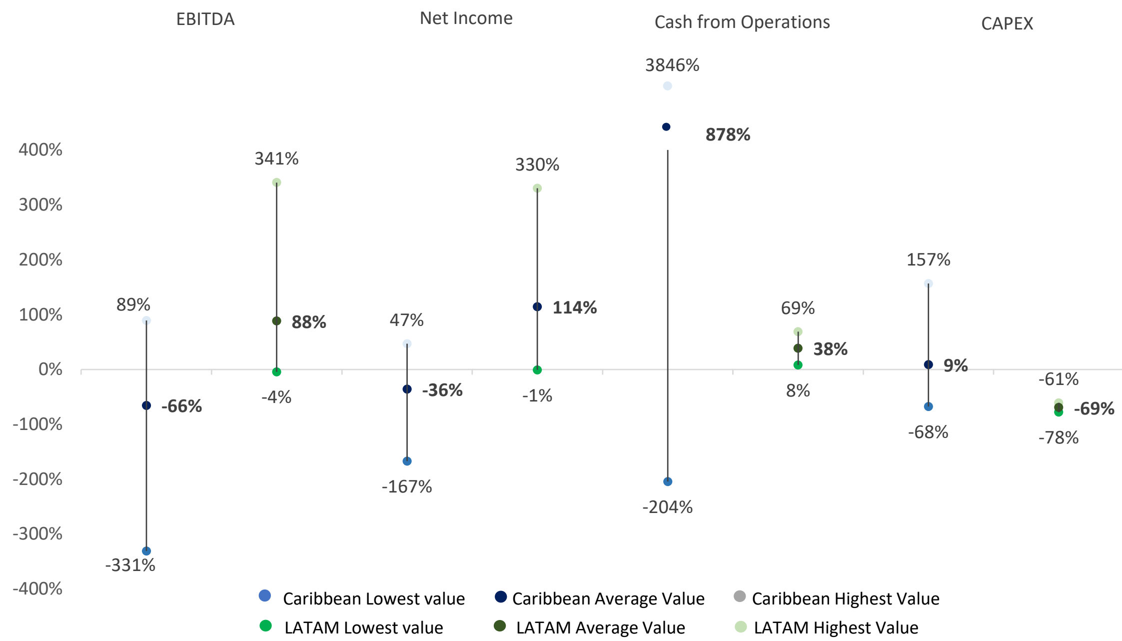
Consumption is measured using billed water. For billed water, water supplied, NRW, and revenues the pre-COVID period is the monthly average for January 2019 and March 2020. For average tariffs, the values for the pre-COVID period are for January 2020 to March 2020. The pre-COVID period for CAPEX for all utilities is for FY2019. The pre-COVID period for OPEX is for the financial year preceding COVID and for COVID, it is the financial year completed after March 2020. The OPEX for SWM (SUR) is not included due to insufficient data.

The COVID period for billed water, water supplied, NRW, revenues, OPEX, and average tariffs is for the average from April 2020 to the last month in 2020 with available data. The COVID period for CAPEX is the monthly average in FY2020.

Figure 4.2 shows the impact of COVID on profitability (as measured by EBITDA and net income), liquidity (as measured by cash from operations), and capital expenditures. The average profitability for the Caribbean utilities surveyed decreased, while that of LATAM utilities increased. Cash from operations, on average, increased for both Caribbean and LATAM utilities, with Caribbean utilities having a bigger increase. The average increase in cash from operations for the

Caribbean utilities we surveyed is largely the result of the increase seen in DOWASCO (DOM). While most Caribbean utilities we surveyed registered a decrease in CAPEX, the marked increase registered in BWS (BEL), led to an increase in the average CAPEX of these utilities. Utilities with decreases in CAPEX and OPEX will likely face deterioration of operating efficiency, quality of service, and access.[55]

Figure 4.2: EBITDA, Net Income, and Cash from Operations: pre-COVID vs COVID



Source: K&M's calculations based on information provided by the utilities

Notes: The impact of COVID is measured as the percent change between the COVID-1 and COVID periods. The values for the COVID-1 period are for the fiscal year before COVID started. The values for the COVID period are for the most current fiscal year after COVID began (assumed to be March 2020). Due to insufficient data, the EBITDA, net income, and cash from operations values do not include SWM (SUR).

The following detailed analysis of the impact of COVID on the surveyed utilities reveals that:

- Consumption increased on average, while changes in volumes of water supplied and NRW were not significant (Section 4.2.1)
- Led by large decreases in revenues from non-residential customers, total revenues from water and wastewater charges fell for three of five Caribbean utilities surveyed (Section 4.2.2)
- Average tariffs fell for all Caribbean utilities surveyed, with NWC (JAM) registering the largest drop (Section 4.2.3)
- OPEX decreased in two of four Caribbean utilities surveyed (Section 4.2.4)

55 Contrary to expectations, and not due to improvements in efficiency, decreases in operating expenditures (OPEX) led to increases in profitability and liquidity in the LATAM utilities surveyed. This unexpected increase in profitability and in cash from operations should not be considered a positive outcome. It is the result of decreases in OPEX, which when combined with decreases in CAPEX, will likely lead to deterioration of operating efficiency, quality of service, and access.

- Most Caribbean utilities surveyed had a decrease in profitability, except for DOWASCO (DOM) where increases in revenues and decreases in OPEX led to increased profitability (Section 4.2.5)
- Collections from customers fell in all utilities surveyed (Section 4.2.6)
- Liquidity seems to have worsened for two of the four Caribbean utilities surveyed (Section 4.2.7)
- Capital expenditures fell in three of the Caribbean utilities surveyed but increases in BWS (BEL) led to an average increase of about nine percent for the Caribbean utilities surveyed (Section 4.2.8)

4.2.1 Consumption increased on average, while changes in volumes of water supplied and NRW were not significant

At the beginning of COVID, it was expected that water utilities would register large increases in residential consumption and, perhaps, an increase in non-revenue water as changes in the location of consumption affected the networks. Of these two hypotheses, the one regarding the increase in residential consumption is confirmed with data from the surveyed utilities. The hypothesis regarding increases in NRW cannot be confirmed. In general, the analysis of the impact of COVID on the surveyed utilities reveals that:

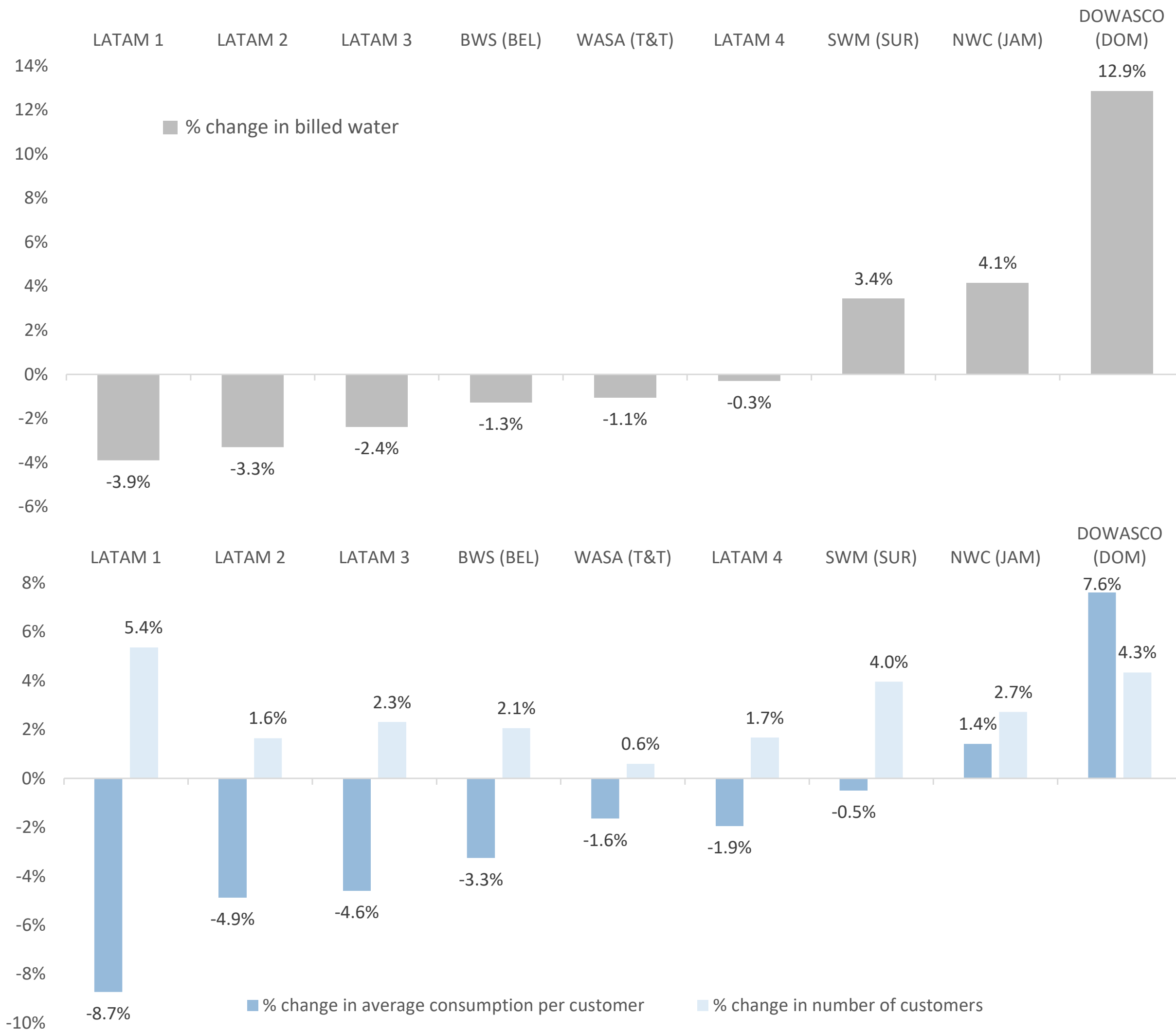
- On average, decreases in non-residential consumption offset increases in residential consumption and led to a marked increase in the residential share of demand
- Caribbean utilities did not register significant changes in volumes of water supplied and/or NRW

These findings are described further below.

On average, decreases in non-residential consumption offset increases in residential consumption and led to an increase in the residential share of demand

Figure 4.3 shows the changes from the pre-COVID period to the COVID period in total consumption and details its decomposition between changes in monthly average consumption (measured as billed water per customer) and number of customers. Changes in total consumption ranged from a 3.9 percent decrease for LATAM 1 to a 12.9 percent increase for DOWASCO (DOM). Three utilities in the Caribbean—SWM (SUR), NWC (JAM), and DOWASCO (DOM)—were the only ones with increases in consumption, with most of the utilities registering a decrease in total consumption. Decreases in average consumption per customer, primarily for non-residential customers, offset increases in the number of customers.

Figure 4.3: Changes in consumption from pre-COVID to COVID



Source: K&M's calculations based on information provided by the utilities

Notes: The % change for all the variables in the figure is calculated as the change between the pre-COVID period and COVID period.

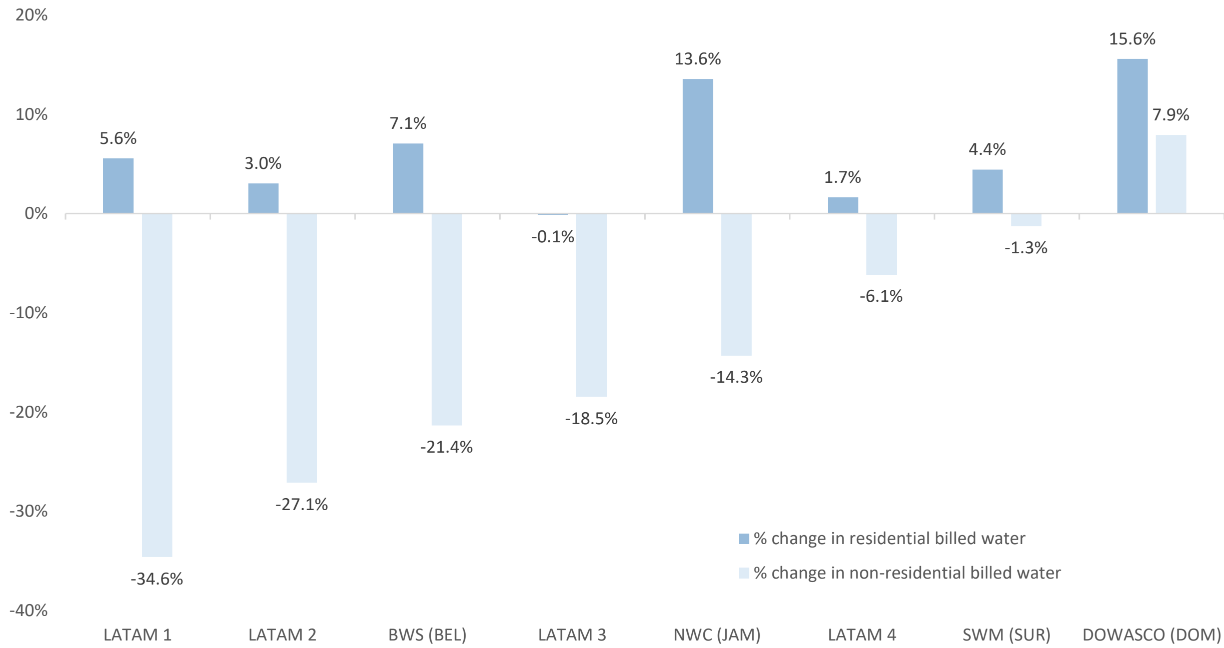
The pre-COVID period for all utilities is the monthly average from January 2019 to March 2020.

The COVID period for LATAM 2, BWS (BEL), LATAM 5, and NWC (JAM) is the monthly average from April 2020 to October 2020. For LATAM 1, DOWASCO (DOM), LATAM 3, LATAM 4, SWM (SUR), and WASA (T&T) it is the monthly average from April 2020 to September 2020.

For DOWASCO (DOM) only annual data for number of customers is available.

Figure 4.4 shows the changes in monthly average consumption (measured as billed water) from the pre-COVID period to the COVID period, differentiated by residential and non-residential customers. Among the Caribbean utilities surveyed, DOWASCO (DOM) was the only one in which non-residential consumption increased, while BWS (BEL), NWC (JAM), and SWM (SUR) had decreases in non-residential consumption. For BWS (BEL) and NWC (JAM), the decreases in non-residential consumption offset the increases in residential consumption. DOWASCO (DOM) registered the highest increase in residential consumption (15.6 percent).

Figure 4.4: Percent changes in consumption: residential vs non-residential



Source: K&M's calculations based on information provided by the utilities

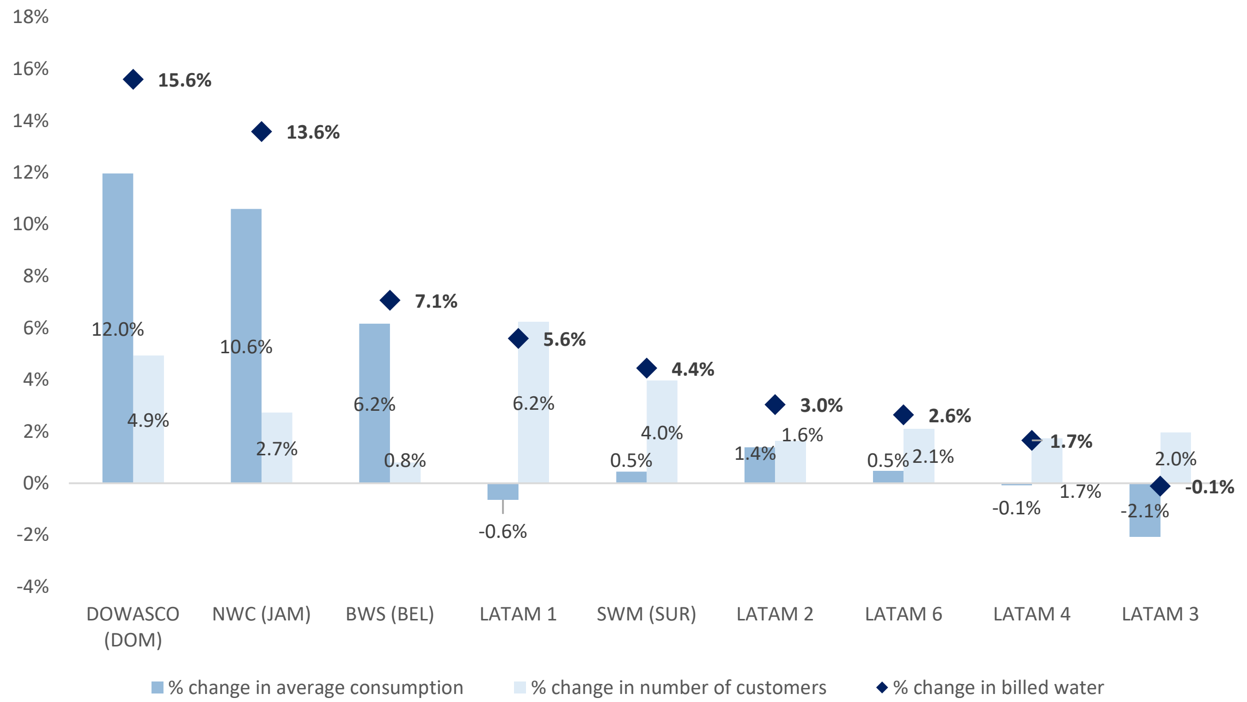
Notes: The % change in residential billed water and non-residential billed water is calculated as the change between the pre-COVID period and COVID period. The pre-COVID period for all utilities is the monthly average from January 2019 to March 2020.

The COVID period for LATAM 2, BWS (BEL), LATAM 5, and NWC (JAM) is the monthly average from April 2020 to October 2020. For LATAM 1, DOWASCO (DOM), LATAM 3, LATAM 4, and SWM (SUR) it is the monthly average from April 2020 to September 2020.

Information on residential and non-residential consumption for WASA (T&T) is not available.

Figure 4.5 shows the changes in monthly average residential consumption (measured as billed water) from the pre-COVID period to the COVID period, decomposed by the percent change in number of customers and average consumption. All Caribbean utilities registered increases in residential consumption. DOWASCO (DOM), NWC (JAM), and BWS (BEL) were the three utilities in the sample with the largest increases in residential consumption. These increases resulted from an increase in the number of customers (for all the utilities) and/or an increase in average consumption per customer (in six of the utilities). At 15.6 percent, DOWASCO (DOM) had the largest increase in residential consumption. This increase was the result of a 12.0 percent increase in average consumption per customer and a 4.9 percent increase in the number of customers.

Figure 4.5: Decomposition of changes in residential consumption



Source: K&M's calculations based on information provided by the utilities.

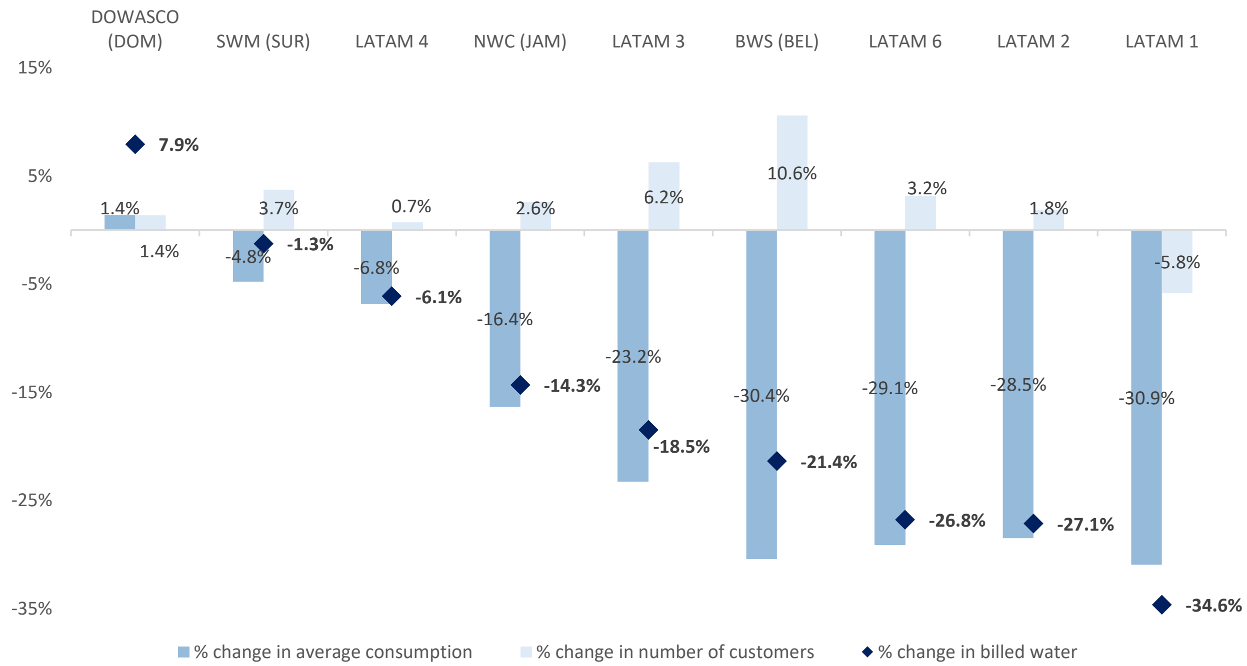
Notes: The % change for all the variables in the figure is calculated as the change between the pre-COVID period and COVID period. The pre-COVID period for all utilities is the monthly average from January 2019 to March 2020.

The COVID period for LATAM 2, BWS (BEL), LATAM 5, and NWC (JAM) is the monthly average from April 2020 to October 2020. For LATAM 1, DOWASCO (DOM), LATAM 3, LATAM 4, and SWM (SUR) it is the monthly average from April 2020 to September 2020.

WASA (T&T) is not included in the graph because we only have partial information from this utility.

Figure 4.6 shows the changes in monthly average non-residential consumption (measured as billed water) from the pre-COVID period to the COVID period, decomposed by the percent change in number of customers and monthly average consumption. Except for DOWASCO (DOM), all the utilities for which we have relevant data registered a decrease in non-residential consumption. These decreases resulted from falls in average consumption by non-residential customers ranging from 4.8 percent for SWM (SUR) to 30.9 percent for LATAM 1.

Figure 4.6: Decomposition of changes in non-residential consumption



Source: K&M's calculations based on information provided by the utilities

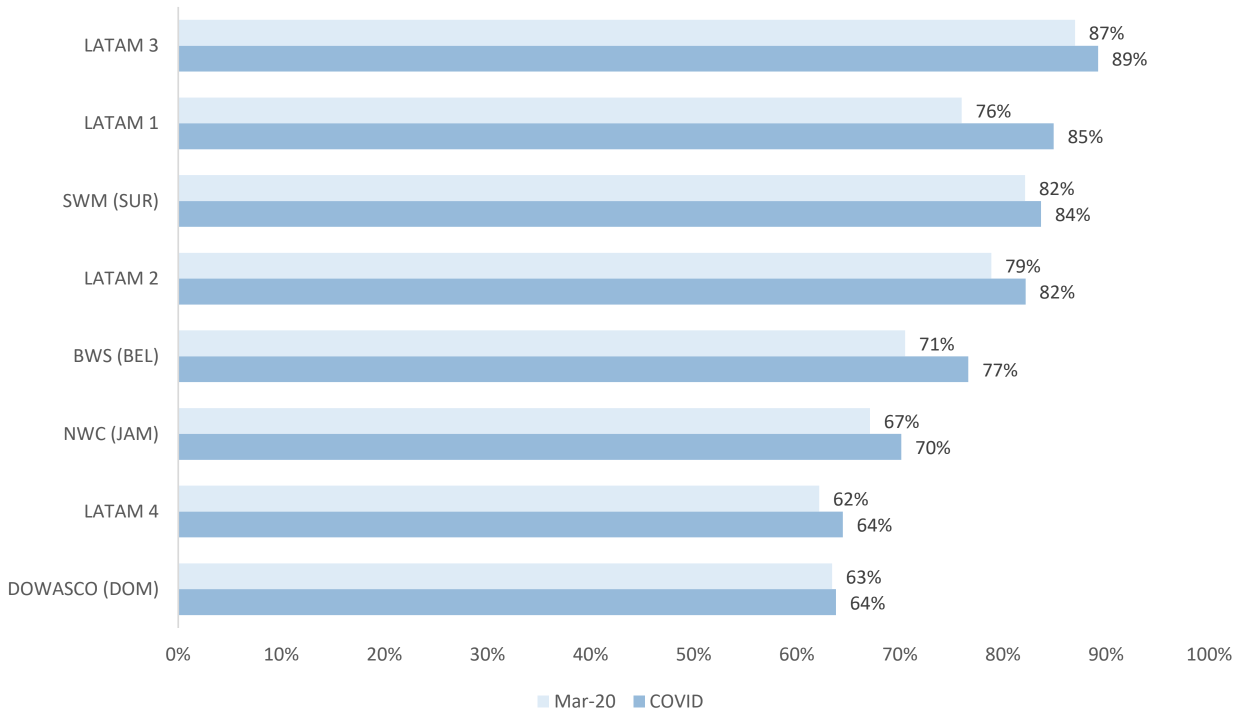
Notes: The percent change for all the variables in the figure is calculated as the change between the pre-COVID period and COVID period. The pre-COVID period for all utilities is the monthly average between January 2019 and March 2020.

The COVID period for LATAM 2, BWS (BEL), LATAM 5, and NWC (JAM) is the monthly average from April 2020 to October 2020. For LATAM 1, DOWASCO (DOM), LATAM 3, LATAM 4, SWM (SUR), and it is the monthly average from April 2020 to September 2020. For LATAM 6, it is the monthly average from April 2020 to May 2020.

WASA (T&T) is not included in the graph because we only have partial information from this utility.

As a result of the increases in residential consumption and decreases in non-residential consumption, the share of residential consumption rose in all utilities for which we have relevant data. Figure 4.7 shows residential consumption as a share of total consumption for all the utilities for which we have relevant data. The largest increases in the share of residential consumption were in LATAM 1 (from 76 to 85 percent) and BWS (BEL) (from 71 to 77 percent).

Figure 4.7: Residential consumption as a percent of total: pre-COVID vs COVID



Source: K&M's calculations based on information provided by the utilities

Notes: The COVID values correspond to the most recent month in 2020, after March 2020. For LATAM 2, BWS (BEL), and NWC (JAM), the value is for October 2020. For LATAM 1, DOWASCO (DOM), LATAM 3, LATAM 4, and SWM (SUR) it is for September 2020. For LATAM 6, it is for May 2020.

WASA (T&T) is not included in the graph because we do not have complete information for this utility.

Nearly all the surveyed utilities have tariffs with cross subsidies from non-residential customers to residential customers. If this shift in demand persists after COVID, average tariffs and, most likely revenues also, may fall below the levels present before COVID. For those surveyed utilities with tariffs set by regulators on what is intended to be a cost recovery basis—for example, those in Colombia and Jamaica—the regulators will need to review the underlying demand forecasts to ensure the tariffs continue to be adequate.

Caribbean utilities did not register significant changes in volumes of water supplied and/or non-revenue water

Table 4.2 shows the percent changes in average monthly consumption (measured as billed water), water supplied, and NRW from the pre-COVID period to the COVID period. For most of the surveyed utilities, COVID did not result in a significant change in the volumes of water supplied and NRW. NWC (JAM) and WASA (T&T) had slight increases in both variables, while SWM (SUR) had a decrease.

Table 4.2: Changes in consumption, water supply, and volume of NRW

Utility	% change in total consumption	% change in water supplied	% change in NRW
LATAM 2	-3.3%	1.0%	10.8%

LATAM 1	-3.9%	-1.1%	-4.2%
BWS (BEL)	-1.3%	NA	NA
DOWASCO (DOM)	12.9%	NA	NA
LATAM 3	-2.4%	32.6%	61.0%
LATAM 4	-0.2%	1.1%	-0.6%
NWC (JAM)	4.1%	3.2%	2.9%
SWM (SUR)	3.4%	-9.6%	-9.2%
WASA (T&T)	0.2%	0.2%	0.2%

Source: K&M's calculations based on information provided by the utilities

Notes: The % change in consumption (as measured by billed water), supply, and NRW are calculated as the change in monthly averages between the pre-COVID period and COVID period.

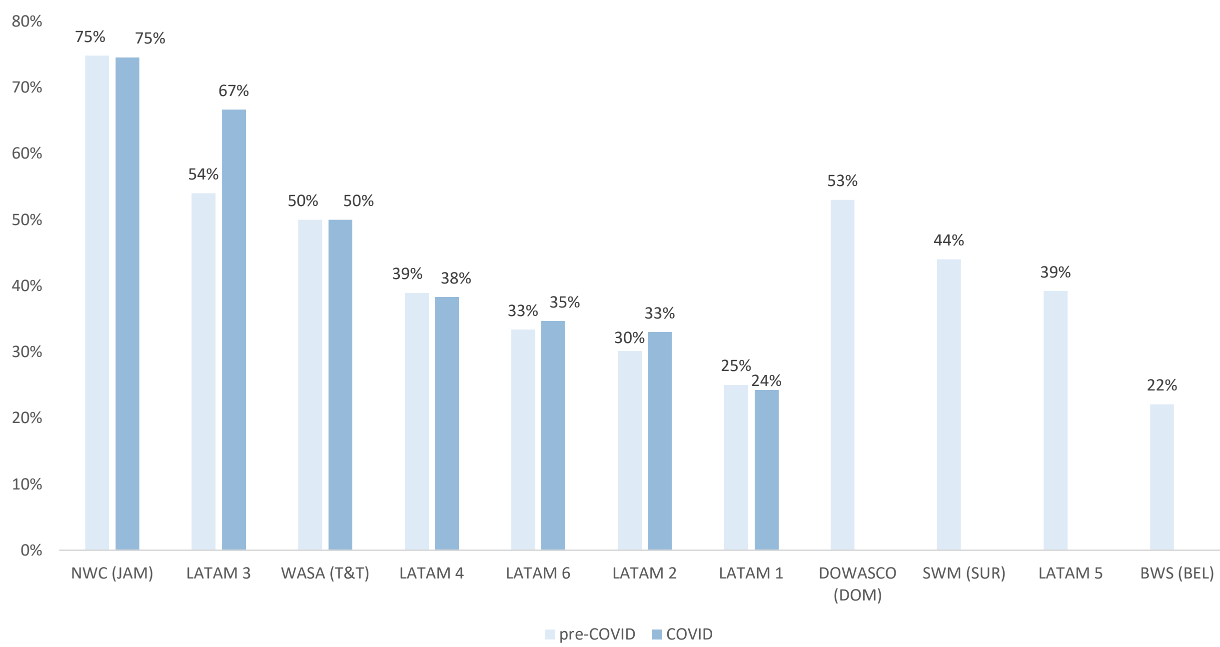
The pre-COVID periods for LATAM 2, LATAM 1, BWS (BEL), DOWASCO (DOM), LATAM 3, LATAM 6, LATAM 4, NWC (JAM) and WASA (T&T) is the monthly average from January 2019 to March 2020. For SWM (SUR), it is the monthly average from January 2019 to December 2019.

The COVID period for LATAM 2, BWS (BEL), NWC (JAM), and WASA (T&T) is the monthly average from April 2020 to October 2020. For LATAM 1, DOWASCO (DOM), and LATAM 3 it is the monthly average from April 2020 to September 2020. For LATAM 4, it is the monthly average from April 2020 to August 2020. For SWM (SUR) the COVID period is the monthly average from January 2020 to September 2020.

For BWS (BEL) we did not receive any data for water supply or NRW after March 2020. For DOWASCO (DOM) we only have annual data for FY2018 and FY2019 for water supply and NRW.

Figure 4.8 compares NRW as a percent of water supplied for the pre-COVID period with the COVID period. COVID did not lead to a significant change in this indicator for most of the surveyed utilities.

Figure 4.8: NRW percent: pre-COVID vs COVID



Source: K&M's calculations based on information provided by the utilities

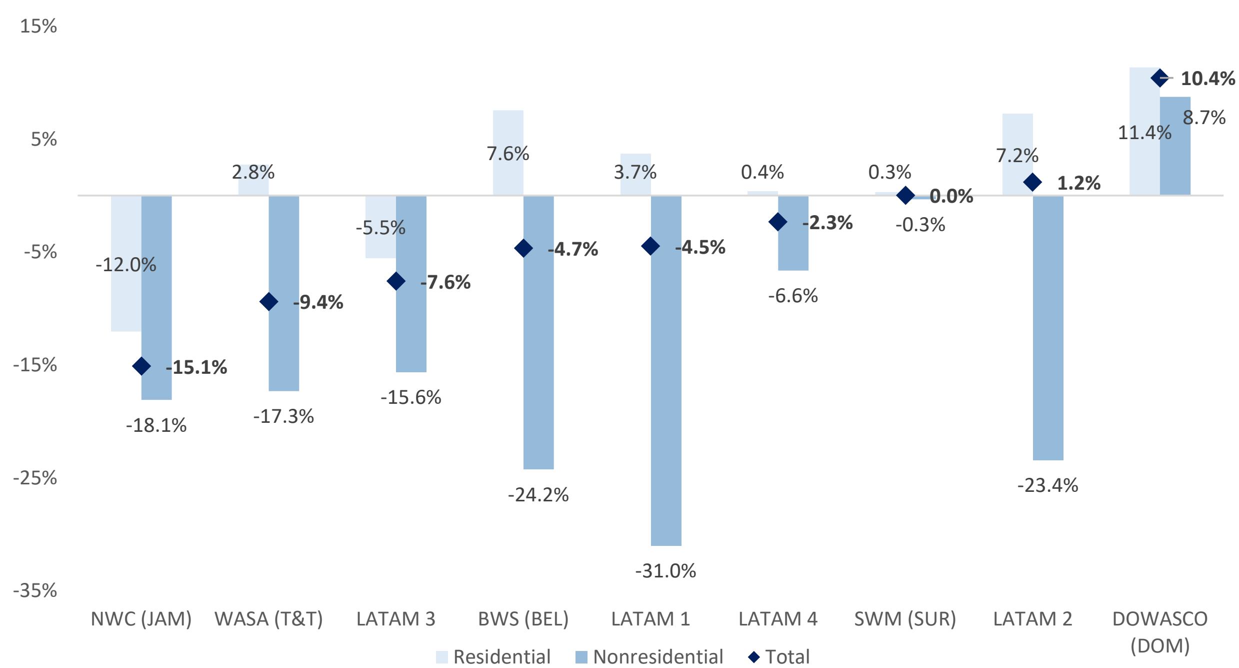
Notes: The pre-COVID values calculated as the average from January 2019 to March 2020. The COVID period values for LATAM 2, NWC (JAM), and WASA (T&T) are calculated as the average from April 2020 to October 2020. For LATAM 1 and LATAM 3 the value is calculated as the average from April to September 2020. For LATAM 4 the value is the average from April 2020 to August 2020, and for LATAM 6, it is the average for April 2020 and May 2020.

For BWS (BEL), DOWASCO (DOM), and SWM (SUR) we do not have sufficient available data for the COVID period.

4.2.2 Led by large decreases in revenues from non-residential customers, total revenues from water and wastewater charges fell for three of five Caribbean utilities surveyed

Figure 4.9 shows the percent changes in monthly average revenues from charges for water and wastewater from the pre-COVID period to the COVID period. These revenues fell for six of the utilities (ranging from 15.1 percent for NWC (JAM) to 2.3 percent for LATAM 4). This fall was caused by a decline of over 15 percent in revenues from non-residential customers for five of the utilities. As described in Section 4.2.1, reductions in non-residential customers produced this decline in revenues. In contrast, revenues from residential customers increased for most of the utilities. NWC (JAM) and LATAM 3 were the only utilities with reductions in revenues from residential and non-residential customers, and DOWASCO (DOM) was the only utility with increases in both residential and non-residential revenues.

Figure 4.9: Percent changes in revenues from charges for water and wastewater



Source: K&M's calculations based on information provided by the utilities

Notes: The percent change in residential, non-residential, and total revenues is calculated as the change in average monthly values between the pre-COVID period and COVID period.

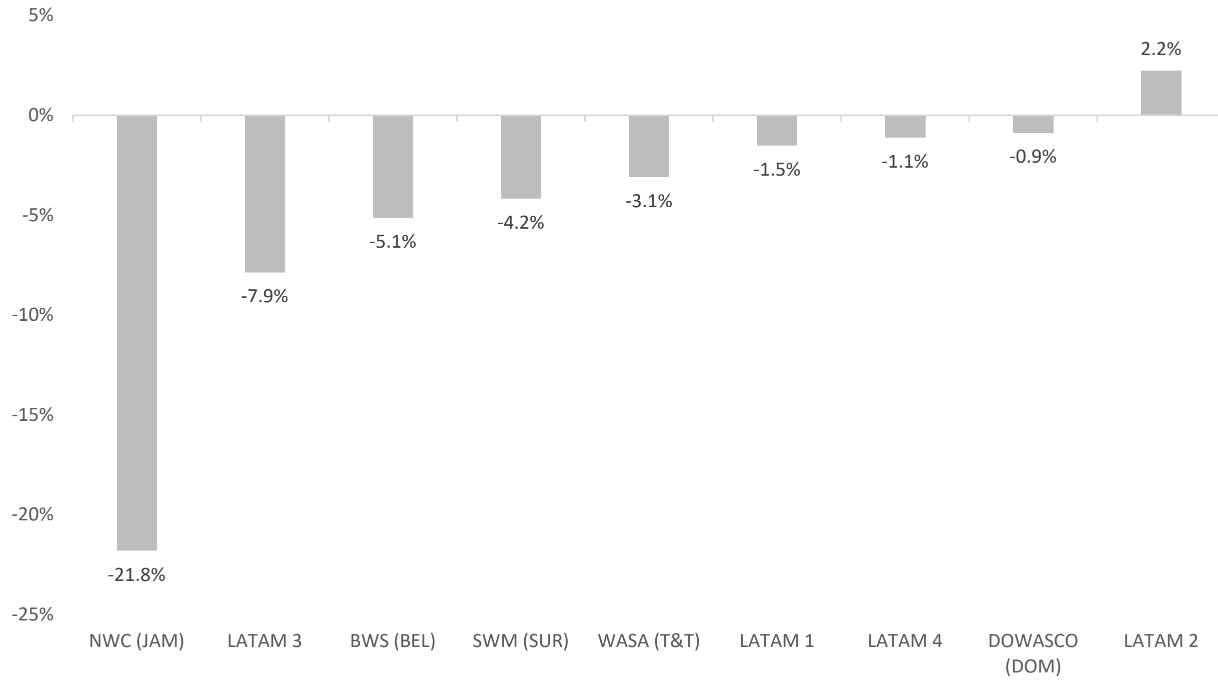
The values for the pre-COVID period for all utilities equal the monthly averages for January 2019 to March 2020.

The values for the COVID period for LATAM 2 and NWC (JAM) are calculated as the monthly averages for April 2020 to October 2020. For LATAM 1, BWS (BEL), DOWASCO (DOM), LATAM 3, LATAM 4, SWM (SUR), and WASA (T&T) the values are calculated as the monthly averages from April 2020 to September 2020.

4.2.3 Average tariffs fell for all Caribbean utilities surveyed, with NWC (JAM) registering the largest drop

Figure 4.10 shows that average tariffs, measured as revenues from water charges divided by billed water, fell for eight of the nine surveyed utilities. NWC (JAM) and LATAM 3 registered the largest declines in average tariffs. The decrease in the share of non-residential consumption likely accounts for this fall in average tariffs.

Figure 4.10: Percent change in average tariff



Source: K&M's calculations based on information provided by the utilities

Notes: The percent change in the average tariff is calculated as the change between the pre-COVID period and COVID period.

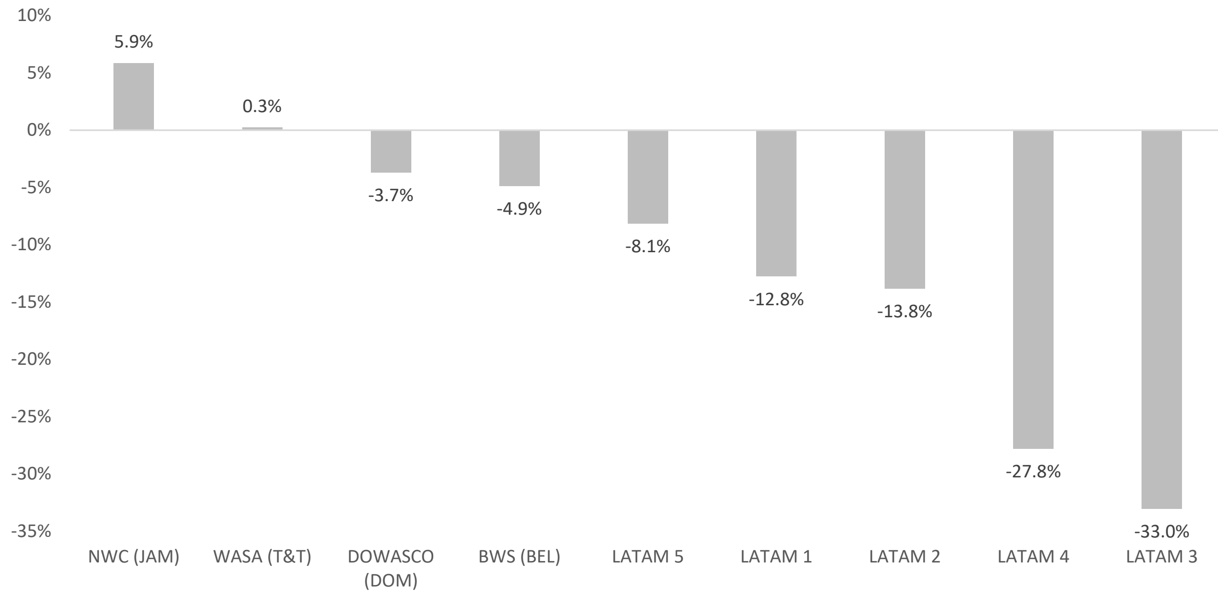
The pre-COVID period value for all utilities equals the monthly average for January 2020 to March 2020.

The COVID period value for LATAM 2, BWS (BEL) and NWC (JAM) is calculated as the monthly average for April 2020 to October 2020. For LATAM 1, DOWASCO (DOM), LATAM 3, LATAM 4, SWM (SUR), and WASA (T&T) the value is calculated as the monthly average from April 2020 to September 2020.

4.2.4 OPEX decreased in two of four Caribbean utilities surveyed

Figure 4.11 shows the changes in OPEX from the pre-COVID period to the COVID period. Two of the Caribbean utilities surveyed—BWS (BEL) and DOWASCO (DOM)—registered a decrease in OPEX, while NWC (JAM) and WASA (T&T) registered increases. On the contrary, all LATAM utilities for which we have relevant data for, registered a decrease in OPEX. The decreases in OPEX may be due to logistical difficulties related to COVID or the utilities having less cash available (due to a decrease in collections as described in Section 4.2.6), and, therefore, reducing expenses on items that may not be priorities (for example, repairs and maintenance). The reduction in OPEX may lead to a deterioration in operating efficiency and quality of service of the utilities, especially when combined with the reduction in capital expenditures described in Section 4.2.8.

Figure 4.11: Changes in OPEX: pre-COVID vs COVID



Source: K&M's calculations based on information provided by the utilities

Notes: The percent change is calculated as the change between the pre-COVID period and COVID period.

The values for the pre-COVID period for LATAM 1, LATAM 2, LATAM 3, LATAM 4, and LATAM 5 are from January 2019 to December 2019. For BWS (BEL) and NWC (JAM) the values are the monthly average for April 2019 to March 2020. The value for DOWASCO is from July 2018 to June 2019. The value for WASA is from October 2018 to September 2019.

The values for the COVID period for LATAM 1, LATAM 2, LATAM 3, and LATAM 5 are from January 2020 to September 2020. The value for LATAM 4 is for January 2020 to June 2020. For BWS (BEL) the values are for April 2020 to September 2020. For NWC (JAM) the values are for April 2019 to October 2020.The value for DOWASCO (DOM) is from July 2019 to June 2020. The value for WASA (T&T) is from October 2019 to September 2020.

For LATAM 6 we only received values through May 2020. With the values for April 2020 and May 2020, the change in OPEX for LATAM 6 is a 34.4 percent decrease when compared to the average from January 2020 to March 2020.

SWM (SUR) is not included in the figure because we do not have the utility's financial statements for any period after 2018.

Table 4.3 quantifies the change from pre-COVID to COVID, in percent and on an absolute basis in local currency units (LCU), in key OPEX items for three Caribbean utilities. For the two utilities for which 'repairs and maintenance' could easily be identified, this item decreased significantly on a percent and monetary basis. BWS (BEL) reported a 21.3 percent decrease and NWC (JAM) a 55.9 percent decrease in this item. BWS (BEL) also registered decreases in staff cost equivalent to 7.8 percent.

Table 4.3: Analysis of OPEX: pre-COVID vs COVID

	pre-COVID	Apr 19 - Mar 20	Apr 19 - Mar 20	Oct 18 - Sep 19
	COVID	Apr 20 - Sep 20	Apr 20 - Oct 20	Oct 19 - Sep 20
		BWS (BEL)	NWC (JAM)	WASA (T&T)
Percent change pre-COVID to COVID				
Staff costs	%	-7.8%	17.7%	0.6%
Electricity costs	%	2.0%	9.1%	-21.9%
Repair and maintenance	%	-21.3%	-55.9%	NA
Chemicals	%	NA	NA	-7.3%
Water purchases	%	NA	-9.1%	-1.1%
Connection costs	%	NA	NA	NA
Bad debt	%	NA	14.3%	NA
Other OPEX	%	2.4%	85.6%	6.8%
Total OPEX	%	-4.9%	5.9%	0.3%
Increase/(decrease) pre-COVID to COVID				
Staff costs	LCU millions	(1.06)	1,555	7.42
Electricity costs	LCU millions	0.06	688	(24.06)
Repair and maintenance	LCU millions	(0.82)	(3,379)	NA
Chemicals	LCU millions	NA	NA	(2.76)
Water purchases	LCU millions	NA	(45)	(5.81)
Connection costs	LCU millions	NA	NA	NA
Bad debt	LCU millions	NA	699	NA
Other OPEX	LCU millions	0.27	2,265	31.35
Total OPEX	LCU millions	(1.55)	1,783	6.14

Source: K&M's calculations based on information provided by the utilities

NA indicates information was not available for the calculation.

Notes: The percent change and increase/(decrease) in LCU millions pre-COVID to COVID are calculated as the change between the COVID-1 period and COVID period.

The same level of detail was not available for each of the surveyed utilities.

4.2.5 Most Caribbean utilities surveyed had a decrease in profitability, except for DOWASCO (DOM) where increases in revenues and decreases in OPEX led to increased profitability

Table 4.4 shows the change from pre-COVID to COVID, in percent and on an absolute basis in LCU, in the key items on the income statement. Profitability, as measured by EBITDA and Net

Income, increased for DOWASCO (DOM).[56] BWS (BEL), NWC (JAM) and WASA (T&T) registered decreases in profitability. For BWS, the decrease in profitability was primarily determined by a decrease in revenues. For NWC (JAM) and WASA (T&T) the decrease in EBITDA can be attributed to a decrease in revenues and an increase in OPEX.

Table 4.4: Impact on income statement: pre-COVID vs COVID

		BWS	DOWASCO	NWC	WASA
	pre-COVID	Apr 19 - Mar 20	Jul 18 - Jun 19	Apr 19 - Mar 20	Oct 18 - Sep 19
	COVID	Apr 20 - Sep 20	Jul 19 - Jun 20	Apr 20 - Oct 20	Oct 19 - Sep 20
Percent change pre-COVID to COVID					
Revenues	%	-8.8%	10.5%	-2.1%	-9.2%
OPEX	%	-4.9%	-3.7%	24.2%	0.3%
EBITDA	%	-15.4%	89.2%	-183.0%	-4.9%
Depreciation	%	8.4%	6.4%	-5.3%	21.3%
Other revenues	%	0.0%	-88.7%	46.5%	-19.9%
Other expenses	%	0.0%	0.0%	-48.9%	0.0%
Net interest income/(expenses)	%	-17.7%	4.3%	-1.8%	0.9%
Taxes	%	17.1%	0.0%	-69.5%	0.0%
Net income/(loss)	%	-41.9%	47.0%	-27.1%	-167.3%
Increase/(decrease) pre-COVID to COVID					
Revenues	LCU millions	**(4.50)**	1.87	(615)	(72.21)
OPEX	LCU millions	(1.55)	**(0.60)**	**6,264**	6.14
EBITDA	LCU millions	(2.95)	2.52	(6,880)	(78.36)
Depreciation	LCU millions	0.67	(0.31)	(289)	57.48
Other revenues	LCU millions	-	(0.07)	1,671	**(352.81)**
Other expenses	LCU millions	-	-	(3,027)	-
Net interest income/(expenses)	LCU millions	(0.18)	(0.10)	43	1.79
Taxes	LCU millions	(0.15)	-	(714)	-
Net income/(loss)	LCU millions	(3.37)	1.28	(2,564)	(490.44)

Source: K&M's calculations based on information provided by the utilities

NA indicates information was not available for the calculation.

Notes: The percent change and increase/(decrease) in LCU millions pre-COVID to COVID are calculated as the change between the COVID-1 period and COVID period.

The shaded values indicate the item on the income statement for each utility that was most determinant in the results of the COVID period.

SWM (SUR) is not included because we do not have financial statements for them beyond FY 2018.

Table 4.5 shows the EBITDA margin for the Caribbean surveyed utilities and the average of the utilities in LATAM for each of the two years prior to COVID (COVID-2 and COVID-1) and COVID. The value for COVID is for the most recent period in 2020 with financial statements (assuming that it includes months after March 2020). For example, since the financial year for BWS (BEL) is from April to March, COVID-2 for BWS (BEL) is from April 2018 to March 2019, COVID-1 is from April 2019 to March 2020, and COVID is from April 2020 to March 2021. BWS (BEL), NWC (JAM), and WASA (T&T)

[56] These results are based on financial statements that are not for a full financial year. It is possible that the financial statements for the full financial years may have slightly different results. It is recommended that the results of this analysis be confirmed when the financial statements for the full financial years are available.

had the lowest EBITDA margin during the COVID period, while the average for LATAM utilities (LATAM AVG) shows that the highest EBITDA margins for these utilities was during the COVID period.

Table 4.5: EBITDA Margin in COVID-2, COVID-1, and COVID

Utility	COVID-2	COVID-1	COVID
BWS (BEL)	38.0%	37.5%	34.8%
DOWASCO (DOM)	-8.8%	14.8%	25.4%
NWC (JAM)	2.8%	-2.4%	-10.7%
WASA (T&T)	-175.9%	-204.8%	-236.7%
SWM (SUR)	1.3%	NA	NA
CARIBBEAN AVG	-28.5%	-38.7%	-46.8%
LATAM AVG	8,7%	5.6%	22.6%

Source: K&M calculations based on information provided by the utilities.

Notes: The COVID EBITDA margin is for the most recent period in 2020 with financial statements. For LATAM 1, LATAM 2, LATAM 3, LATAM 5 it is for January 2020 to September 2020. For LATAM 4 it is for January 2020 to Jun 2020, for LATAM 6 it is for January 2020 to May 2020, for BWS (BEL) for April 2020 to September 2020, for DOWASCO for July 2019 to June 2020, for NWC (JAM) for April 2020 to October 2020, and for WASA (T&T) for October 2019 to September 2020.

The COVID-1 EBITDA margin is for the fiscal year that preceded the COVID period. The COVID-2 EBITDA margin is for the fiscal year two years before the COVID period.

Financial statements for SWM (SUR) are not available after FY2018.

Table 4.6 shows the annualized net income in LCU millions for each of the surveyed Caribbean utilities in the financial year before COVID and the financial year that included COVID. It also shows the percent change from one period to the next. For example, the annualized net income for BWS (BEL) in COVID-1 was BZD8.0 million and in the most recent period with financial statements that included COVID (April 2020 to March 2021) it was BZD4.7, resulting in a 42 percent decrease. Annualized income increased for DOWASCO (DOM) and NWC (JAM) during COVID both of which had net losses in both periods.

Table 4.6: Changes in annualized net income

Utility	Annualized Net Income (COVID-1 in LCU million)	Annualized Net Income (COVID in LCU million)	% change from COVID-1 to COVID
DOWASCO (DOM)	(4.3)	(2.3)	47%
NWC (JAM)	(10,149)	(8,231)	19%
BWS (BEL)	8.0	4.7	-42%
WASA (T&T)	(293)	(784)	-167%

Source: K&M calculations based on information provided by the utilities.

Notes: The annualized net income for the COVID-1 period for BWS (BEL), DOWASCO, and WASA (T&T) is for FY2019.

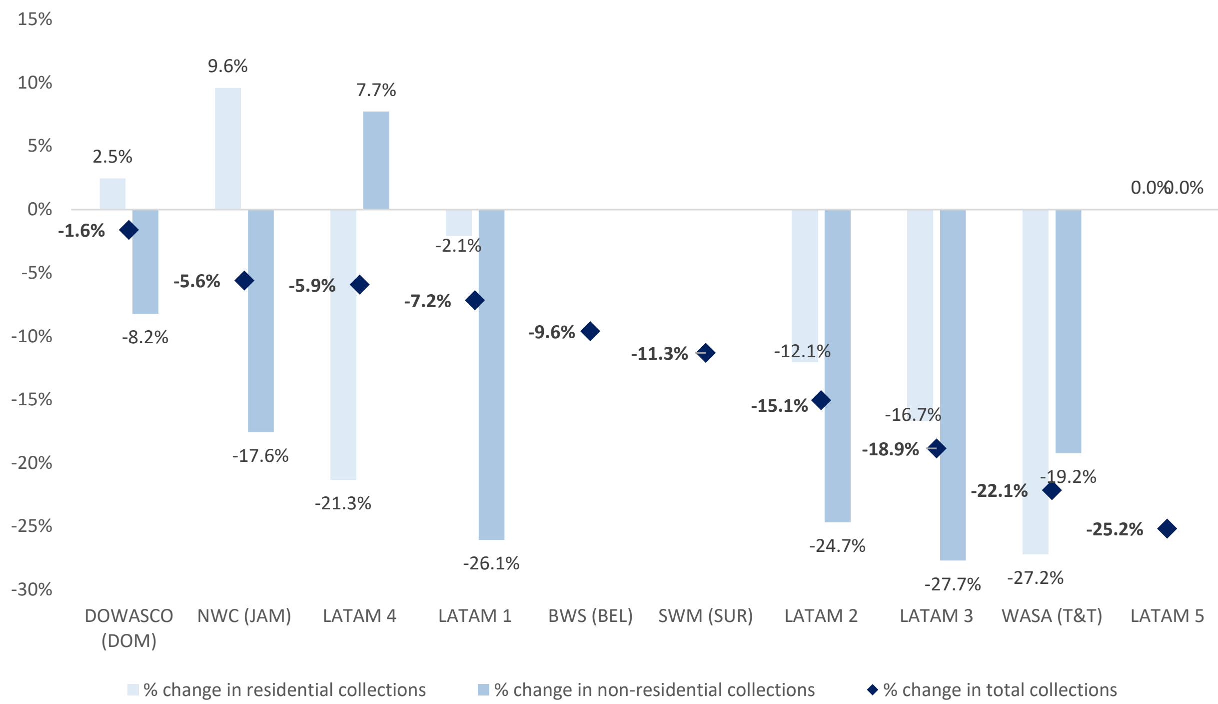
The annualized net income for the COVID period for BWS (BEL) is for the period from January 2020 to September 2020. For DOWASCO (DOM) the value is for the period from January 2020 to June 2020, for NWC (JAM) the value is for the period from April 2020 to October 2020, and for WASA (T&T) it is for the period from October 2019 to September 2020.

SWM (SUR) is not included because it does not have financial statements available after December 2018.

4.2.6 Collections from customers fell in all utilities surveyed

Figure 4.12 shows the percent change in monthly average collections from the pre-COVID period to the COVID period. This change is shown for all customers, and then differentiated by residential and non-residential customers. Collections fell for all utilities during COVID, ranging from a decrease of 1.6 percent for DOWASCO (DOM) to 25.2 percent for LATAM 5. Six of the utilities had decreases in collections from non-residential customers. DOWASCO (DOM) and NWC (JAM) were the only utilities with increases in collections from residential customers.

Figure 4.12: Changes in collections from customers: pre-COVID vs COVID



Source: K&M's calculations based on information provided by the utilities.

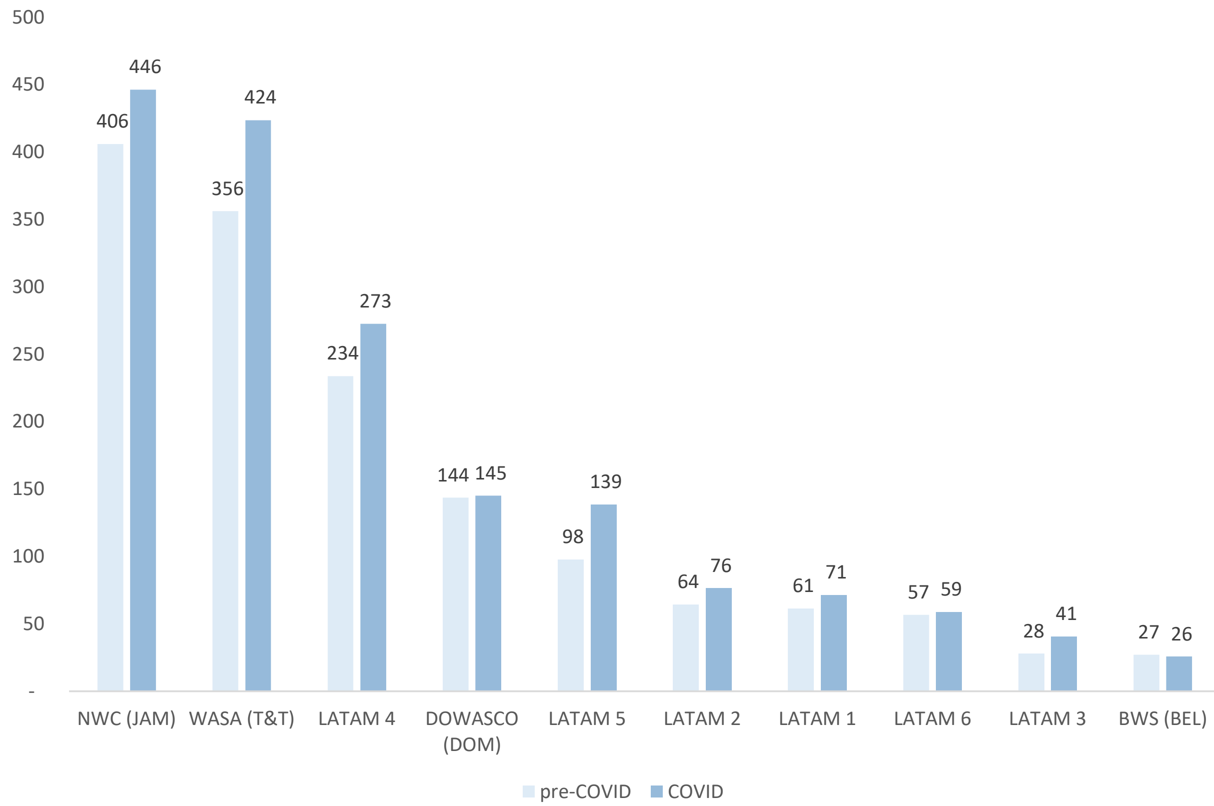
Notes: The % change is calculated as the change in the monthly average between the pre-COVID period and COVID period. The pre-COVID period for all utilities is the monthly average for January 2019 to March 2020.

The COVID period for LATAM 2 and NWC (JAM) is the monthly average for the period from April 2020 to October 2020. For BWS (BEL), DOWASCO (DOM), LATAM 1, LATAM 3, LATAM 4, LATAM 5, SWM (SUR), and WASA (T&T) the value is the monthly average from April 2020 to September 2020.

We do not have data on collections disaggregated by residential and non-residential customers for BWS (BEL) and SWM (SUR).

Figure 4.13 compares the value for accounts receivable (AR) days (calculated as gross accounts receivable divided by revenues times 365) in the pre-COVID period with the value in the COVID period. This is an indicator of the amount due by customers to the utilities, with a value around 60 being considered good. The figure shows that AR days increased from the pre-COVID period to the COVID period for all utilities for which we have relevant data.

Figure 4.13: Accounts receivable days: pre-COVID vs COVID



Source: K&M's calculations based on information provided by the utilities. The values for the COVID period are calculated as follows: Gross Accounts Receivable at the end of the period for which we have information divided by the annualized revenues for the period for which we have information.

Notes: The pre-COVID period for LATAM 1, LATAM 2, LATAM 3, LATAM 4, LATAM 5, LATAM 6, DOWASCO (DOM), and WASA (T&T) is for FY2020. For BWS (BEL) and NWC (JAM), the pre-COVID period corresponds to FY2020.

The value for the COVID period for LATAM 1, LATAM 2, LATAM 3, and LATAM 5 equals the accumulated values from January 2020 to September 2020. For DOWASCO (DOM) it equals the accumulated values from July 2020 to September 2020. For LATAM 6, it equals the accumulated values from January 2020 to May 2020. For LATAM 4 it equals the accumulated values from January 2020 to Jun 2020. For WASA (T&T), the COVID values are for October 2019 to September 2020.

We do not have data on accounts receivable for FY2019 or FY2020 for SWM (SUR). We do not have data on accounts receivable for BWS for the period after March 2020.

4.2.7 Liquidity seems to have worsened for two of the four Caribbean utilities surveyed

To measure the impact of COVID on the financial liquidity of the utilities, we used two indicators, the current ratio and net cash flows from operations. Contrary to expectations, the liquidity for two Caribbean utilities seems to have improved during COVID. This improvement in liquidity is the result of the reduction in OPEX exceeding the reduction in collections. Table 4.7 shows the current ratio (calculated as current assets divided by current liabilities) and the adjusted current ratio (calculated as current assets minus accounts receivable divided by current liabilities) for each utility in the pre-COVID period and the COVID period.[57] Both ratios will increase when the utility's liquidity increases. In addition, a value below 1.0 for the current ratio indicates that the utility may have difficulty covering its current liabilities (obligations due within the next 12 months) with its current assets. During COVID, the current ratio and adjusted current ratio both fell for two Caribbean utilities, DOWASCO (DOM) and NWC (JAM) (indicating a decrease in liquidity). None of the Caribbean utilities had an increase in both ratios. Also, out of the Caribbean utilities, only BWS (BEL) had a current ratio above 1.0 during COVID. For the LATAM utilities, all had an increase in the current ratio.

Table 4.7: Current Ratio and Adjusted Current Ratio: pre-COVID vs COVID

Utility	Current Ratio (pre-COVID)	Current Ratio (COVID)	Current Ratio (% change)	Adjusted Current Ratio (pre-COVID)	Adjusted Current Ratio (COVID)	Adjusted Current Ratio (% change)
BWS (BEL)	1.50	1.83	22%	1.26	1.04	-17%
DOWASCO (DOM)	1.12	0.88	-21%	0.78	0.60	-23%
LATAM 1	1.30	1.42	10%	0.74	1.01	37%
LATAM 2	1.00	1.38	38%	0.40	0.52	31%
LATAM 3	1.22	1.87	53%	0.91	1.14	25%
LATAM 4	1.09	1.11	2%	0.72	0.66	-8%
LATAM 5	1.19	1.68	41%	0.58	0.92	58%
LATAM 6	2.51	3.04	21%	2.12	2.60	23%
NWC (JAM)	0.64	0.63	-8%	0.46	0.41	-10%
WASA (T&T)	0.15	0.16	1%	0.14	0.14	-1%

Source: K&M calculations based on information provided by the utilities.

Notes: The values for the COVID-1 period for DOWASCO, LATAM 1, LATAM 2, LATAM 3, LATAM 4, LATAM 5, LATAM 6, and WASA (T&T) are for FY 2019. For BWS (BEL) and NWC (JAM), the values are for FY 2020.

The values for the COVID period for DOWASCO (DOM), LATAM 1, LATAM 2, LATAM 4, LATAM 5, and WASA (T&T) are for the end of FY2020. For BWS (BEL), LATAM 1, LATAM 2, LATAM 3, LATAM 5, and WASA (T&T), the value is for the period ending September 2020. For DOWASCO (DOM) and LATAM 4 it is for the period ending June 2020. For LATAM 6it is for the period ending May 2020. For NWC (JAM), it is for the period ending October 2020.

SWM (SUR) is not included because we do not have financial statements for this utility for any period after FY2018.

Table 4.8 shows the annualized cash from operations in USD for each of the utilities in the financial year before COVID and the financial year that included COVID. It also shows the percent change from one period to the next. An increase in net cash from operations indicates an improvement in liquidity. Of the Caribbean utilities surveyed for which we have relevant data, this indicator increased for two utilities and decreased for the other two of them.

[57] The current ratio measures a utility's capacity to pay its current liabilities with its current assets. The standard calculation of the current ratio is current assets divided by current liabilities. This standard calculation includes accounts receivable as part of the current assets. However, with the increase in accounts receivable during COVID described in Section 3.6, the standard calculation of the current ratio does not reflect the full effect of COVID. For this reason, we calculated an adjusted current ratio that does not include accounts receivables as part of the current assets.

Table 4.8: Changes in net cash from operations

Utility	Annualized cash from operations (COVID-1)	Annualized cash from operations (COVID)	% change from COVID-1 to COVID
DOWASCO (DOM)	(0.1)	3.7	3846%
LATAM 4	(458.5)	(142.8)	69%
LATAM 2	9.9	10.7	8%
NWC (JAM)	26.3	27.3	5%
WASA (T&T)	75.3	(78.6)	-204%
LATAM 5	19.9	NA	NA
LATAM 1	3.6	NA	NA
LATAM 3	3.4	NA	NA
BWS (BEL)	8.4	(2.8)	-133%

Source: K&M calculations based on information provided by the utilities.

Notes: The annualized cash from operations for the COVID-1 period for BWS (BEL), DOWASCO, LATAM 1, LATAM 2, LATAM 3, LATAM 4, LATAM 5, and WASA (T&T) is for the value for FY2019.

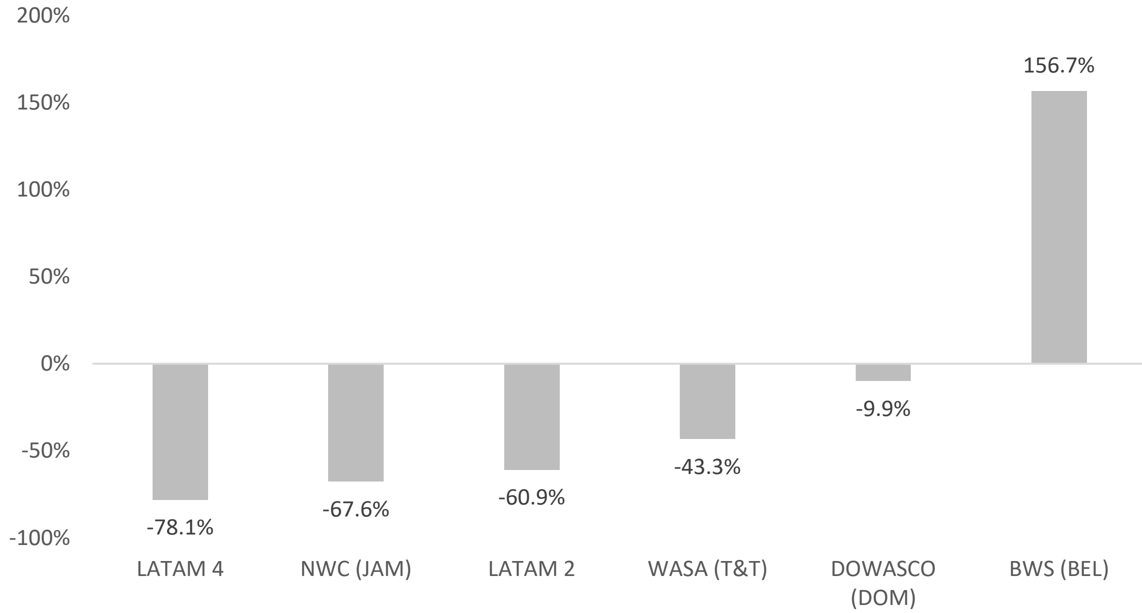
The annualized cash from operations for the COVID period for DOWASCO (DOM), LATAM 2, LATAM 4, and WASA (T&T) is for the ending month for the most recent financial statements in 2020. For LATAM 1 it is the for January 2020 to September 2020, for DOWASCO (DOM) it is for July 2019 to Jun 2020, for LATAM 4 it is for January 2020 to June 2020, for NWC (JAM) it is for April 2020 to October 2020, and for WASA it is for October 2019 to September 2020.

We do not have available data for BWS (BEL, and SWM (SUR) does not have financial available after FY2018.

4.2.8 Capital expenditures fell in three of the Caribbean utilities surveyed but increases in BWS (BEL) led to an average increase of about nine percent for the Caribbean utilities surveyed

Figure 4.14 shows the percent change between CAPEX in the financial year before COVID and the annualized CAPEX in the financial year that included COVID. Three of the Caribbean utilities for which we have data reported a decrease of at least 9 percent during the COVID period. BWS (BEL) was an outlier as its annualized CAPEX increased by 156.7 percent, leading the Caribbean utilities to have an average 9 percent increase in CAPEX, while LATAM had an average 69 percent decrease.

Figure 4.14: CAPEX: pre-COVID vs COVID



Source: K&M calculations based on information provided by the utilities.

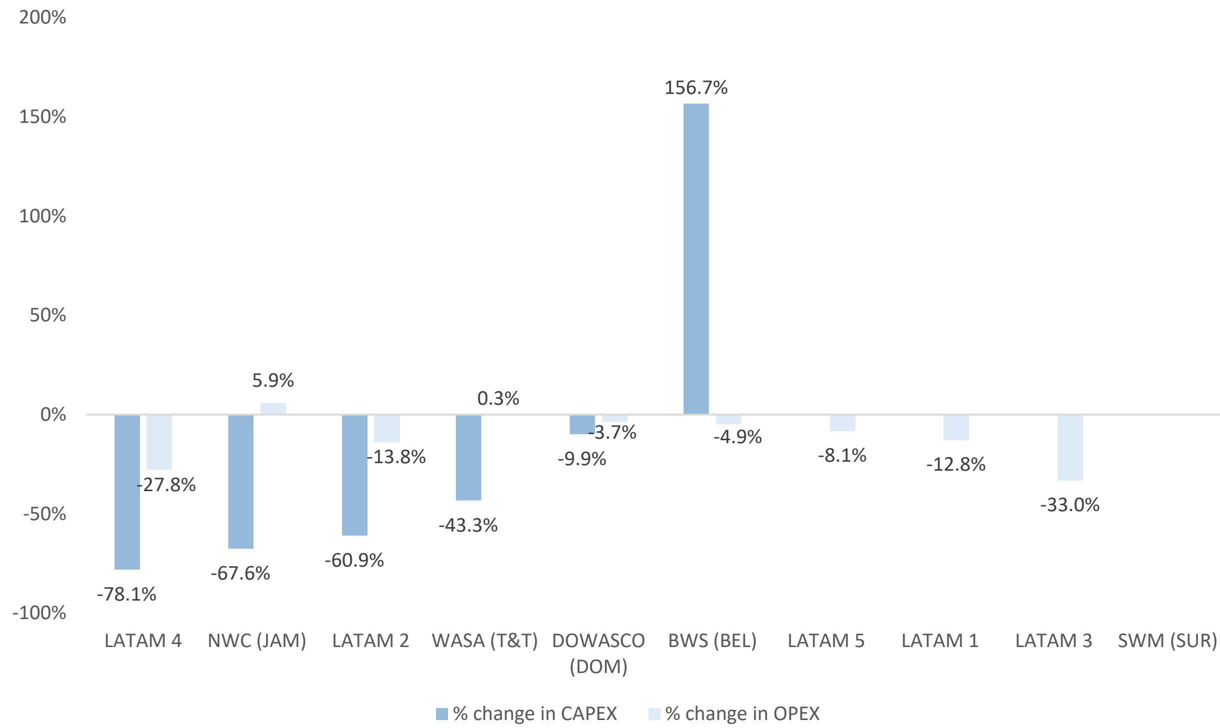
Notes: The % change in CAPEX for all the variables in the figure is calculated as the change between the pre-COVID period and COVID period.

The value for the pre-COVID period is for CAPEX in FY2019.

The value for the COVID period for LATAM 2 is for January 2020 to September 2020. For DOWASCO (DOM) it is for July 2019 to Jun 2020. For LATAM 4 it is for January 2020 to June 2020. For NWC (JAM), it is for April 2020 to October 2020. For WASA (T&T) it is for October 2019 to September 2020. For BWS (BEL) it is for April 2020 to September 2020.

Figure 4.15 shows the percent changes in OPEX and CAPEX between the pre-COVID and COVID period. The changes in OPEX and CAPEX are calculated by comparing the values in the financial year before COVID with the annualized OPEX and CAPEX in the financial year that included COVID. We received the relevant data on OPEX and CAPEX for six of the utilities. Of these six, three utilities reported decreases in CAPEX and OPEX, two of these utilities are in the Caribbean (NWC (JAM) and DOWASCO (DOM)). These decreases may well lead to deterioration in the condition of the fixed assets and/or a reduction in their expected expansion. This will result in lower levels of operating efficiency, quality of service, and/or access to water and sanitation. Therefore, to identify urgent actions and investments the utilities must carry out for achieving any targets that may have been set or agreed upon, it will be important to assess the condition of the utilities' fixed assets and analyze indicators of operating efficiency, quality of service, and access to water and sanitation.

Figure 4.15: Changes in CAPEX and OPEX: pre-COVID vs COVID



Source: K&M calculations based on information provided by the utilities.

Notes: The % change in CAPEX and OPEX is calculated as the change between the pre-COVID period and COVID period.

The CAPEX value for the pre-COVID period is for FY2019. The value for the COVID period for LATAM 2 is for January 2020 to September 2020. For DOWASCO (DOM) it is for July 2019 to Jun 2020. For LATAM 4 it is for January 2020 to June 2020. For NWC (JAM), it is for April 2020 to October 2020. For WASA (T&T) it is for October 2019 to September 2020. For BWS (BEL) it is for April 2020 to September 2020. We do not have CAPEX data available for the COVID period for SWM (SUR).

The OPEX values are calculated the same as in Figure 4.11.

SWM (SUR) is not included in the figure because we do not have the utility's financial statements for any period after December 2018.

5 Levels of Resilience of Water Utilities in the Caribbean to Natural Disasters

The Caribbean is one of the most vulnerable regions in the world to natural disasters, particularly hurricanes.[58] Amid rising global temperatures, jurisdictions in the Caribbean have experienced tropical cyclones (hurricanes and typhoons) with higher precipitation rates and greater frequency of intense (Category 4-5) hurricanes since the 1970s.[59] Many of the Caribbean nations are among the top 25 most vulnerable nations to natural disaster in the world.[60]

As a result of natural disasters, the water and sanitation sector has experienced tremendous losses in recent decades. In most cases, water and sanitation utilities "lack adequate resources for quick recovery" when a hurricane strikes.[61] For example, the Grand Bahama Utility Company (GBUC) and the Water and Sewerage Corporation (WSC) in the Bahamas suffered USD54 million in damages in the wake of Hurricane Dorian in 2019. Over one year after the storm, WSC was still working on restoring operations to pre-Hurricane Dorian levels. Other storms such as Hurricane Maria and Hurricane Ivan have demonstrated the human, physical, and economic toll that these disasters can bring. The vulnerability of the Caribbean to natural disasters coupled with the limited resources of water and sanitation utilities in this region poses a serious threat to the water and sanitation sector and people's access to a reliable supply of services.

While it is impossible to predict what future hurricane seasons will bring, many experts have warned that climate change will continue to exacerbate the impact of natural disasters.[62] Many scientists expect that the number of hurricanes each year will stay roughly the same or even slightly decrease, but the intensity, wind speeds, and levels of precipitation of storms will likely increase in the future.[63] The damages that water and sanitation utilities have withstood due to natural disasters have highlighted the importance of improving post-disaster response, natural disaster preparedness, investments to increase resiliency, and access to funds. Most utilities in the Caribbean lack adequate insurance for natural disasters, something that would boost their capacity to restore operations in the wake of a storm. With the strong possibility of storms becoming

58 "Effects of 2017 Hurricanes Still a Reality for Some Families in the Caribbean," February 6, 2020. https://www.unicef.org/easterncaribbean/stories/effects-2017-hurricanes-still-reality-some-families-caribbean.

59 Kossin, J.P., T. Hall, T. Knutson, K.E. Kunkel, R.J. Trapp, D.E. Waliser, and M.F. Wehner, 2017: Extreme storms. In:*Climate Science Special Report: Fourth National Climate Assessment, Volume I* [Wuebbles, D.J., D.W. Fahey, K.A. Hibbard, D.J. Dokken, B.C. Stewart, and T.K. Maycock (eds.)]. U.S. Global Change Research Program, Washington, DC, USA, pp. 257-276, doi:10.7930/J07S7KXX.

60 Ötker, İnci, and Krishna Srinivasan. "Building Resilience in the Caribbean to Climate Change and Natural Disasters," March 2018. https://www.imf.org/external/pubs/ft/fandd/2018/03/otker.htm.

61 Peters, Everson J. "Impact of Hurricane Ivan on Grenada Water Supply." *Proceedings of the Institution of Civil Engineers*, Water Management, Water Management, no. WM2 (February 2010): 57–64. https://doi.org/10.1680/wama.2010.163.2.57.

62 "Hurricanes and Climate Change," June 25, 2019. https://www.ucsusa.org/resources/hurricanes-and-climate-change.

63 "Hurricanes and Climate Change," June 25, 2019. https://www.ucsusa.org/resources/hurricanes-and-climate-change.

more intense in the future, it is imperative that the water and sanitation sector take natural disaster preparedness more seriously.

In response to this urgent need, the IDB Group is developing an innovative insurance mutual—the Caribbean Water Utility Insurance Company (CWUIC)—to support water utilities in the Caribbean prepare for, insure against, and recover from natural disasters. Thus, to fully address water utilities' needs for natural disaster insurance, CWUIC would include three key components:

- **Component 1,** referred to as the CWUIC Response Program, which would coordinate post-disaster response between participating utilities
- **Component 2** which would allow participants in CWUIC to obtain parametric insurance for natural disasters. Through CWUIC, Caribbean water utilities could obtain natural disaster insurance on better terms than what they could obtain on their own.
- **Component 3** would allow CWUIC to provide financing for investments in water utility resiliency projects. Investing in loss control measures can help utilities mitigate future losses, potentially reducing, over time, recovery costs and the time it takes to restore services while having the potential benefit of reducing insurance premium costs.

The following sections describe the different facets of the vulnerabilities of water utilities in the Caribbean. These sections are organized as follows:

- Caribbean jurisdictions are highly vulnerable to natural disasters (Section 5.1)
- Impact of natural disasters on water and wastewater infrastructure in the Caribbean (Section 5.2)
- Recent natural disasters that have caused damages to water utilities in the Caribbean (Section 5.3)
- Post-disaster recovery needs of water utilities in the Caribbean (Section 5.4)
- Water utilities in the Caribbean lack adequate insurance coverage for natural disasters (Section 5.5)

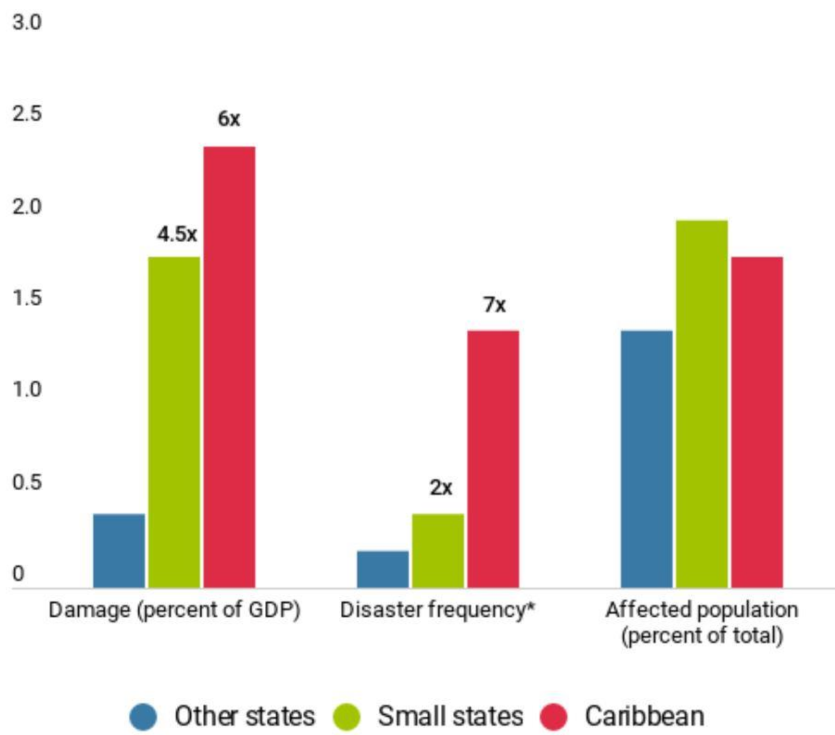
5.1 Caribbean Jurisdictions Are Highly Vulnerable to Natural Disasters

In general, the small size and limited resources of Caribbean jurisdictions make it difficult for them to recover from the impact of natural disasters on their own. In addition to tropical cyclones, the Caribbean faces a wide variety of natural disasters including windstorms, earthquakes, volcanic eruptions, drought, landslides, flooding, and tidal waves. Some of the jurisdictions, such as St. Vincent and the Grenadines, Barbados, Guadeloupe, and the United States Virgin Islands are susceptible to all of these natural disasters. Out of 30 Caribbean jurisdictions, 21 are susceptible to at least 5 of the 8 types of natural disasters. The Global Climate Risk Index[64] indicates to what extent countries and regions have been adversely affected by the impacts of weather-related loss events. The most recent data, from 2018, lists Puerto Rico as the most heavily and negatively impacted Caribbean jurisdiction between 1999 and 2018, with Haiti ranked third, Dominica ranked tenth, and Saint Kitts and Nevis ranked twelfth. Sixteen jurisdictions in total are ranked on the Global

[64] Global Climate Risk Index 2020: Who Suffers Most from Extreme Weather Events? Weather-Related Loss Events in 2018 and 1999 to 2018 accessed from Germanwatch on 13 January 2021.

Climate Risk Index. Table B.1 in Appendix A provides more detailed information regarding the vulnerability of the jurisdictions to natural disasters. Figure 5.1 demonstrates the vulnerability of the Caribbean to natural disasters in comparison with other states, based on data from 1990 to 2014.[65] States in the Caribbean experienced six times as much damage as a percent of GDP than other states and the frequency of disasters were seven times higher.

Figure 5.1: Vulnerability of the Caribbean to natural disasters compared to other states (1990-2014)



Source: The World Bank, based on the following sources: EM-DAT, IMF (2016), "Small States' Resilience to Natural Disasters and Climate Change—Role for the IMF", IMF World Economic Outlook; World Bank, World Development Indicators; and the World Bank's computations. *Disaster frequency: Average annual disasters per 1,000km^2

To illustrate the difference between the impact of a hurricane on a jurisdiction in the Caribbean versus the United States, the Caribbean Catastrophe Risk Insurance Facility Segregated Portfolio Company (CCRIF SPC) reported that while Hurricane Katrina caused several hundred billion dollars in damage it only caused a 1 percent loss of gross domestic product (GDP) to the United States economy. In comparison, Hurricane Ivan resulted in an over 200 percent loss to GDP for the Cayman Islands and Grenada.[66]

Developing countries and small island nations generally do not have sufficient resources to rebuild after hurricanes and other natural disasters occur, posing serious challenges to the economies of

65 Small states include five Pacific countries (Kiribati, Palau, Samoa, Tonga, Vanuatu), six Caribbean countries ((Antigua and Barbuda, Belize, Dominica, Grenada, St. Lucia, St. Vincent and the Grenadines) and two other states (Comoros and Maldives). Other states includes all countries with a population of over 1.5 million, regardless of income levels.

66 CCRIF SPC. 2011, p. 11. *A collection of papers, articles, and expert notes: volume 2*. Caribbean Catastrophe Risk Insurance Facility.

the jurisdictions and the culture and well-being of the population.[67] When jurisdictions experience natural disasters, governments often find it difficult to continue efforts to achieve development goals. Instead, as they address the emergency, they reallocate funds from education, health, and infrastructure projects to support emergency and recovery efforts.[68] Box 1 further elaborates this point.

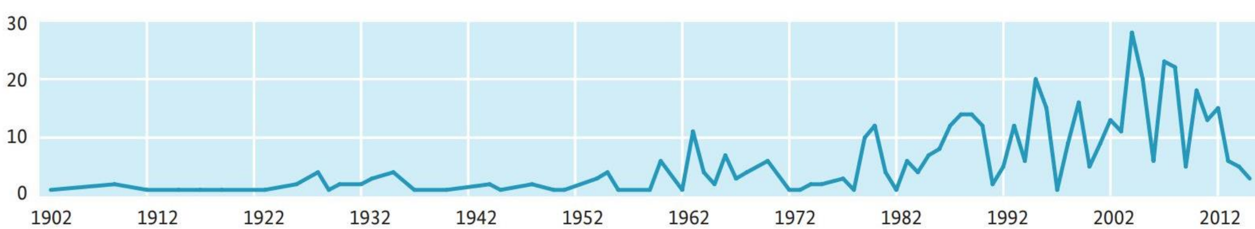
Box 1: Caribbean countries remain in "permanent repair mode"

Many Caribbean countries have a strong dependence on external humanitarian assistance and grants to meet development goals. However, even in the best of times, this external funding often falls short of funding requirements. Responding to natural disasters exacerbates the situation, with GIZ noting that governments delay activities meant to address developmental priorities, deferring, or abandoning existing plans and projects and re-channeling funds to disaster response. Governments also take on additional debt to close the financing gap, which worsens an already overly leveraged national fiscal situation. As a result, many Caribbean countries remain in "permanent repair mode", negatively impacting their ability to prepare for the next natural disaster and/or build resilience.[69]

Source: Germany's Gesellschaft für Internationale Zusammenarbeit Report

CCRIF SPC reports that the vulnerability of the Caribbean Community (CARICOM) countries to climate events is already evidenced by the increasing impact of hurricanes, tropical storms, drought and flooding in the region.[70] Hurricane Irma struck Barbuda, Saint Martin, Saint Barthélemy, Anguilla, Turks and Caicos, and Cuba in 2017 resulted in an estimated $2.97 billion in damages.[71] Figure 5.2 shows that the number of weather related hazards per year in the Caribbean have increased in the last century.

Figure 5.2: Number of weather and climate hazards occurring per year in the Caribbean (1902-2015)



Source: GIZ. "Loss and damage in the Caribbean: Climate change realities in Small Island Developing States." Pg. 14

67 CCRIF SPC, 21.

68 CCRIF SPC, 67.

69 GIZ. 2017, p. 3. *Loss and damage in the Caribbean: Climate change realities in Small Island Developing States.* Deutsche Gesellschaft für Internationale Zusammenarbeit.

70 CCRIF SPC. 2011, p. 58. A collection of papers, articles, and expert notes: volume 2. Caribbean Catastrophe Risk Insurance Facility.

71 National Hurricane Center and Central Pacific Hurricane Center. "National Hurricane Center Tropical Cyclone Report. Hurricane Irma (AL112017)" NOAA. https://www.nhc.noaa.gov/data/tcr/AL112017_Irma.pdf Accessed 04 September 2019.

Climate research projections estimate that windstorms will increase in intensity, enhancing the potential for substantial damage in the Caribbean.[72] GIZ research indicates that:

- Surface temperatures are expected to increase by approximately 1.2C to 1.9C by 2100
- Precipitation is projected to decrease by about 5 percent by 2100
- Sea level rise projections range from 0.5m to 0.6m by 2100 in the Caribbean Sea
- Hurricanes are expected to increase in severity, but may become slightly less frequent
- Ocean acidification is expected to continue as more carbon dioxide, also anticipated to increase in the atmosphere, and other pollutants are absorbed by the oceans.[73]

Box 2 is taken from a report by the Intergovernmental Panel on Climate Change (IPCC). It provides scientific evidence that climate change has had, and will continue to have, an adverse effect on weather patterns. It also indicates the likelihood of natural disasters intensifying in the future.

Box 2: Likelihood of natural disasters occurring or intensifying in the future

As reported by the Intergovernmental Panel on Climate Change (IPCC), AR5[74] presented scientific evidence that suggests that most of the global warming observed over the past half century is due to human-caused greenhouse gas emissions. The report provides likelihood statements that indicate the likelihood of natural disasters occurring or intensifying in the future. It concluded that:

- **Sea level rise**—should cause higher coastal inundation levels for tropical cyclones that do occur
- **Tropical cyclone rainfall rates will likely increase** in the future due to anthropogenic warming and accompanying increase in atmospheric moisture content. Modeling studies on average project an increase on the order of 10-15 percent for rainfall rates averaged within about 100 km of the storm for a 2-degree Celsius global warming scenario
- **Tropical cyclone intensities globally will likely increase on average by 1 to 10 percent** according to model projections for a 2-degree Celsius global warming. This change would imply an even larger percentage increase in the destructive potential per storm, assuming no reduction in storm size. Storm size responses to anthropogenic warming are uncertain
- **The global proportion of tropical cyclones that reach very intense (Category 4 and 5) levels will likely increase** due to anthropogenic warming over the 21st century. There is less confidence in future projections of the global number of Category 4 and 5 storms, since most modeling studies project a decrease (or little change) in the global frequency of all tropical cyclones combined
- **In comparison to global temperature, in terms of detection and attribution, much less is known about hurricane/tropical cyclone activity**. In the Atlantic, it is premature to conclude

---

72 GIZ. 2017, p. 2. *Loss and damage in the Caribbean: Climate change realities in Small Island Developing States.* Deutsche Gesellschaft für Internationale Zusammenarbeit.

73 GIZ, 15.

74 Intergovernmental Panel on Climate Change. Climate Change 2013: The Physical Science Basis. http://www.ipcc.ch/report/ar5/wg1/. Accessed on 5 September 2019.

with high confidence that human activities–and particularly greenhouse gas emissions that cause global warming–have already had a detectable impact on hurricane activity. A recent study finds that the observed increase in an Atlantic hurricane rapid intensification metric (1982-2009) is highly unusual compared to climate model simulations of multi-decade climate variability while pointing to variances resulting from long-term response to anthropogenic factors. Reduced aerosol forcing since the 1970s factored into, for example, the increased Atlantic hurricane activity since then, but the amount of contribution, relative to natural variability, remains uncertain. There is some evidence for a slowing of tropical cyclone propagation speeds over the continental U.S. over the past century, but these observed changes have not yet been confidently linked to anthropogenic contributions to climate change. Human activities may have already caused other changes in tropical cyclone activity that are not yet detectable due to the small magnitude of these changes compared to estimated natural variability, or due to observational limitations."[75]

Source: Intergovernmental Panel on Climate Change (IPCC) AR5

The 2020 North Atlantic hurricane season was on many accounts a record-breaking hurricane season. It brought 30 named storms[76], (the highest number since 1851[77]), 13 of the storms were hurricanes (the average season has six hurricanes), and six of these hurricanes were major hurricanes (top winds of 111 mph or greater). Another unusual element of the 2020 season was that several places, such as Louisiana, Mexico, Nicaragua, and Honduras, experienced repeated storms that followed similar paths.[78] For example, Nicaragua and Honduras were hit by Hurricane Eta (Category 4 on the five-step Saffir-Simpson scale) in November and then again by Hurricane Iota (Category 5) two weeks later. Furthermore, many of the storms intensified rapidly when they approached coastlines, meaning that wind speeds strengthened by about 35 mph within 24 hours.

One hurricane that impacted several Caribbean nations was Hurricane Laura (Category 4). It killed more than 35 people in the Caribbean.[79] It also destroyed thousands of homes and electricity infrastructure and even caused landslides in Jamaica.[80]

The highly active and intense hurricane season of 2020 can be explained by "a combination of warmer oceans, weather patterns triggered by La Niña, and an unusually busy African monsoon

---

75 Geophysical Fluid Dynamics Laboratory. Global Warming and Hurricanes: An overview of Current Research Results. https://www.gfdl.noaa.gov/global-warming-and-hurricanes/. Accessed on 5 September 2019.

76 "Swiss Re Institute Estimates USD 83 Billion Global Insured Catastrophe Losses in 2020, the Fifth-Costliest on Record | Swiss Re." Accessed December 21, 2020. https://www.swissre.com/media/news-releases/nr-20201215-sigma-full-year-2020-preliminary-natcat-loss-estimates.html.

77 Rojanasakul, Mira, and Brian K. Sullivan. "This Year's Wild Hurricane Season Is an Ominous Sign of What's Ahead." *Bloomberg.Com*. Accessed January 4, 2021. https://www.bloomberg.com/graphics/2020-hurricane-season-overview/.

78 Rojanasakul, Mira, and Brian K. Sullivan. "This Year's Wild Hurricane Season Is an Ominous Sign of What's Ahead." *Bloomberg.Com*, December 5, 2020. https://www.bloomberg.com/graphics/2020-hurricane-season-overview/.

79 Research, CNN Editorial. "2020 Atlantic Hurricane Season Fast Facts." CNN, December 31, 2020. https://www.cnn.com/2020/05/11/us/2020-atlantic-hurricane-season-fast-facts/index.html.

80 Marsh, Andre Paultre, Sarah. "Cash-Strapped Caribbean Recovers from Deadly Storm Laura." *Reuters*, August 25, 2020. https://www.reuters.com/article/us-storm-laura-caribbean-idUSKBN25L2K9.

season."[81] While experts predict that future seasons will also produce powerful storms, they do not predict that 2020's record number of storms will be surpassed soon.

Figure 5.3 presents the various records that the 2020 hurricane season broke.

Figure 5.3: Storm Occurrences in the North Atlantic Region in 2020

Source: National Oceanic and Atmospheric Administration. "Record-Breaking Atlantic Hurricane Season Draws to an End," November 24, 2020. https://www.noaa.gov/media-release/record-breaking-atlantic-hurricane-season-draws-to-end.

Not only was 2020 an unusually active hurricane season, but it was the "5th consecutive above-normal season" according to the National Oceanic and Atmospheric Administration (NOAA).[82] 2019 was a relatively "average year" for the Caribbean regarding the number of weather and other natural disasters.[83][84] Nonetheless, it witnessed one category 5 hurricane, Hurricane Dorian, that hit The Bahamas and caused several billions of dollars in damage, with losses exceeding 25 percent of The Bahamas' GDP.[85]

---

81 Rojanasakul, Mira, and Brian K. Sullivan. "This Year's Wild Hurricane Season Is an Ominous Sign of What's Ahead." *Bloomberg.Com*, December 5, 2020. https://www.bloomberg.com/graphics/2020-hurricane-season-overview/.

82 National Oceanic and Atmospheric Administration. "Record-Breaking Atlantic Hurricane Season Draws to an End," November 24, 2020. https://www.noaa.gov/media-release/record-breaking-atlantic-hurricane-season-draws-to-end.

83 Per Colorado State University data, for the period 1981 – 2010 the Atlantic Ocean had, on average, 12.1 named storms and 6.4 hurricanes, of which 2.7 were intense, category 3 or higher, hurricanes.

84 The 2019 hurricane season in the North Atlantic Ocean included 18 named storms and 6 hurricanes, of which 3 were considered "intense." Source Hurricane Center, National Oceanic and Atmospheric Agency.

85 Source: Inter-American Development Bank November 15, 2019 report.

2019 marked the fourth consecutive year in which the Atlantic experienced a category 5 event, and Hurricane Dorian's sustained winds of more than 185 mph, with gusts of up to 220 mph, made it the second strongest hurricane ever recorded in the Atlantic (after Hurricane Allen, 1980).[86] The generally slow paths followed by windstorms in 2019 contributed to losses, causing extensive damage from wind as well as rain and flooding.

5.2 Impact of Natural Disasters on Water and Wastewater Infrastructure in the Caribbean

When damage occurs to a water utility and the service area, as a result of a natural disaster, the damage can prevent the water utility from providing services while also causing the utility to face losses due to a reduction in its revenues. Outages in such situations can lead to substantial revenue losses. For example, an outage of two months (a typical amount of time for a utility to take to restore operations following a category 1 hurricane) for NWC in Jamaica could be as much as USD32 million based on annual revenues of about USD200 million. Disruptions of service for any length of time can also have consequences for human health and other sectors that are reliant upon regular services.

Water and wastewater infrastructure include assets above ground and underground. These assets face different levels of vulnerability to natural disasters and experience different types and levels of damage depending on the type and intensity of the natural disaster event. For example, above ground assets such as conventional water treatment plants, desalination plants, wastewater treatment plants, pumping stations, water tanks and intakes are very vulnerable to hurricanes, windstorms, volcanoes, and earthquakes. They have medium vulnerability to flooding, except for water sources such as ponds and lagoons that can be contaminated and are highly vulnerable to flooding. Underground assets such as water mains and sewage collectors, as well as water distribution and wastewater networks on the other hand are very vulnerable to earthquakes and landslides. Table B.1 in Appendix C presents a matrix showing how different types of natural disasters affect different types of assets.

Water utilities are vulnerable to direct impacts and indirect impacts from natural disasters as described below:

- **Direct impacts** include asset damage to the facilities of the water utility, and expenses and losses of revenues experienced due to business interruption. Fixing and replacing damaged assets, both infrastructure and equipment, typically incurs extraordinary costs that cannot be budgeted for by the utility. For small utilities with low annual revenues and/or utilities in smaller or poorer economies to overcome such expenses is a major challenge due to their inability to increase revenues. Meanwhile, until service is restored, the company cannot sell water leading to losses in revenue while the utility incurs substantial repair costs
- **Indirect impacts** include electricity supplies being reduced or cut, disabling filtration and pumping and leading to interruptions in service. Indirect impacts could also include a lack of potable water occurring due to exogenous factors, including, but not limited to, severe drought or water source contamination, that can result in business interruption or water supply rationing.

[86] Ibid.

To restore service after a catastrophic event, effective emergency responses include transporting water by hired vehicles to areas where the distribution system has been destroyed, as well as the provision of portable filtration and purification equipment. This incurs extraordinary costs for the utility. Restoring water service after a major natural disaster also poses logistical challenges as a result of damage to roads, bridges, ports, and telecommunications, making the response team's job harder and more costly.

5.3 Recent Natural Disasters That Have Caused Damages to Water Utilities in the Caribbean

In recent years, water and sanitation utilities in the Caribbean have weathered multiple major hurricanes which have caused devastation to their physical assets. Table 5.1 shows the types and magnitude of the damages utilities incurred as a result of specific storms.

Table 5.1: Damages caused by natural disasters to utilities

Utility	Event (Year)	Description of Damages Caused	Amount in Damages (USD million)
GBUC and WSC (The Bahamas)	Hurricane Dorian (2019)	The hurricane primarily affected **water pumping systems, storage tanks, distribution systems, two of its largest wellfields, above ground infrastructure such as control panels, housings, and power, buildings, underwater mains, and electrical/mechanical systems**. The water and sewerage systems in Marsh Harbour and Treasure Cay experienced particularly severe damage.	54
PRASA (Puerto Rico)	Hurricane Irma (2017) and Hurricane Maria (2017)	PRASA suffered **damages to water treatment facilities** and structures across the island, and as a result over one third of PRASA customers did not have drinking water. PRASA **suffered direct physical losses, damages and the suspension of its billing and collections process** for about 2 months.	700-800
DOWASCO (Dominica)	Tropical Storm Erika (2015) and Hurricane Maria (2017)	The hurricanes had a **catastrophic impact on water supply infrastructure and watersheds.** They demonstrated how water supply is strongly dependent on other ancillary services**; post-disaster recovery was hindered by inaccessibility of intakes, lack of excavators and equipment, and social impacts on DOWASCO's staff and personnel.**	24
WASCO (St. Lucia)	Hurricane Tomas (2010)	**Pipelines in the north part of the island were damaged, and all intakes were affected.** A landslide into the Hon Compton Dam resulted in damages and loss of power at its pump house and residents lost access to water.	20
NAWASA (Grenada)	Hurricane Ivan (2004)	The hurricane **caused widespread water rationing due to a lack of water.** This had a negative impact on vital economic sectors, like tourism and agriculture which depend on reliable sustainable water services.	3.0

WAC (Grand Cayman)	Hurricane Ivan (2004)	Operations on Grand Cayman suffered significant damage from Hurricane Ivan. Water service could not be restored immediately after the storm because **water mains in areas along the south and east coast of Grand Cayman, extending from South Sound in George Town to Colliers in East End, were badly damaged and had to be replaced.**	3.25

Sources: CDB, IDB, PAHO, Hon. Adrian Gibson at the 16th HLF, OCHA, Inception Report Appendix A, and HR Wallingford. 2019. "Planning for the Integration of Climate Resilience in the Water Sector in the Caribbean: Dominica-Climate Risk and Vulnerability Assessment Report."

Below we describe the impact of some of the major storms in the Caribbean in recent decades and how they impacted water and sanitation utilities.

Hurricane Dorian in the Bahamas in 2019

Hurricane Dorian was the first major hurricane in 2019 and made landfall in the Bahamas on the islands of Elbow Cay and Grand Bahama. The storm intensified rapidly, increasing from a Category 4 to Category 5 hurricane in a span of three days and reaching winds of 185 mph.[87] It was the strongest recorded storm to take place in the Bahamas. The total cost of the impacts of Hurricane Dorian in the Bahamas is estimated at USD3.4 billion.[88] Hundreds of people lost their lives and thousands lost their homes. The infrastructure sector experienced approximately USD452.5 million in damages, losses, and additional costs.[89]

Key water and sanitation infrastructure was damaged and destroyed, resulting in costly repairs and long-term consequences. The water and sanitation sector endured approximately USD14.5 million in damages, USD36 million in losses, and USD2 million in additional costs.[90] In total, this amounts to about USD54 million. According to Adrian Gibson, the Executive Chairman to the WSC, over a year later, "two systems on remote islands/cays that are especially challenging only still receive supply between the hours of 6am and 10 pm."[91]

The heavy storm led to severe damages to the Grand Bahama Utility Company (GBUC) and the Water and Sewerage Corporation (WSC). The utilities suffered damages to water pumping systems, storage tanks, and distribution systems.

WSC's service area is a complex network that consists of about 25 Islands and cays. All of its offices were impacted by the storm, but some incurred more damage than others. The location in

[87] US Department of Commerce, NOAA. "Hurricane Dorian, September 6, 2019." NOAA's National Weather Service, September 6, 2019. https://www.weather.gov/mhx/Dorian2019.

[88] "Damages and Other Impacts on Bahamas by Hurricane Dorian Estimated at $3.4 Billion: Report." Inter-American Development Bank, November 15, 2019. https://www.iadb.org/en/news/damages-and-other-impacts-bahamas-hurricane-dorian-estimated-34-billion-report.

[89] The infrastructure sector includes the power, telecommunications, water and sanitation, and transport sectors.

[90] The assessment of the impact of Hurricane Dorian on the Bahamas was carried out by the Inter-American Development Bank, the United Nations Economic Commission for Latin America and the Caribbean (ECLAC), and the Pan-American Health Organization (PAHO). Damages refers to the monetary estimate of physical assets that were destroyed or partially destroyed, losses refer to the monetary estimate of goods that do not get produced or services that are not provided, and additional costs are additional expenditures for providing goods or services.

[91] Gibson, Adrian. "Bahamas Intervention: Recovery from Hurricane Dorian, The Bahamas Experience--Lessons Learnt." Presented at the 16th High-Level Forum for Caribbean Ministers Responsible for Water, Bahamas, October 2020. Pg. 8.

Treasure Cay was completely destroyed while Marsh Harbour experienced roof damage and loss of city power. The office in Green Turtle Cay was partially destroyed and the Cooper's Town office experienced wind and water damage. [92]

After the hurricane, the Government of the Bahamas depended on relief funds from regional and international organizations in order to recover from the storm's devastation. The Caribbean Emergency Management Agency (CDEMA) facilitated direct donations to the government[93] and the American Red Cross, among many other charitable organizations that provided assistance, donated USD42 million in support of the relief efforts.[94]

Given the critical importance of water and sanitation services to public health, several organizations assisted with the immediate and long-term restoration needs. USAID contributed USD7.5 million to support essential sectors, including water, sanitation and hygiene (WASH), health, and shelter projects.[95] Other organizations such as UNICEF, Mercy Corps, and Mission Resolve Foundation assisted with installing reverse osmosis water treatment units to provide 7,500 gallons of safe drinking water per day to health clinics and the public water system, bottled water, water tanks, and water disinfection tablets.[96]

Hurricane Irma and Hurricane Maria in Puerto Rico in 2017

In September of 2017, Puerto Rico was hit by two major hurricanes in the span of two weeks. Hurricane Irma, a category 5 storm, arrived on 7 September while Hurricane Maria struck on 20 September as a category 4 hurricane.[97]

Hurricane Maria was Puerto Rico's most destructive hurricane in modern history and "the third costliest hurricane in United States history."[98] The eye of the storm moved across the main island and came close to the capital of San Juan. The storm surge and tide resulted in six to nine feet of inundation in the Puerto Rico's coastal municipalities of Humacao, Naguabo, and Ceiba.[99] The island received about 38 inches of rainfall, resulting in mud slides and flooding, particularly near

---

92 Gibson, Adrian. "Bahamas Intervention: Recovery from Hurricane Dorian, The Bahamas Experience--Lessons Learnt." Presented at the 16th High-Level Forum for Caribbean Ministers Responsible for Water, Bahamas, October 2020. Pg. 8.

93 Real Simple. "Hurricane Dorian Donations: Best Ways to Donate for Hurricane Relief." Accessed January 13, 2021. https://www.realsimple.com/work-life/money/hurricane-dorian-donations.

94 "Hurricane Dorian Recovery Information." Accessed January 13, 2021. https://www.redcross.org/about-us/our-work/disaster-relief/hurricane-relief/hurricane-dorian-recovery-information.html.

95 U.S. Agency for International Development. "The Bahamas - Hurricane Dorian Fact Sheet #12, (FY) 2019," September 30, 2019. https://www.usaid.gov/crisis/dorian/fy19/fs12.

96 U.S. Agency for International Development. "The Bahamas - Hurricane Dorian Fact Sheet #12, (FY) 2019," September 30, 2019. https://www.usaid.gov/crisis/dorian/fy19/fs12.

97 "Hurricanes Irma and Maria: Impact and Aftermath." Accessed January 11, 2021. https://www.rand.org/hsrd/hsoac/projects/puerto-rico-recovery/hurricanes-irma-and-maria.html.

98 Pasch, Richard J., Andrew B. Penny, and Robbie Berg. "Hurricane Maria." National Hurricane Center Tropical Cyclone Report. National Hurricane Center, February 14, 2019. https://www.nhc.noaa.gov/data/tcr/AL152017_Maria.pdf.

99 Pasch, Richard J., Andrew B. Penny, and Robbie Berg. "Hurricane Maria." National Hurricane Center Tropical Cyclone Report. National Hurricane Center, February 14, 2019. https://www.nhc.noaa.gov/data/tcr/AL152017_Maria.pdf. Pg. 5.

the La Plata River. The exact death toll in Puerto Rico is unknown but is estimated at 65 people. The estimated damage to Puerto Rico and the U.S. Virgin Islands was USD90 billion. [100]

As a result of both storms, the Puerto Rico Aqueducts and Sewers Authority (PRASA) suffered damages to water treatment facilities and structures across the island, and, as a result, over one third of PRASA customers did not have drinking water. PRASA suffered direct physical losses, damages and the suspension of its billing and collections process for about two months. It took over nine months to return to normal operations.[101] The recovery from both hurricanes highlighted the need to improve the effectiveness of the utility's emergency response efforts.

Tropical Storm Erika and Hurricane Maria in Dominica in 2015 and 2017

The water and sanitation infrastructure in Dominica experienced repeated blows from natural disasters when Tropical Storm Erika hit in 2015 followed by Hurricane Maria in 2017. Both of these natural disasters exposed the vulnerabilities of the sector and highlighted the need for more resilient infrastructure.

Tropical Storm Erika and Hurricane Maria "caused damage estimated to be respectively 96% and 226% of gross domestice product (GDP)" in Dominica.[102] The IMF estimated that it would take at least five years for Dominica's economy to restore pre-Maria levels of output.

In August 2015, Tropical Storm Erika brought 12 inches of rain in less than ten hours, doubling the expected rainfall.[103] The deluge created dangerous floods and mudslides, destroying hundreds of homes, roads and bridges and resulting in the death of 20 people.[104] Two years later, the island faced Hurricane Maria, which brought even more destruction. The storm made landfall in Dominica as a category 5 hurricane. The hurricane intensified quickly, ramping up from windspeeds of 115 mph to 166 mph in a matter of 12 hours, shortly before it approached the island.

Once the storm hit Dominica, it reached a peak of 160 mph winds and a central pressure of 922 millibars. Figure 5.4 portrays Hurricane Maria during its peak intensity. The storm created a massive amount of rainfall, amounting to 22.8 inches. This resulted in dangerous flooding and mud slides. [105] 31 people lost their lives as a direct result of the storm and 34 people went missing. The total estimated damage to infrastructures was USD1.31 billion and the agricultural sector was nearly wiped out.

---

100 Pasch, Richard J., Andrew B. Penny, and Robbie Berg. "Hurricane Maria." National Hurricane Center Tropical Cyclone Report. National Hurricane Center, February 14, 2019. https://www.nhc.noaa.gov/data/tcr/AL152017_Maria.pdf. Pg. 7.

101 Banks, Stacy. "Region 2's Hurricanes Irma and Maria Response Efforts in Puerto Rico and U.S. Virgin Islands Show the Need for Improved Planning, Communications, and Assistance for Small Drinking Water Systems." Environmental Protection Agency, December 3, 2020.

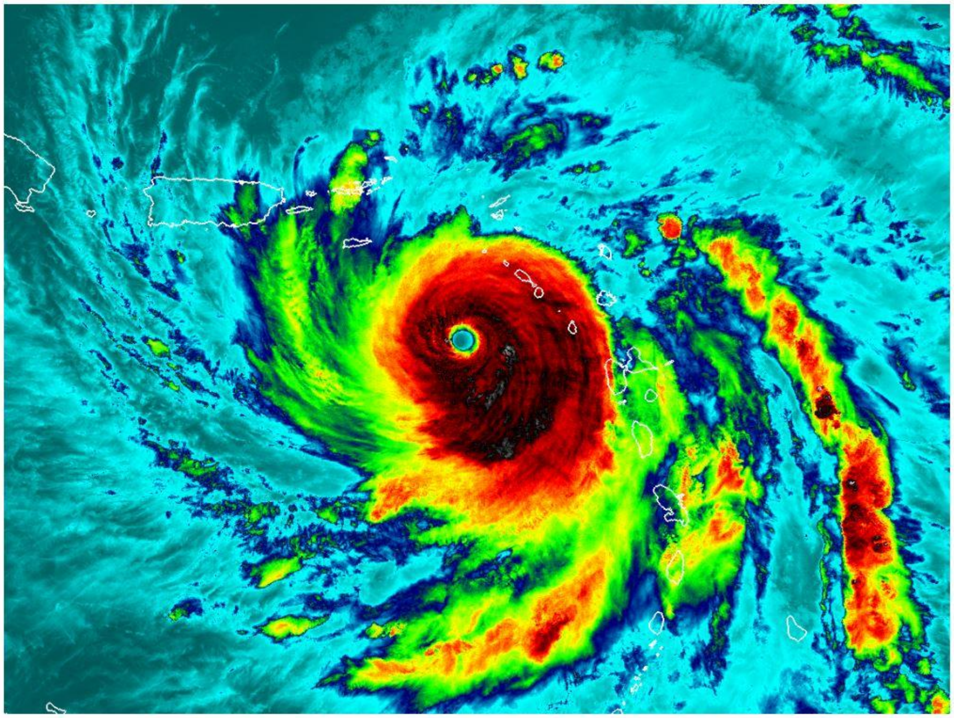
102 HR Wallingford. "Planning for the Integration of Climate Resilience in the Water Sector in the Caribbean: Dominica Investment Plan." March, 2019. Pg. 4.

103 CNN, By Joshua Berlinger and Steve Almasy. "Tropical Storm Erika Dumps Rain on Hispaniola after Killing 20 in Dominica." CNN Digital, August 28, 2015. https://www.cnn.com/2015/08/28/us/tropical-weather-erika/index.html.

104 "Tropical Storm Erika Kills at Least 20 in Dominica." *BBC News*, August 29, 2015, sec. Latin America & Caribbean. https://www.bbc.com/news/world-latin-america-34091475.

105 Pasch, Richard J., Andrew B. Penny, and Robbie Berg. "Hurricane Maria." National Hurricane Center Tropical Cyclone Report. National Hurricane Center, February 14, 2019. https://www.nhc.noaa.gov/data/tcr/AL152017_Maria.pdf.

Figure 5.4: Hurricane Maria at Peak Intensity on 19 September 2017



Source: National Hurricane Center

As a result of both storms, water supply infrastructure and watersheds weathered damages from strong winds, flooding, landslides, and fallen trees.[106] Many production and water distribution lines were damaged or destroyed, intakes were blocked by debris, and some intakes were completely destroyed. Roads to key infrastructure sites were blocked, preventing speedy recovery.

Tropical Storm Erika resulted in "a significant decrease in DOWASCO's revenue." [107] From FY2014 to 2015, DOWASCO experienced a decrease in 5 percent in revenues due to Tropical Storm Erika. Its operational costs increased by 24 percent, 85 percent of which is attributed to restoring services after Erika. As a result of Hurricane Maria, DOWASCO experienced USD24 million in damages[108] and also reported a decrease in revenues the following year.

Hurricane Ivan in Grenada and Grand Cayman island in 2004

At the time it took place, Hurricane Ivan was the most powerful storm to impact the Caribbean in a decade.[109] In September of 2004, Hurricane Ivan devastated several islands in the region, including Grenada, Barbados, St. Lucia, St. Vincent and the Grenadines, Jamaica, Cuba, the

---

106 Planning for the Integration of Climate Resilience in the Water Sector in the Caribbean: Dominica-Climate Risk and Vulnerability Assessment Report." HR Wallingford. March, 2019. Pg. 55.

107 HR Wallingford. "Planning for the Integration of Climate Resilience in the Water Sector in the Caribbean: Dominica-Climate Risk and Vulnerability Assessment Report." March, 2019. Pg. 55.

108 HR Wallingford. "Planning for the Integration of Climate Resilience in the Water Sector in the Caribbean: Dominica-Climate Risk and Vulnerability Assessment Report." March 2019. Pg. 4.

109 Press, Associated. "Hurricane Ivan Devastates Grenada." the Guardian, September 9, 2004. http://www.theguardian.com/environment/2004/sep/09/naturaldisasters.climatechange.

Dominican Republic, as well as Venezuela and the southern coast of the United States. The eye of the storm did not pass over the Cayman Islands, however, the storm still caused power outages and flooding on Grand Cayman island.[110]

Although Grenada lies below the "hurricane belt," it was not spared the devastation of Hurricane Ivan. This was the first hurricane Grenada had experienced since Hurricane Janet in 1955.[111] What started as a tropical storm quickly strengthened to a category 4 hurricane when it reached Grenada, and even escalated to a category 5 hurricane. [112] The storm reached maximum winds of 165 mph.[113] As a result of the storm, 39 people lost their lives[114] and 90 percent of homes were destroyed or damaged.[115] The total estimated damages of Hurricane Ivan on Grenada were USD900 million, which is about twice the country's gross domestic product.[116]

The National Water and Sewerage Authority (NAWASA), the utility responsible for producing and distributing all the public water supply on Grenada's three main islands, experienced USD2.82 million in damages as a result of the storm.[117] This was a heavy economic burden to the utility which had little to no insurance for natural disasters and an average annual revenue of USD6.23 million. The majority of the damages were related to pipelines and buildings, the rest consisted of damages to reservoirs and pumping stations and loss of revenue. 95 percent of the island's water supply was disrupted after the storm and it took 30 days to reach full restoration. Wastewater systems, which were limited to the capital city of St. Georges and the southern part of the island to begin with, became non-functional after the storm until stand-by power generation was installed.

In the days following the storm, urban areas relied on over 300 tons of bottled water that came from relief efforts. Rural residents resorted to traditional methods such as using water from "streams,

---

110 CNN. "Hurricane Ivan Passes Battered Cuba," September 13, 2004. https://www.cnn.com/2004/WEATHER/09/13/hurricane.ivan/.

111 Peters, Everson J. "Impact of Hurricane Ivan on Grenada Water Supply." *Proceedings of the Institution of Civil Engineers*, Water management, Water Management, no. WM2 (February 2010): 57–64. https://doi.org/10.1680/wama.2010.163.2.57. Pg. 57.

112 Meteorologist Robert Molleda noted that "It is not very common for a tropical storm to strengthen so quickly." AP NEWS. "Hurricane Ivan Churns Toward Barbados," September 6, 2004. https://apnews.com/article/b661ba0e8396e76bfe2b8ad4b2562c53.

113 "Hurricane - Ivan Hits below the Belt," October 2004. https://www.caribbeancompass.com/hurricanegren.htm.

114 Ehrhart, Jay. "Hurricane Ivan Rolls Toward Cuba." AP NEWS, September 13, 2004. https://apnews.com/article/b37da35d7edf564df46d03fddcf2bd41.

115 Press, Associated. "Hurricane Ivan Devastates Grenada." the Guardian, September 9, 2004. http://www.theguardian.com/environment/2004/sep/09/naturaldisasters.climatechange.

116 Peters, Everson J. "Impact of Hurricane Ivan on Grenada Water Supply." *Proceedings of the Institution of Civil Engineers*, Water management, Water Management, no. WM2 (February 2010): 57–64. https://doi.org/10.1680/wama.2010.163.2.57.

117 Peters, Everson J. "Impact of Hurricane Ivan on Grenada Water Supply." *Proceedings of the Institution of Civil Engineers*, Water management, Water Management, no. WM2 (February 2010): 57–64. https://doi.org/10.1680/wama.2010.163.2.57.

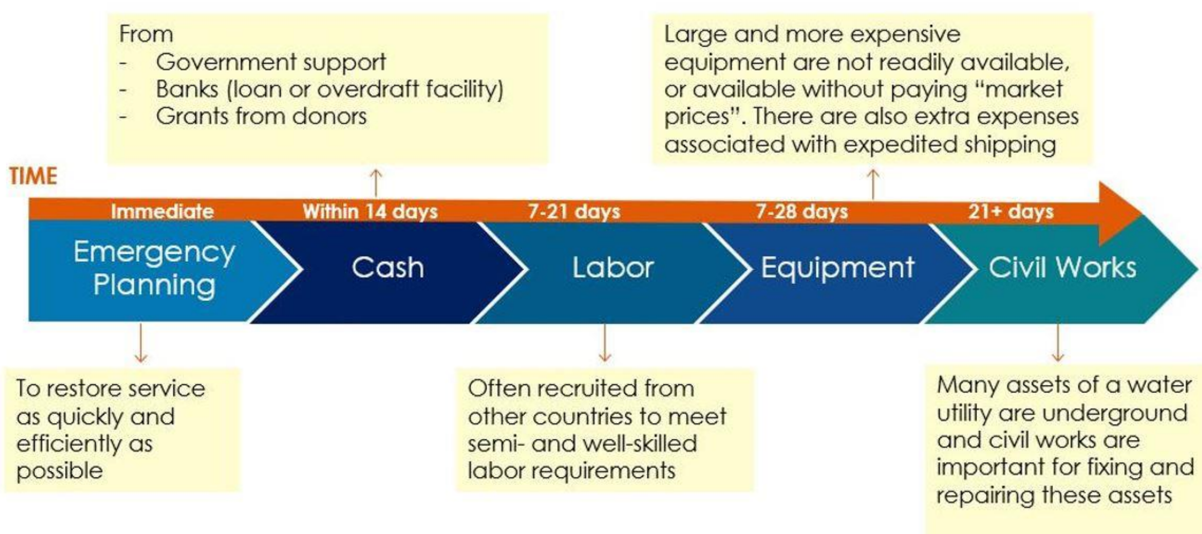
rivers, and springs for bathing, washing and cooking."[118] The disruption of the water supply shortly after the storm had a negative impact on vital economic sectors, like tourism and agriculture which depend on reliable sustainable water services.

In Grand Cayman, Hurricane Ivan arrived as a category 5 hurricane and brought destructive winds of 150 mph and flooding.[119] Water Authority Cayman (WAC), the main water supplier for the island, experienced USD3.25 million in damages. Operations on the Grand Cayman island were severely impacted. The water mains on the southern and eastern coast of Grand Cayman were badly damaged and had to be replaced.

5.4 Post-Disaster Recovery Needs of Water Utilities in the Caribbean

To restore water service after a natural disaster is neither an easy nor routine task for any water utility. Recovery requires a full set of competencies and resources that few water utilities in the Caribbean (or, anywhere) possess on their own, especially if there is widespread and serious damage. In such instances, water utilities need support in various forms, including cash, labor, equipment, logistics, civil works, repair expertise, and emergency response. Such needs can be in addition to the support often provided by local volunteers, "sister agencies," (i.e. other local or regional authorities), non-governmental organizations, and regional organizations. These needs range from emergency coordination in the wake of the disaster, to urgently repairing civil works once supplies and equipment become available. Figure 5.5 illustrates what needs water utilities have in order to recover from natural disasters.

Figure 5.5: Needs of water utilities to recover from natural disasters



[118] Peters, Everson J. "Impact of Hurricane Ivan on Grenada Water Supply." *Proceedings of the Institution of Civil Engineers*, Water management, Water Management, no. WM2 (February 2010): 57–64. https://doi.org/10.1680/wama.2010.163.2.57. Pg. 59.

[119] Deep Blue Images. "Hurricane Ivan Remembered.," September 11, 2013. http://deepblueimages.com/dbi/2013/09/11/hurricane-ivan-remembered/.

Water utility planning for natural disasters should detail how different personnel and resources will be mobilized. Utilities indicated that they routinely conduct disaster recovery training and have instituted plans, depending on the severity of the natural disaster event and what assets are damaged or lost, as to where various personnel or equipment will be deployed.

As shown in Figure 5.5, following a natural disaster, the needs of water utilities include:

- **Cash:** to buy supplies, equipment, materials to repair civil works, and to pay for additional extra labor needed to restore service as quickly and efficiently as possible. Unfortunately, just as cash needs increase the revenue available after a natural disaster decreases due to non-delivery of service and/or delays in billing and collections. Within this context, there are three ways cash (without insurance) can be provided: 1) cash can come from government support; 2) banks (either in the form of commercial loans or through prior arrangements to extend overdraft facilities); or 3) grants from donors
- **Labor:** to restore service after a natural disaster event is often a labor-intensive task. Manpower is needed to make repairs, manage extra stocks, assemble and put in place new and existing equipment, and manage emergency teams. To meet semi- and well-skilled labor requirements in the Caribbean, labor is often recruited from other countries. Operational staff from neighboring water utilities, that have not been affected by the natural disaster, can travel to the affected location and help restore the service in various ways: specifically, by fixing and replacing equipment (such as pipes, pumps, valves, and others) and helping to repairs civil works
- **Equipment:** depending on the natural disaster event, different types of equipment can be damaged. Replacing large, unique and/or more expensive equipment, such as pumps and large mains for example, that are not often readily available or available without paying "market prices" and the extra expenses associated with expedited shipping leads to increased expenses incurred by the water utility. To improve the speed of response, it is important to have the capacity to buy equipment, make contracts with different solution providers, and have a group of prepared professionals and the equipment necessary on "stand-by" to respond to disasters. While each utility would have its own emergency plan for restorative action and emergency mobilization programs, a regional entity, such as CWUIC, would also have helped organize a core first responder group and set of equipment that it would draw from other, non-impacted utilities.
- **Civil works:** following a natural disaster event, restoring civil works to a functional level is the first priority of a utility. Many of the assets of a water utility are underground and these and other civil works, including but not limited to reservoirs, tunnels, and bridges, generally withstand lesser natural disasters but can experience modest to extensive damage when catastrophic natural disasters occur. Ageing water infrastructure and a low level of investment in replacement and rehabilitation in many cases creates a heavy financial burden for repair costs.[120] As reported by HR Wallingford, intense rainfall results in:
  - Siltation of water intakes
  - Damage to underground infrastructure which includes the distribution network

120 HR Wallingford. 2018, p. 11. Planning for the Integration of Climate Resilience in the Water Sector in the Caribbean. Grenada – Task 3 – Investment Plan for Climate Resilient Water Supply Services.

- Damage to roads which limit access to water infrastructure
- Degradation of watersheds
- Damage to treatment facilities
- Loss of power at pumping stations thereby resulting in further delays with respect to restoring services.

- **Emergency planning:** the existence of an emergency plan is most relevant to restore service as quickly and efficiently as possible. Positioning key items and readying personnel according to the emergency plan is crucial for the successful recovery of water supply and wastewater services. For example, emergency plans may include the installation of a mobile desalination plant and distribution of water tanks on one hand, and a communications plan to manage population expectations as to how and when the service will be restored, on the other. Moreover, plans should include coordinating with immigration and other government authorities to waive work permits and customs rules to allow foreign workers and heavy equipment to enter the country quickly to re-establish supplies. Also, emergency plans need to consider maintaining adequate stocks of chemicals (chlorine, alum or other deflocculant), as well as the prepositioning of treatment chemicals and fuel for backup generators. The stocks must be maintained in a hardened, secure location in case they are lost or damaged as a result of a natural disaster. Lastly, one should not forget that GIS tools and hydraulic models, when available, can be extremely useful during emergencies.

The needs of water utilities will vary depending on a variety of factors, including but not limited to their geography, economies/"rate base" of consumers, support from their governments and international development agencies, and also if the natural disaster event is limited to one or several utilities. Meanwhile, the size of water utilities in the Caribbean varies greatly, leading to wide variances with respect to staffing, equipment, revenues, and capital expenditures.

5.5 Water Utilities in the Caribbean Lack Adequate Insurance Coverage for Natural Disasters

The record number of severe convective storms[121] and wildfires in 2020 resulted in the fifth costliest year to the insurance industry, with global losses amounting to USD83 billion.[122] The highly active North Atlantic hurricane season resulted in USD20 billion in insured losses, which is moderate compared to other record-breaking seasons in 2005 (Hurricane Katrina, USD87 billion in losses) and 2017 (Hurricanes Harvey, Maria, and Irma, USD97 billion in losses). With the greater number of hurricanes and the enormous losses that water and sanitation utilities in the Caribbean have experienced, insurance and reinsurance companies have made an effort to adjust to the market.

Data indices show wide variances, year-to-year and jurisdiction-to-jurisdiction, in the frequency and intensity of natural disaster events, limiting the ability to effectively model exposures to natural disaster risk events for more than a short period of time. Nonetheless, insurers and reinsurers have

121 Convective storms are storms that are caused by the release of latent heat into the atmosphere, including thunderstorms, tornados, and hurricanes.

122 "Swiss Re Institute Estimates USD 83 Billion Global Insured Catastrophe Losses in 2020, the Fifth-Costliest on Record | Swiss Re." Accessed December 21, 2020. https://www.swissre.com/media/news-releases/nr-20201215-sigma-full-year-2020-preliminary-natcat-loss-estimates.html.

offered natural disaster insurance for losses in the Caribbean for more than 20 years, expanding their product offerings and increasing the amounts of insurance available over time as they have gained experience covering such risks. Several insurers in recent years have also decided to begin offering natural disaster insurance. While the variability of loss events remains difficult to model, insurers indicate that with the appropriate capital base and premiums, policies can be issued and claims regularly paid.

In many Caribbean jurisdictions, insurers and reinsurers currently and typically limit overall claim payments for natural disasters to no more than USD10 to USD20 million. This may be sufficient to cover losses for some smaller utilities, but even some of the smaller utilities have required tens of millions of USD or more to restore services. In a few countries, notably the Bahamas, the Cayman Islands, the Dominican Republic, Jamaica, and Trinidad and Tobago, insurers can currently provide up to USD175 million in cover, with insurers noting that higher amounts of cover, if necessary, may be available on a "case by case" basis (such as for Trinidad's oil and gas infrastructure). In Puerto Rico, for example, PRASA has obtained windstorm insurance covering more than USD300 million in physical damage losses. In addition, PREPA, the electricity utility in Puerto Rico, is a member of the OIL Mutual, enabling it to potentially access large amounts of insurance for windstorms.[123]

Parametric insurance is of particular relevance for covering natural disasters:

> *The term parametric insurance describes a type of insurance contract that insures a policyholder against the occurrence of a specific event by paying a set amount based on the magnitude of the event, as opposed to the magnitude of the losses in a traditional indemnity policy. An example is a policy that pays $100,000 if an earthquake with magnitude 5.0 or greater occurs. The amount of payment, the parameter, and a third party responsible for verifying that the parameter was triggered must all be specified in the contract. The third party will usually be a government agency, for example, earthquake magnitude could be determined by the measurement issued by the National Earthquake Information Center.*[124]

Insurance is a mechanism for financing risk. It is traditionally purchased for the purpose of mitigating and transferring risk. There are many methods to finance risk depending upon the complexity, exposure, and needs of the insured. The insurance vehicle selected should be tailored to the financial needs of the insured and their projected exposure to risk.

There are three primary vehicles to fund insurance risk:

- **Standard Market (purchasing an insurance policy)** where a policy of insurance is purchased and the risk is 100 percent transferred to the insurance company. Limitations of this approach are limitations of coverage, terms and conditions, and a lack of pricing

---

123 In addition, Puerto Rico received more than USD13 billion from the United States federal government in the form of emergency assistance following Hurricane Maria (2017). Puerto Rico's unique status, it is a commonwealth of the United States, makes it eligible for assistance of this kind. However, Puerto Rico also purchases, as noted above, various parametric weather insurance products as do many of its industries, hotels and resorts, and other large property owners.

124 The Center for Insurance Policy and Research. Parametric disaster insurance. Last updated 27 September 2019. National Association of Insurance Commissioners. Accessed 27 December 2019. https://content.naic.org/cipr_topics/topic_parametric_disaster_insurance.htm

control. The insurance company takes 100 percent of the risk and retains 100 percent of any underwriting profit

- **Self-Insurance** where the insured retains 100 percent of the risk. The limitations to this approach are related to the financial strength of the insured and ability to effectively finance risk and self-absorb claims
- **Risk Pooling/Mutual** which is a hybrid of the standard market and self-insurance approaches. In this approach the insured participates with a group of other entities and shares risk by way of pooling funds and spreading risk. This approach may be tailored to customize coverage, terms and conditions, and pricing. The mutual works for the benefit of its members and is not profit driven like standard insurance markets. Any underwriting profit and investment income is typically returned to its members.

Among insurance and reinsurance companies who provide natural disaster insurance products within the region, there is a wide variance as to what natural disaster insurance covers. In some instances, this insurance is limited to only paying claims for damage resulting from windstorms, often limited to catastrophic hurricanes, with insurers and reinsurers paying a larger percentage of the aggregate costs to repair and replace damaged items in step with the severity of the hurricane (i.e., higher payouts for Category 4 hurricanes versus Category 2 hurricanes). In other instances, insurers and reinsurers have agreed to also cover damage resulting from named windstorms, tropical waves, earthquakes, and volcanic eruptions.

At present, many natural disaster reinsurers provide cover on a parametric basis, meaning that if the natural disaster meets various criteria, then a specific claim amount will be paid. Insureds, nonetheless, are often required, or "encouraged," to return unspent claim proceeds, and, typically, the insurance policy limits compensation to repairing and replacing damaged facilities. Water utilities, on the other hand, build their systems for the long-term and work to assure safe and adequate water supply throughout the year. Therefore, having sufficient funds to incorporate resiliency, protecting the water supply from future natural disasters, is not only a priority but it also means that water utilities will need to retain most, if not all, of a natural disaster-related claim payment in order to build in resiliency. By building in resiliency, water utilities should experience smaller losses and be able to restore services more quickly.

Insurers and local brokers in the Caribbean and Central American offering natural catastrophe (Nat Cat) cover in property insurance policies generally could provide insurance for USD15 million to USD25 million per risk with deductibles of 2 to 10 percent of total insurable value (TIV). It is unclear what rates or premiums insurers and insurance brokers could offer. However, it is evident that premium amounts vary according to the time of the year when insurance is purchased, what deductible is chosen/agreed, and other factors related to risk modeling.

Appendix A: Health and Economic Impacts of COVID-19 in LAC

By the end of December 2020, LAC reached 15 million confirmed cases and 720 deaths per 1 million population. Across the region there are large differences in the health impacts of the pandemic. Table A.1 shows that Argentina, Brazil, Chile, Colombia, Mexico, Panama, and Peru have more than 800 deaths per 1 million population, while Dominica, Haiti, Nicaragua, Trinidad and Tobago, and Uruguay have reported less than 100 deaths per 1 million inhabitants.

Table A.1: Coronavirus situation by country and region (at 30 December 2020)

Country/Region	COVID Confirmed Cases	Deaths	Deaths per 1 million population
Argentina	1,590,513	42,868	949
Belize	10,591	236	594
Bolivia (Plurinational State of)	155,594	9,106	780
Brazil	7,504,833	191,570	901
Chile	603,986	16,488	863
Colombia	1,603,807	42,374	833
Costa Rica	165,762	2,144	421
Dominica	96	0	0
Dominican Republic	168,265	2,405	222
Ecuador	210,326	14,001	794
El Salvador	45,415	1,313	202
Guatemala	136,287	4,781	267
Guyana	6,298	164	209
Haiti	9,999	236	21
Honduras	120,103	3,088	312
Jamaica	12,752	298,	101
Mexico	1,389,430	122,855	953
Nicaragua	4,829	165	25
Panama	233,705	3,892	902
Paraguay	105,37 4	2,202	309
Peru	1,008,908	37,525	1,138
Suriname	6,013	120	205
Trinidad and Tobago	7,127	125	89
Uruguay	17,306	160	46

Country/Region	COVID Confirmed Cases	Deaths	Deaths per 1 million population
LAC	15,008,814	495,550	815
Caribbean	361,202	5,789	130
Americas	35,072,919	848,883	880
Europe	25,628,041	563,176	760

Source: WHO. Coronavirus Dashboard. 30 December 2020

In addition to the health risks, measures taken by governments to address COVID and risk-aversion from households and firms restricted activity in the formal sector.[125] The World Bank estimates a 6.9 percent contraction of the real GDP in 2020 in LAC and forecasts a 3.7 percent increase in 2021.[126] Table A.2 shows that within LAC, the Caribbean had the largest contraction in its real GDP in 2020, equivalent to 7.7 percent. For 2021, however, the Caribbean region is expected to have the highest recovery among the other regions.

Table A.2: Latin America and the Caribbean Growth in Real GDP

Country	2019	2020 expected	2021 forecast
Argentina	-2.2%	-10.6%	4.9%
Belize	0.3%	-20.3%	6.9%
Bolivia	2.7%	-6.7%	3.9%
Brazil	1.1%	-4.5%	3.0%
Chile	1.1%	-6.3%	4.2%
Colombia	3.3%	-7.5%	4.9%
Dominica	9.6%	-10.0%	1.0%
Costa Rica	2.1%	-4.8%	2.6%
Dominican Republic	5.1%	-6.7%	4.8%
Ecuador	0.1%	-9.5%	3.5%
Grenada	3.1%	-12.0%	3.0%
El Salvador	2.4%	-7.2%	4.6%
Guatemala	3.6%	-3.5%	3.6%
Guyana	4.7%	23.2%	7.8%
Haiti	-0.9%	-3.8%	1.4%
Honduras	2.7%	-9.7%	3.8%

[125] World Bank. 2021. Global Economic Prospects, January 2021. Washington, DC: World Bank.

[126] World Bank. 2021. Global Economic Prospects, January 2021. Washington, DC: World Bank.

Jamaica	0.7%	-9.0%	4.0%
Mexico	-0.3%	-9.0%	3.7%
Nicaragua	-3.9%	-6.0%	-0.9%
St. Lucia	1.4%	-18.0%	8.1%
St. Vincent and the Grenadines	0.4%	-5.0%	0.0%
Panama	3.0%	-8.1%	5.1%
Paraguay	0.0%	-1.1%	3.3%
Peru	2.2%	-12.0%	7.6%
Suriname	2.3%	-13.1%	-1.9%
Uruguay	0.2%	-4.3%	3.4%
Latin America and the Caribbean	0.8%	6.9%	3.7%
South America	1.0%	-6.1%	3.7%
Central America	2.4%	-6.1%	3.6%
Caribbean	3.6%	-7.7%	4.5%

Sources: World Bank. 2021. Global Economic Prospects, January 2021 and World Bank. 2020. Global Economic Prospects, June 2020.

Appendix B: Vulnerability of Jurisdictions to Natural Disasters

Table B.1: Vulnerability of Jurisdictions to Natural Disasters

Jurisdiction	CRI*	Hurricane	Windstorm	Earthquake	Volcanic Eruption	Drought	Landslide	Flooding	Tidal Waves
Anguilla		✓	✓	✓	✓			✓	✓
Antigua & Barbuda	47	✓	✓	✓	✓	✓		✓	
Aruba		✓	✓	✓	✓			✓	✓
Bahamas	86	✓	✓				✓	✓	✓
Barbados	151	✓	✓	✓	✓	✓	✓	✓	✓
Belize	32	✓	✓	✓				✓	✓
Bermuda		✓	✓	✓		✓	✓	✓	✓
Bonaire			✓	✓		✓	✓	✓	
British Virgin Islands		✓	✓	✓		✓	✓	✓	
Cayman Islands		✓	✓	✓	✓	✓		✓	✓
Cuba		✓	✓	✓		✓	✓	✓	✓
Curacao		✓	✓	✓		✓	✓	✓	
Dominica	10	✓	✓	✓	✓		✓	✓	✓
Dominican Republic	50	✓	✓	✓				✓	✓
Grenada	21	✓		✓	✓		✓		✓
Guadeloupe		✓	✓	✓	✓	✓	✓	✓	✓
Guyana	1205		✓	✓		✓		✓	✓
Haiti	3	✓	✓	✓		✓	✓	✓	✓
Jamaica	57	✓	✓	✓		✓	✓	✓	✓
Martinique		✓	✓	✓	✓	✓	✓	✓	✓

Montserrat		✓	✓	✓	✓		✓	✓	✓
Puerto Rico	1	✓	✓	✓	✓		✓	✓	✓
Saint Barthelémy		✓	✓	✓	✓			✓	
Saint Kitts & Nevis	127	✓	✓	✓	✓	✓		✓	✓
Saint Lucia	51	✓	✓	✓	✓		✓	✓	✓
Saint Martin		✓	✓	✓	✓	✓	✓	✓	
Saint Vincent & the Grenadines	52	✓	✓	✓	✓	✓	✓	✓	✓
Suriname	173	✓	✓			✓		✓	✓
Trinidad & Tobago	161	✓	✓	✓	✓			✓	✓
Turks & Caicos		✓	✓	✓	✓	✓		✓	
United States Virgin Islands		✓	✓	✓	✓	✓	✓	✓	✓

Source: Global Climate Risk Index 2020, Table 4: Climate Risk Index for 1999-2018, accessed from Germanwatch on 21 October 2020

Vulnerability data accessed from the World Bank, Climate Change Knowledge Portal on 5 September 2019, and Think Hazard accessed on 8 September 2019

Note: * Climate Risk Index Rank

Appendix C: Vulnerability of Water and Wastewater Infrastructure to Natural Disasters

Table C.1: Vulnerability of Water and Wastewater Infrastructure to Natural Disaster

Jurisdiction	Hurricane	Windstorm	Earthquake	Volcanic Eruption	Wildfire	Drought	Landslide	Flooding	Tidal Waves
Above ground assets									
Conventional WTP	High	High	High	Low	Low	Low	Low	Medium	Medium
Desalination plants	High	High	High	Low	Low	Low	Low	Medium	High
WWTP	High	High	High	Low	Low	Low	Low	Medium	Medium
Pumping stations	High	High	High	Low	Low	Low	Low	Medium	Medium
Water tanks	High	High	High	Low	Low	Low	Low	Medium	Medium
Dams/Reservoirs	Medium	Medium	High	Low	Low	Medium	Medium	Medium	Medium
Intakes	High	High	High	Low	Low	Low	Medium	High	Medium
Underground assets									
Water mains and Sewage collector	Low	Low	High	Low	Low	Low	High	Medium	Low
Water distribution and wastewater networks	Low	Low	High	Low	Low	Low	High	Medium	Low
Water source (submersible pumps)	Low	Low	High	Low	Low	Low	High	Medium	Low

Note: levels of vulnerability based on collected testimonials and consultant's assessment

K&M ADVISORS
a Dorado Group Company