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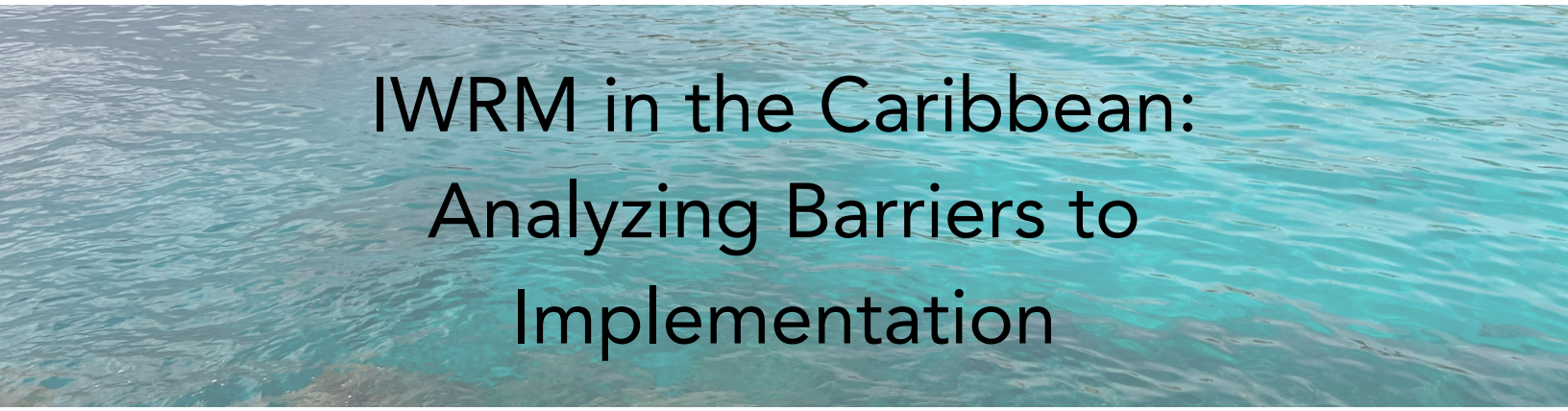

IWRM in the Caribbean: Analyzing Barriers to Implementation

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Acronym List

BWA	Barbados Water Authority
CARICOM	Caribbean Community
CARIWIN	Caribbean Water Initiative
CIMH	Caribbean Institute for Meteorology and Hydrology
GEF	Global Environment Facility
GWP	Global Water Partnership
GIS	Geographic Information System
IGO	Intergovernmental Organization
IICA	Inter-American Institute for Cooperation on Agriculture
IWCAM	Integrating Watershed and Coastal Areas Management
IWRM	Integrated Water Resources Management
LAKI	Lima Adaptation Knowledge Initiative
NGO	Non-Governmental Organization
NRW	Non-Revenue Water
PSA	Public Service Announcement
PUB	Public Utilities Board
SDG	Sustainable Development Goal
SIDS	Small Island Developing States
UN	United Nations
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
WASCO	Water and Sewage Company
WRMA	Water Resources Management Agency

Abstract

Many Caribbean nations are especially susceptible to water scarcity, and the effects of climate change continue to exacerbate this scarcity of water resources, leading to an increased need for adaptation and resilience. Within the Caribbean, Antigua and Barbuda, Barbados, and St. Kitts and Nevis are the most water scarce nations, closely followed by St. Vincent and the Grenadines (World Bank Data, 2020). Other Small Island Developing States, or SIDS, have more abundant water resources, such as Guyana and Suriname, giving the Caribbean region a very heterogeneous water landscape. Integrated Water Resources Management (IWRM) has a low implementation score throughout the Caribbean region, as ranked by a United Nations SDG indicator- the causes of which this paper seeks to address. Through literature reviews, interviews, and an analysis of the SDG 6.5.1 2023 IWRM survey data, this paper was able to identify four themes: Governance and Political Support, Financial Capacity, Stakeholder Participation and Collaboration, and Knowledge, Data, and Capacity Building. Contained within each of these themes are barriers that hinder the implementation of IWRM processes. The theme of Knowledge, Data, and Capacity Building was identified as a nexus barrier, which when addressed, can exact positive change on all other barriers examined in this paper. The identification of this nexus barrier provides a tangible starting point for which to continue IWRM implementation throughout the Caribbean nations.

1.0 Introduction

1.1 The Challenges of Fresh Water Resources in the Caribbean

Most Caribbean island nations rely heavily on groundwater as their primary source of freshwater (Cashman et al, 2014) In the last seven decades, the renewable internal freshwater resources in the Caribbean have decreased by over 60% (World Bank Data, 2020), leading the region to face higher levels of water stress. This rapid decline in freshwater resources is caused by three major factors: fragile natural water systems exacerbated by climate change, inefficient industry water consumption, and ineffective water management. Four nations are currently classified as water-scarce (determined as being under 1000 cubic meters of freshwater per capita), with Barbados being in the most disadvantaged situation and facing an absolute scarcity water crisis (under 500 cubic meters of freshwater per capita) (World Bank Data, 2020). Climate change is continuing to exacerbate this situation (Farrel, 2010).

Small island groundwater systems are relatively fragile as they depend on a delicate balance of precipitation, evapotranspiration, and runoff. A tip in this balance, such as hotter and drier weather, will result in a loss in freshwater supply (Ault, 2016). In addition to this, the low and flat porous limestone shoreline of many Caribbean islands makes them susceptible to sea level rise and coastal flooding, leading to frequent water problems caused by pollution and contamination (Strauss & Kulp, 2018). Both of these issues also lead to increased saltwater intrusion, which pushes freshwater sources into further decline. IPCC projections suggest that the Caribbean region may experience up to one meter of sea level rise above current high tide levels (Strauss & Kulp, 2018), will experience more extreme weather events, and have heavier rainfalls and extended dry seasons (Biasutti, 2012).

Another critical factor that has increased water stress in the region is the growing demand for freshwater from industries. In 2019, over 19 million people visited the Caribbean islands (World Bank 2019), which has since grown to an estimated 28 million in 2022 (Walters, 2023). Tourism constitutes over 10% of the islands' GDP (WTTC, 2022), making it one of the most prominent industries that supply jobs and support the economy in the region (Cashman et al., 2012). The tourism industry is considered a heavy water user, where each tourist uses over 3x more water than the average Caribbean citizen (Emmanuel & Spence, 2009). To uphold the economy, many Caribbean governments tend to support allocating more water resources to hotels and resorts, even if this means that the water goes to maintaining golf courses for tourists (Emmanuel & Spence, 2009). Agriculture is another important industrial water user to consider. While agriculture plays a lesser role in supporting the economy, it is a critical industry that supplies local food and addresses the region's food security concerns (Emmanuel & Clayton, 2017). Poor irrigation practices and dated farming techniques decrease water use efficiency and contribute to pollution, thus impacting freshwater supply. The demand for agriculture will continue to

grow as the population in the Caribbean increases and Caribbean countries want to become less reliant on expensive food imports (Yawson, 2022). Because all countries in the Caribbean are categorized as Small Island Developing States (SIDs) and face an additional set of development challenges, one of the most significant issues that the region faces is balancing the need to conserve freshwater resources while still allowing industries to bolster the economy (Cashman et al., 2014).

One key approach to reducing water stress is effective water resources management; However, the last couple of decades have shown that the Caribbean region faces challenges in this area. For many years, even after independence, Caribbean countries carried legacy water policies and practices from their colonial predecessors, where water resources management focused on providing water access as a municipal or governmental responsibility. The focus on distribution and access was something that the region needed to address at that time so as to ensure all citizens had equal access to water regardless of class, race, or gender. However, even when the issue of access was addressed, the expansion of managing water cycles was still only seen as an extension of water supply services (Cashman et al., 2014). The mentality around water management in the Caribbean has historically been fragmented and convoluted. Multiple departments and institutions within the government have had authority over different aspects of water management, with each one having little accountability in delivering consistent water services. This fragmentation led to weakened water infrastructure, either redundant or non-existent efforts around solving water problems, and ineffective management of water funding.

The challenges of water scarcity threaten the economic, social, and ecological stability in the Caribbean. The region was in desperate need of water reform, and in 1992, at the World Summit for Sustainable Development in Rio de Janeiro, the idea of Integrated Water Resources Management (IWRM) emerged. While IWRM is not meant to be a prescriptive solution for water management issues, it is a promising concept that will help the Caribbean adapt to and mitigate the impacts of climate change.

1.2 The Promises of IWRM

The most commonly cited definition of Integrated Water Resources Management is one that the Global Water Partnership (GWP) created in 1999 (Agarwal et al., 2000):

> "Integrated Water Resources Management is a process that promotes the coordinated development and management of water, land and related resources in order to maximize economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems."

This definition is straightforward and captures the essence of IWRM, however the scope of IWRM is much more comprehensive and provides a robust framework for water management.

Integrated refers to both the natural and human water systems that are managed in unison with each other. The natural water system refers to the hydrological cycle and its

impacts on glaciers, lakes, rivers, coastal ecosystems, watersheds, basins, and catchments. The human water system refers to how human demand for water resources interacts with the natural water system, such as dams, treatment plants, sewage systems, and irrigation systems (NSF, 2017). Any changes in either water system can directly impact the other, and the required interaction between the two systems is considered and addressed rather than ignored when making water management decisions (O'Connell, 2017). Integrated also means taking a holistic approach to engaging all various stakeholder groups to understand their experiences with water, and managing water resources in a way that best fits the needs of those stakeholders. Holistic stakeholder approaches include involving people within government and across industries, academics, and civil society in decision-making processes while also inserting water management considerations in different facets of society, like city planning, education, and healthcare (Agarwal et al., 2000).

Water resources refers to where water originates, whether from rainfall, surface, or subsurface sources, as well as collection methods, storage, treatment, distribution, disposal, and use. It also measures water quality and quantity. Therefore, it considers how environmental factors like pollution, biodiversity loss, and land degradation impact access and availability of water in the long run (NSF, 2017).

Management entails the available mechanisms that are in place to support the IWRM process. The United Nations Sustainable Development Goal (SDG) 6: Ensure Availability and Sustainable Management of Water and Sanitation for All identified a set of water management elements that make up a robust IWRM process. This includes policies, legislation, and institutions that create a governance structure to enable IWRM processes through accountability and transparency. It also examines how coordination and participation promote stakeholder engagement throughout the IWRM process. Finally, it considers how data, knowledge, technical capacity, and financing help build more consequential water management plans and practices.

IWRM is an intentional participatory process that weaves water availability and stakeholder needs together. How IWRM is implemented, however, is where this concept gets complicated and often causes confusion for water managers who are tasked with its application. Expectations that IWRM will be a prescribed recipe for water management successes is not accurate. Instead, it is more closely aligned with an ideology or process. There are no exact series of steps to be taken, but rather a philosophy on water management that is used to guide countries on their water management journey (Nagata et al., 2022). IWRM is meant to have a degree of flexibility that allows it to be tailored to each nation, region, and community's different water issues, needs, and challenges. With that said, there is an opportunity for each Caribbean nation to craft an IWRM process that is thoughtfully crafted for maximum benefit to their unique water situation. With that, IWRM should help each country build resilience against water scarcity and help them adapt to climate change.

1.3 Can IWRM Work in the Caribbean?

The benefits of IWRM are clear. However, implementation comes with challenges, and those challenges are what the Caribbean region is facing today. In 2002, at the Johannesburg World Summit of Sustainable Development, all Caribbean countries, along with most nations across the globe, signed on to generate their own IWRM plans, and have them implemented by 2005 (Cashman, 2012). However, today, the average degree of implementation of IWRM plans across the Caribbean is about 40% as per the SDG 6.5.1 Target: Degree of IWRM Survey (the world averages about 57%). Despite aid from international development agencies, they have yet to gain the needed momentum towards further implementation.

Seeing the Caribbean nations' slow progress in IWRM adoption leads to the question: What are embedded barriers that prevent full implementation of IWRM in the Caribbean? Through this exploration, we can begin to understand what needs to be done to close the implementation gap. This paper will consider what barriers are hindering the region from reaching higher rates of implementation, and examine continued adoption of IWRM processes. We have studied Barbados and Saint Lucia as examples, and Singapore, one of two countries that has achieved 100% IWRM implementation, has been studied as a comparison.

The United Nations Framework Convention on Climate Change (UNFCCC) is a strong advocate for building knowledge, and its Lima Adaptation Knowledge Initiative (LAKI) is an example of how it supports programs that help find and close climate adaptation knowledge gaps. Specifically this paper addresses gaps in knowledge on the optimization of technologies and techniques for managing water resources and adapting to climate change. Tracing the pathways that lead to partial IWRM implementation falls under this scope of discovery. Establishing a strong IWRM plan is vital to the Caribbean's climate health because water is how climate change will directly impact lives (UNEP-DHI, 2018). Getting clarity on what holds the Caribbean nations back from full IWRM implementation is the primary step in assisting them in establishing more powerful climate adaptation strategies.

2.0 Methods

To discover the reasons behind the Caribbean's slow IWRM implementation, we devised a research plan consisting of three approaches to data collection and analysis. Our first method was an extensive literature review, which enhanced our understanding of Caribbean water issues and helped us to conceptualize potential barriers to IWRM implementation. We then conducted a series of interviews, both in person and virtually, with water experts and end water users in Barbados and Saint Lucia. Finally, we evaluated and analyzed the survey data from the SDG 6.5.1 Target: Degree of IWRM. This is a self-elected survey each country is encouraged to submit to the UN every 3 years to attest to progress made towards IWRM implementation.

2.1 Literature Review: Understanding Caribbean Water Issues and the IWRM Process

2.1.1 Literature Review Goals and Process

The goal of the literature review was to understand the critical water and climate change issues the Caribbean region faced and determine the benefits and challenges of IWRM so that we can begin to identify the key barriers preventing full IWRM implementation in the Caribbean.

To begin, the Inter-American Institute for Cooperation on Agriculture (IICA), our client organization, recommended five prominent subject matter experts with publications related to and relevant to water challenges and the Caribbean. Following this, we explored the citations in these authors' papers and conducted a keyword search in Google Scholar to come up with a set of 50 papers related to IWRM and Caribbean water issues to review. This selection is from a population of 451 papers written about IWRM and Caribbean water challenges found in the Web of Science Core Collection. This initial review revealed six groups of recurring themes that were discussed in these papers, as shown in Figure 1.

2.1.2 Narrowing the Scope

Our next step was to understand how these themes act as barriers and find representative examples from the Caribbean. To do this, we carefully selected the two Caribbean islands, Barbados and Saint Lucia, to focus on. We wanted to examine a country that was defined by the UN as water scarce, and another one that is close to, but not completely facing water scarcity issues yet, thus giving us a more rounded perspective of IWRM and how it is used situationally. We also wanted to examine a SID that had a relatively high IWRM implementation to set as our control for comparison. The thought was to see if these barriers were universal and if so, how are they similar and different between the countries. We chose Singapore as our control country because it was the only SID that scored themselves 100% in the SDG 6.5.1 self survey.We wanted to expand our literature review to capture more relevant studies and strengthen our understanding of the six groups of recurring themes.

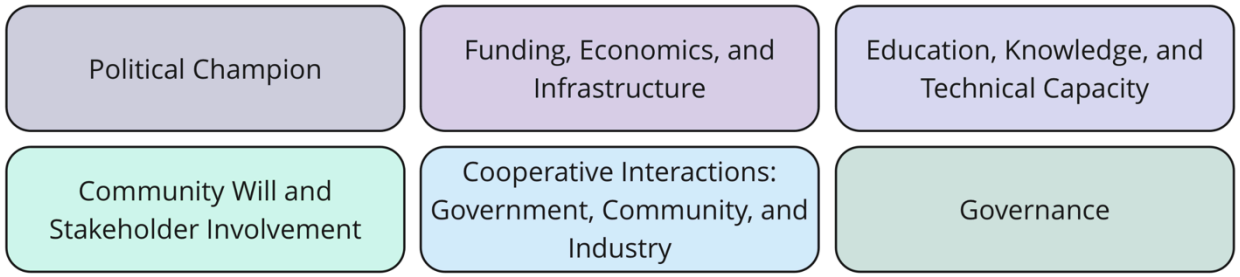

Figure 1: Initial six key grouped themes identified IWRM

First, we searched the Web of Science Core Collection using the search strings and found the following:

- 'Caribbean x IWRM' had 84 papers
- 'Barbados x IWRM' had 15 papers
- 'Saint Lucia x IWRM' had 5 papers
- 'Singapore x IWRM' had 7 papers.

We then extended our search to Google Scholar and meticulously designed a systematic approach for queries that included the following keywords and phrases: Country (Barbados, Saint Lucia or Singapore) x Barrier (Political Champion, Governance, etc.) x IWRM x Integrated Water Resources Management. We also set the date parameter for after 1992 to capture IWRM research from when the concept became popular. The first ten results that appeared in the search were recorded and read as part of the literature review. In this selection of literature we included academic journal articles, news articles, white papers, published reports, conference proceedings, thesis, case studies and books. We reviewed an additional 85 pieces of literature, of which 22 related to Barbados, 37 related to Saint Lucia and 37 related to Singapore. Note that there were some papers that were relevant in all three countries and that is why the sum of papers for each country is greater than total papers.

2.1.3 Theme & Barrier Identification

For a comprehensive understanding of our literature review, we coded all the papers in NVIVO. This allowed us to see clearly which themes were represented across all the reviewed literature and whether some themes were discussed more than others. Our starting assumption was that themes which came up more often could indicate points of contention, importance, or success.

Each paper was coded when a theme was discussed in depth, and if the same theme came up more than once as a new concept, it was coded again for the same paper. For example, if the paper had discussed tariff structure and national budgeting, it would have been coded twice for finance. We wanted to capture a variety of concepts that fell under each theme. Papers that discussed agriculture, tourism, and climate change were also coded to see how often these concepts were mentioned. If a recurring theme not on our initial list appeared more than three times in one paper, it would be coded into a new section. This coding scheme ensures we capture what might have been missed in our initial literature review.

This review helped us identify 13 themes, with the 4 overarching concepts of Governance and Political Support, Financial Capacity,

Stakeholder Participation and Collaboration, and Knowledge and Capacity Building. We then went into each coded section to dissect and see how these themes presented as barriers to IWRM implementation. Building on the literature review, we then moved to interviewing stakeholders to fill in knowledge gaps that could not be found in the literature.

2.2 Stakeholder Interviews in Barbados and Saint Lucia

To expand on the findings from the literature review, we conducted semi-structured interviews, both in person and virtually, with 20 people and 1 focus group with IWRM stakeholders in Barbados and Saint Lucia—the breakdown of participants is shown in Figure 2. Out of the two countries, we selected Barbados for our in-country fieldwork as it was a location where we wanted to gain a deeper perspective on water scarcity and learn about the water challenges that locals face.

2.2.1 Question Development

Our interview questions (Appendix A) were designed around the six grouped themes we identified from our initial literature review (Figure 1). The goal was to see how these themes presented as barriers and what insights each interviewee or focus group would provide around these topics. It was also an opportunity to collect current examples of Caribbean nations' experiences of IWRM and water issues.

Our questions were designed to have two different response types: one response was either a yes or no answer, followed by optional elaboration. The other was open-ended questions. These types of questions were chosen because we believed that it would provide a holistic picture of what was happening on the ground while adhering to a one-hour time limit that we imposed to respect everyone's time. Informal interview questions were developed depending on the credentials of the interviewee. For example, a water expert was asked about water scarcity in Barbados, while a general end-user was asked about their experience with water disruptions.

2.2.2 Participants

Our interviewees were selected based on their relationship to water and water management procedures. Participants included people who worked in sewage management and water utilities, academics who specialized in water and hydrology, people who worked in industries with high water use, and leaders who worked with vulnerable populations. We decided that interviewing subject matter experts in these different areas would give us a comprehensive picture of the current water situation in Barbados and Saint Lucia.

We identified an extensive list of specific organizations we wanted interviewees from and worked with our local partners, IICA, to obtain meetings. IICA searched through their network and reached out on our behalf to organize these interviews. Informal interviewees were selected on a situational basis. The decision to engage in an informal interview took place at the interview site. Project members decided to interview if the potential interviewee was knowledgeable about water management or IWRM processes.

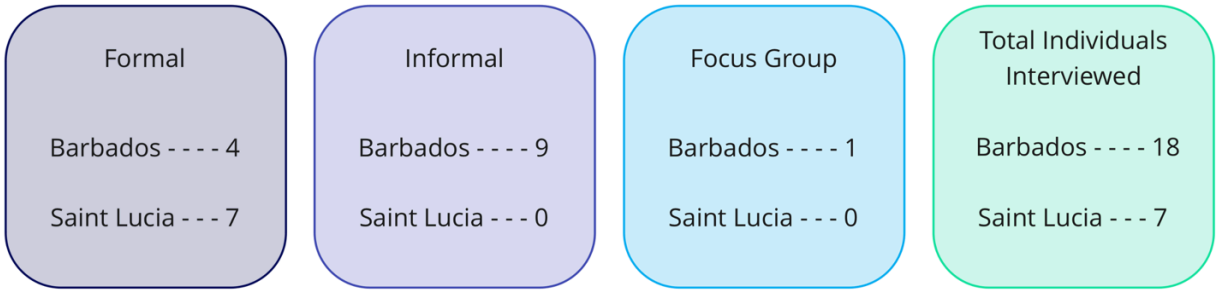

Figure 2: Interview participant counts from both Saint Lucia and Barbados

2.2.3 Administration

Our initial interviews were conducted in and around Bridgetown, Barbados, by two team members who traveled there to gather on-the-ground contextual research in August of 2023. Upon their return, more interviews were conducted over Zoom during October and November of 2023 with individuals from Saint Lucia and Barbados (Figure 2).

2.3 SDG 6.5.1 Survey Analysis of Caribbean Countries

The last part of our research corroborated our literature review and interviews with an additional secondary data source. The SDG 6.5.1 survey presented a unique data set as it gave us the perspective of water managers in each Caribbean country. These reports were drafted by the country's respective water management leadership and as part of the information gathering process, water stakeholder workshops were supposed to be held so that multiple perspectives could be represented in the survey answers.

Stakeholder engagement could include interviews, surveys (either via phone or email), discussions at conferences, meetings on a related water topic, or specifically held workshops. The results of these surveys gave us a snapshot of how the country views its water issues and IWRM implementation barriers.

We completed a deeper analysis of SDG 6.5.1 2023 IWRM survey data for Caribbean countries. We reviewed each country's survey to identify how each country self-reported across the four categories of Enable Environment, Institutions and Participation, Management Instruments and Financing. We also read through all the qualitative questions in the survey to identify underlying trends in each country's survey. We assumed that lower scores may indicate barriers to full implementation of IWRM and tied these findings back to our literature review and interviews.

3.0 Results

3.1 IWRM Implementation Barriers Identified from Literature Review

After reading 135 different pieces of literature on IWRM and the Caribbean, 13 key themes emerged. These themes are shown in Figure 3. The top five themes that were most commonly mentioned throughout our review were governance (mentioned 99 times), funding (mentioned 93 times), capacity building (mentioned 86 times), participation and collaboration (mentioned 68 times), and water knowledge and education (mentioned 68 times). It is also to note that the number of papers that mention these themes is indicative that it is not simply one or two pieces of literature that mentioned the themes in several different ways but that these themes were the ones prominently emerging. 51 pieces of literature discussed governance, 50 discussed capacity building, 45 discussed funding, 40 discussed participation and collaboration, and 35 discussed water knowledge and education. These numbers suggest that these elements are critical to IWRM, but to determine if they present as barriers, we dug deeper to understand the context in which they were discussed within the papers. By doing this, we also realized that some smaller themes could be grouped with the more prominent themes. For example, land use and political support could be grouped under governance, while relationships and gender could be groups with collaboration and participation.

We defined 'governance' as the systems, frameworks, and institutions supporting the IWRM process in the Caribbean. We coded topics related to government processes and departments, policy, legislation and regulation, agencies, and associations into this theme. We also examined this section using the topics 'Political Support' and 'Land Use'. Governance barriers that became evident through this analysis include the important following points:

- Weak policy or legislation in place that regulates and manages water
- Fragmented or siloed departments, agencies, or institutions govern different parts of the water process with no clear responsibilities.
- Lack of accountability and transparency in governance structures

Funding, demand management, and economics were defined as revenue or other sources of capital that financed water processes and IWRM and the economics behind it. We coded concepts related to water economics, fundamental economics, types of funding, financing instruments, budgeting, tariffs, pricing, taxes, and rates into this section. In our analysis, papers argued the following critical funding and economic barriers:

- Weak revenue structure that does not support existing water operations
- No additional sources of water revenue aside from water utilities
- Dependence on ad-hoc project-based international funding

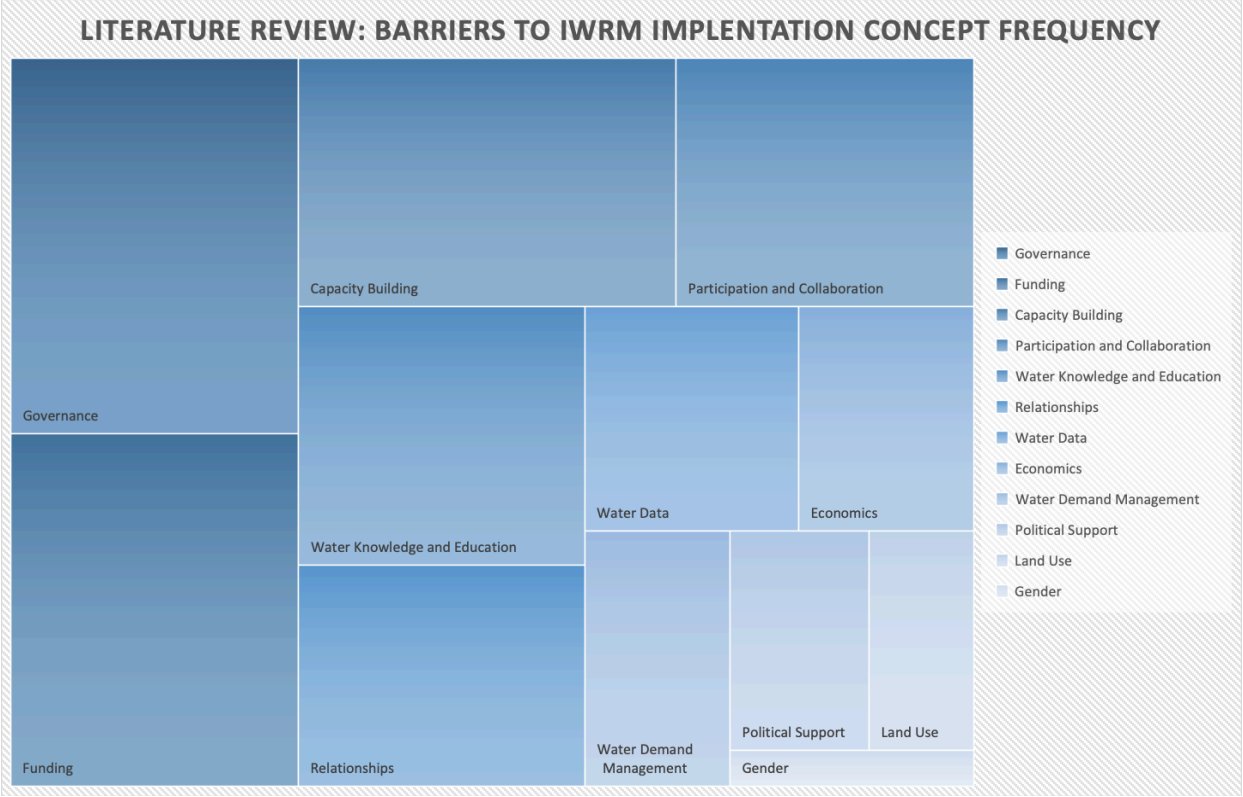

Figure 3: A visual representation of the frequency at which these themes were shown throughout the literature review

We combined capacity building, water knowledge, education, and water data into the same group because they shared many similar points. We defined this section as crucial information and knowledge that enables and supports IWRM processes. We coded topics related to technical capacity, water education, water awareness, data collection and analysis, and data technology into this section. Our analysis concluded that these are the barriers that are derived from this section:

- There is insufficient water data available for decision-makers to make timely decisions
- Not enough water stakeholders have a basic understanding of water and water issues
- Lack of technical capacity makes it difficult to manage water effectively and efficiently

Finally, we looked into the concepts of stakeholders, where we combined collaboration and participation, relationships, and gender. We defined stakeholders and key people or groups that are impacted by how water is managed. We coded concepts like stakeholder engagement, relationship building, collaboration opportunities, types of collaborations, participation opportunities, and types of participation into this section. The papers suggested that these were the following barriers to stakeholder engagement:

- Most stakeholder engagement sits at a communication and consulting level, not a decision-making level.
- Many stakeholders are excluded from water management discussions and do not have explicit opportunities to participate.
- Not enough bottom-up communication channels exist.

A detailed synthesis of these findings is integrated into section 4 of this report.

3.2 Results from Interviews

Our stakeholder interviews gave us unique insight into how IWRM operates in the Caribbean. On-the-ground experience can be very different from what is portrayed in research and literature. Being in Barbados and speaking to people who work in water management or have water management-related experience helped us narrow in on the ideas around barriers that we formed from our literature review.

3.2.1 Political Champion

There was a difference between some responses from interviewees and the anticipated responses, as it was expected that everyone would say political champions are essential. One notable difference was the impact of political champions on water management in IWRM. It was anticipated that most respondents would agree that a political champion is critical to IWRM implementation, but results spoke otherwise. While 67% of interviewees said political champions are essential, 33% did not give a definite answer, and the more extended responses showed a more nuanced understanding of political champions in IWRM.

Another anticipated result was a lack of political champions in the region; however, 77% of interviewees identified a political champion for water management in their community. This result suggests that a lack of a political champion is not a pivotal barrier to IWRM implementation in Barbados and Saint Lucia, as the existence of a political champion did not further IWRM implementation in any substantial way.

3.2.2 Funding, Economics, and Infrastructure

The barriers of funding, economics, and infrastructure were identified as critical to IWRM implementation but not to the anticipated degree. Of the interviewees, only 64% stated that funding, economics, and infrastructure significantly impact IWRM. While this could suggest that most water management experts and stakeholders view this as important for IWRM, it also suggests that some interviewees believe that the issue of funding is complex and may act as a barrier to IWRM implementation.

3.2.3 Education, Knowledge, and Technical Capacity

Aligning with anticipated results, 82% of interviewees explicitly stated that education, knowledge, and technical capacity were highly impactful in IWRM implementation. This value suggests a consensus among diverse stakeholders that education, knowledge, and technical capacity are needed to implement IWRM effectively. 23% of interviewees stated that responsiveness to technical water challenges was poor, suggesting the presence of technical deficiencies in water utilities' ability to respond to leakages, disruptions, and other technical challenges. Interviewees did not identify if the cause of the poor

responsiveness was knowledge, funding, or institutional capacity. However, 75% of interviewees did state that there was a lack of trained professionals in the respective countries of the interviewees. It is inferred that a lack of trained professionals could contribute to poor responsiveness and a barrier to IWRM implementation.

3.2.4 Cooperative Interactions

64% of interviewees explicitly stated that cooperation had a high degree of impact on IWRM implementation. Though cooperation was stated as impactful for IWRM implementation, 17% of interviewees stated that industries were competing against each other. Increased cooperation has potentially significant implications for water management because it could allow for equitable reallocation of water resources among water-intensive industries like agriculture and tourism. When viewing the economic statistics of the countries of Saint Lucia and Barbados, tourism is a large part of the GDP. Agriculture is also water intensive and has a high usage rate when compared to its contributions to the economy of both countries. With this data in mind, it was anticipated that interviewees would overwhelmingly state that these industries are very impactful.

Contrary to the anticipated responses, only 58% of interviewees stated that these industries significantly impact IWRM readiness. One last notable finding of industry interview question responses were the responses regarding the degree of political support for agriculture and tourism. More respondents stated that there is political support for the agricultural industry than the tourism industry. 75% of interviewees stated that there was political support for agriculture, while 58% stated that there was political support. When analyzing the responses, this is likely the case because formal governmental entities like the Ministry of Agriculture in both Barbados and Saint Lucia exist. It is important to note that this does not imply that the agricultural industry has more support than tourism. Instead, it suggests that there is more formal facilitation of political advocacy for agriculture in the government.

3.2.5 Community Will and Stakeholder Engagement

Engaging with the community and stakeholders is integral to IWRM, though some interviewee responses contradicted this. 45% of interviewees stated that community will and stakeholder engagement impact IWRM readiness. The remaining respondents gave ambiguous answers, suggesting that engaging with the community and stakeholders is not very important for implementing IWRM. There was also a strikingly low number of claims of public support for a modernized IWRM plan with only 8% stating this claim. The rest of the respondents stated explicitly that there is a lack of public support. In the responses, interviewees noted a lack of support due to the public not knowing about IWRM.

In contrast, 77% of interviewees stated they had heard of community meetings regarding water management, implying that there have been attempts to inform the public about water management issues and receive input. Only 31% of the interviewees believed there were adequate ways to get involved in the current water management process. As questions relating to how people believe they can get involved in the

water management process were not included in our interview questions, this does not indicate if there are or are not chances to get involved in the process but is indicative of the perception of the people living in the countries. When asked if perspectives were missing from the water management conversation, only 25% of interviewees stated that there were missing perspectives, while all other interviewees were unsure how to answer the question, suggesting that there has been little work done to engage end users and stakeholders that are generally not involved.

3.2.6 Governance

The impact of governance on IWRM was seen as impactful, as 60% of interviewees stated that there is a high degree of impact on IWRM. Similar to the other questions about impact, the question responses suggest that it is important but may vary.

Of the interviewees, only 20% claimed to have heard about IWRM, which suggests that there is a potential lack of policies on a potentially large part of water resources. This leads us to believe that governance is a key barrier to IWRM implementation.

3.3 Analysis of SDG 6.5.1 Survey Results in the Caribbean

The final piece of our analysis is on the 2023 SDG 6.5.1 self-reported survey results.. It is important to note that these self-reports are done on a volunteer basis, and while there are specific guidelines to how each question should be scaled and answered, it is still largely up to the country to make their interpretations. As an observation, some countries may have over-reported their status, while some may have under-reported. We attribute this to countries having their internal benchmark, and their progress is compared to their previous report rather than to other countries on a global scale.

3.3.1 Total Average IWRM Reporting Score

Table 1 presents the 2023 survey results for the entire Caribbean, which were unveiled in early March 2024. The results, evaluated across four key dimensions -Enabling Environment, Institutions and Participation, Management Instruments, and Financing- are instrumental in assessing the success of full IWRM implementation. These dimensions, endorsed and defined by UN-Water and the GWP, gauge the country's progress in its SDG 6.5.1 target. Each category is assigned a value out of 100, and is color-coded to indicate performance, with red denoting relatively low scores and blue indicating relatively high scores.

At first glance, Enabling Environment and Financing scores are on the lower side of the spectrum and Institutions and Participation and Management Instruments are slightly higher, but no sections reach the 4th quartile (75-100) on the rating scale. Barbados gave themselves a total average score of 51 points and in contrast, Saint Lucia gave themselves an average score of 41.

Countries	2023 reporting summary				
Country name	1. Enabling Environment	2. Institutions & Participation	3. Management Instruments	4. Financing	Total Average Score
Antigua and Barbuda	23	56	53	20	38
Bahamas	42	38	45	33	40
Barbados	45	66	71	23	51
Cuba	No Data				
Dominica	25	66	63	58	53
Dominican Republic	24	49	44	40	39
Grenada	28	34	39	40	35
Haiti	No Data				
Jamaica	56	51	68	30	51
Saint Kitts and Nevis	15	23	33	20	23
Saint Lucia	44	42	46	32	41
Saint Vincent and the Grenadines	20	22	48	8	24
Trinidad and Tobago	42	46	48	28	41

Table 1: Total average scoring of the SDG 6.5.1 survey across the Caribbean (UNEP-DHI, 2023)

For reference, the world average for 2023 was 57 points, which has trended upwards from the other three reporting periods that have taken place (baseline reporting in 2017, then reporting every three years in 2020 and 2023).

It is worth looking deeper into each category to understand where these scoring differences are coming from and to understand what is driving the lower scores in Enabling Environment and Financing in particular, as these areas might have specific factors that present as barriers to full IWRM implementation.

3.3.2 Enabling Environment

Enabling Environment refers to the legal, regulatory, and governance framework supporting an IWRM process. This includes consideration of the role of government, the types of water policy and legislation that are in place, and the coordination and collaboration between all groups of stakeholders from the government level to the community and all affected industries (Agarwal et al., 2000). It recognizes the

Countries	1. Enabling Environment							
Country name	National Water Policy	National Water Laws	National IWRM Plan	Sub national Water Resource Policy	Basin/aquifer management plans	Transboundary arrangements	Sub-national Water Resource regulation	Average Score in Section
Antigua and Barbuda	20	20	40	20	20	n/a	20	23
Bahamas	50	40	50	40	30	n/a	40	42
Barbados	60	70	20	n/a	30	n/a	n/a	45
Cuba	No Data							
Dominica	30	30	30	n/a	10	n/a	n/a	25
Dominican Republic	40	20	20	20	20	50	0	24
Grenada	40	30	30	n/a	10	n/a	n/a	28
Haiti	No Data							
Jamaica	60	60	50	60	50	n/a	n/a	56
Saint Kitts and Nevis	0	20	20	n/a	20	n/a		15
Saint Lucia	60	70	40	40	10	n/a	n/a	44
Saint Vincent and the Grenadines	30	30	10	n/a	10	n/a	n/a	20
Trinidad and Tobago	60	30	50	20	50	n/a	n/a	42

Table 2: Part one of the SGD 6.5.1 reporting scoring: Enabling Environment scores across the Caribbean (UNEP-DHI, 2023)

importance of having platforms in place that allow stakeholders to engage, participate, and collaborate in the IWRM process.

Most Caribbean countries have national water policies and laws in place. However, many are not based on the IWRM process or strategies. Some of these laws and policies can be dated back to the mid-1960s and 70s, and while some have been revised to include elements of IWRM, most have not been reconstructed with IWRM principles in mind specifically (Cashman et al., 2014). Originally, roadmaps towards full IWRM implementation and plan designs were facilitated by the UN and the GWP to create initial conditions for IWRM success (CEHI, 2008); however, it can be shown from both the literature review, our interviews, and from this SDG data that much of the issue now stems from obtaining government buy-in and government prioritization. Plans are drafted but have yet to be fully adopted by most countries. However, progress is being made, as is evident in the SDG 6.5.1 "way forward" section of the survey, as many countries included that they are actively pushing IWRM plans for approval by their respective governments and water managing bodies. The lowest scores in the Enabling Environment piece can be seen at the basin/aquifer level, where, as of yet, no

IWRM plans have been considered since the approach is still on a top-down trajectory instead of bottom-up. Beginning IWRM planning with a bottom-up approach in mind requires more stakeholder and governmental support, and the lack of this approach could be due to low capacity in both knowledge and technical aspects (Gopaul, 2004).

From this data, it is apparent that no Caribbean country has IWRM processes fully integrated into their national water policies and laws, and there is no indication that laws and policies are being regularly reviewed and updated to ensure that their IWRM objectives are being met or adjusted to bring the reality closer to the goal.

Please note: Part of the Enabling Environment section includes transboundary water management, and while this is a key element of IWRM it does not apply to most Caribbean countries as they do not share borders. Also, since many Caribbean countries are smaller, many do not need sub-national governmental structures.

3.3.3 Institutions and Participation

Institutions and Participation refer to the functions and roles different organizations, departments, and external bodies play in the IWRM process. (Agarwal et al., 2000). This dimension emphasizes the cross-sectoral collaboration and the technical capacity required to support an IWRM process (UNEP-DHI, 2023). Institutions are encouraged to exist on different levels of society, ranging from national-level planning down to end-user-led efforts. It highlights the need to include vulnerable populations and women in the water management process (UNEP-DHI 2023). Across most Caribbean nations, institutions are given the authority and the indication to take the lead on IWRM initiatives. However, there needs to be more capacity to do so, resulting in lower scores in the Institutions and Participation category. Many counties have multiple government sectors represented in the IWRM process, the roles of which are coordinated and planned in the management process. By focusing mainly on government and industry engagement, there is currently less focus centered on public participation. It can be challenging to engage with the public through discourse alone; presently, communication channels are limited to formal meetings, many of which are not specific to water and water resources management (Burton, 2003). With a bottom-up IWRM approach, it is essential to establish access to communication channels, especially with vulnerable groups and women. This is an area the Caribbean needs to improve on as it is impeding their IWRM implementation goals. The region scores relatively low in the vulnerable groups and gender categories in the table above for participation. While these perspectives are not explicitly excluded, for proper IWRM implementation and improvement of scores, countries must actively include the voices of vulnerable groups and women in the engagement process.

Countries	2. Institutions & Participation											
Country name	National institutions leading IWRM	Cross-sectoral coordination	Public participation in WRM - national	Private sector participation	Developing IWRM capacity	Basin/aquifer level organizations	Public participation in WRM - local	Participation of vulnerable groups	Gender in IWRM laws/plans	Transboundary organizational frameworks	Sub-national authorities for IWRM	Average Score in Section
Antigua and Barbuda	60	100	40	60	40	60	60	40	40	n/a	n/a	56
Bahamas	50	60	30	50	30	30	30	40	30	n/a	30	38
Barbados	80	80	50	80	60	n/a	n/a	60	50	n/a	n/a	66
Cuba	No Data											
Dominica	50	70	70	80	60	n/a	80	50	70	n/a	n/a	66
Dominican Republic	20	80	80	80	60	80	40	20	20	60	0	49
Grenada	10	50	50	50	30	0	50	20	50	n/a	n/a	34
Haiti	No Data											
Jamaica	80	70	50	50	40	n/a	40	40	40	n/a	n/a	51
Saint Kitts and Nevis	20	40	20	20	20	20	n/a		n/a	n/a		23
Saint Lucia	50	80	20	50	30	40	60	30	40	n/a	20	42
Saint Vincent and the Grenadines	50	50	10	0	60	10	0	20	0	n/a	n/a	22
Trinidad and Tobago	40	60	50	50	50	30	50	40	40	n/a	n/a	46

Table 3: Part two of the SDG 6.5.1 reporting scoring: Institution and Participation scores across the Caribbean (UNEP-DHI, 2023)

Capacity building is only one criterion in this table and this contradicts our literature review and interview findings, which suggested capacity building is an important underlying supporting factor to IWRM success. Since many international development agencies, including the UN, have provided programs and support to build technical capacity in IWRM, we expected it to play a more significant part in this SDG target. The lower emphasis placed on capacity building could suggest it has become an impeding barrier to IWRM implementation. While the scoring on developing IWRM capacity suggests that there is above average progress, Caribbean countries still need to implement long-term plans to sustain capacity-building efforts.

3.3.4 Management Instruments

Management Instruments are tools and methods that are used to manage water. This dimension aims to collect and provide knowledge to help stakeholders and decision-makers make informed choices in implementing the processes and strategies of IWRM. Tools and methods include specific plans for basin and aquifer management, systems and technologies for water monitoring and data collection, regular water risk assessments, communication strategies for information and knowledge exchange, and conflict resolution strategies (Agarwal et al., 2000). Most countries have some long-term elements of different water management instruments in place to help monitor their water resources. However, their water data management instruments are a critical limiting factor. They are oftentimes not sufficient to gather all the necessary information for producing good quality data. This lack of robustness underscores the urgency and importance of the issue. Underlying causes for this could again be

Countries	3. Management Instruments									
Country name	Water availability monitoring	Sustainable and efficient use management	Pollution Control	Water ecosystem management	Management of water-related disasters	Basin management instruments	Aquifer management instruments	Data and information sharing within country	Transboundary data and information sharing	Average Score in Section
Antigua and Barbuda	60	40	20	60	60	60	60	60	n/a	53
Bahamas	50	30	50	50	70	30	50	30	n/a	45
Barbados	90	80	90	40	80	n/a	70	50	n/a	71
Cuba	No Data									
Dominica	60	70	50	90	70	50	20	90	n/a	63
Dominican Republic	40	60	40	40	80	40	60	20	20	44
Grenada	40	40	40	40	40	30	40	40	n/a	39
Haiti	No Data									
Jamaica	80	80	80	80	60	40	60	60	n/a	68
Saint Kitts and Nevis	40	40	20	40	40	20	40	20	n/a	33
Saint Lucia	70	50	50	50	50	40	10	50	n/a	46
Saint Vincent and the Grenadines	80	30	60	50	40	40	40	40	n/a	48
Trinidad and Tobago	50	50	50	40	50	50	50	40	n/a	48

Table 4: Part three of the SGD 6.5.1 reporting scoring: Management Instruments scores across the Caribbean (UNEP-DHI, 2023)

tied to capacity, similar to the enabling environment section, since it calls into question knowledge. Another reason could be a lack of financial support to sustain the management instruments on all levels needed to support full IWRM implementation.

3.3.5 Financing

Funding is the final SDG dimension to consider when implementing IWRM. In this section, the goal is to secure long-term funding for the IWRM process. IWRM is best represented as a part of the national budget (UNEP-DHI, 2023). To enable this, it considers how water revenue is used and allocated and encourages water fees and tariffs to be optimized alongside taxes and subsidies to recover the total cost of water. Funding is needed to recover the costs of maintaining and expanding infrastructure to increase reliability for end users and the environmental externalities in which poor water management could result. It is also important to structure fees and tariffs to encourage efficient and sustainable water use and discourage active and passive pollution (Agarwal et al., 2000).

While some Caribbean countries have long-established budgets for the IWRM process, most stop short at the allocation of funds, as actual cash has not consistently flowed to support IWRM related activities. To achieve higher scoring in budgeting, total funds, as already allocated for IWRM implementation, should be dispersed with appropriate accountability measures to ensure proper spending and use. While revenue structures exist for water as a resource, they are not tied to IWRM in most Caribbean nations. For example, abstraction fees exist in sewage and water

Countries	4. Financing						
Country name	National budget for WR infrastructure	National budget for IWRM elements	Sub-national/basin budgets for WR	Revenues raised for IWRM elements	Financing transboundary cooperation	Sub-national/basin budgets for IWRM elements	Average Score in Section
Antigua and Barbuda	40	20	20	20	n/a	0	20
Bahamas	30	40	n/a	30	n/a	n/a	33
Barbados	50	20	n/a	0	n/a	n/a	23
Cuba	No Data						
Dominica	60	70	40	60	n/a	n/a	58
Dominican Republic	80	0	80	40	20	20	40
Grenada	30	30	n/a	60	n/a	n/a	40
Haiti	No Data						
Jamaica	30	50	20	20	n/a	n/a	30
Saint Kitts and Nevis	20	20	n/a	n/a	n/a		20
Saint Lucia	30	30	50	40	n/a	10	32
Saint Vincent and the Grenadines	30	10	0	0	n/a	0	8
Trinidad and Tobago	30	30	30	20	n/a	n/a	28

Scored 0/100 — Scored 100/100

Table 5: Part four of the SGD 6.5.1 reporting scoring: Financing scores across the Caribbean (UNEP-DHI, 2023)

usage, but these revenues are caught in a separate cycle from IWRM. Neither this survey nor the published documents in our literature review indicate where funding originates for IWRM, which suggests insufficient reporting and transparency regarding how IWRM processes are being funded.

4.0 Discussion

Four major themes emerged from our analysis of literature review, interview results, and SDG 6.5.1 surveys. The following four themes contain barriers that are hindering full IWRM implementation in the Caribbean.

4.1 Governance and Political Support

While many Caribbean countries have sufficient independent water policies and legislation, they are uncoordinated and do not share one unified vision. Also, because there is minimal to no legislation or policies crafted specifically for IWRM support, IWRM processes are expected to fit into existing structures (Emmanuel et al, 2017). Lacking this supportive environment causes a disjointed implementation structure where existing water policies take priority over IWRM processes..

4.1.1 Lack of Coordination and Oversight

Currently many water management governance systems in the Caribbean are fragmented and do not foster a cooperative culture. A strong governance structure has built-in accountability and transparency measures (Cashman, 2011), so managing bodies can be held accountable for delivering results as promised while also upholding laws and policies. To facilitate integration and accountability, clear but flexible water management roles and responsibilities in the governance structure need to exist. When these roles are not well defined, they become a barrier to sustaining IWRM processes. It also requires consistent coordination and facilitated relationships between different departments and levels of government (GWP-C, 2015). This coordination is essential to prevent siloed decision-making and encourage cooperation for key government projects that could impact multiple water management departments. The goal is to reduce duplicated efforts and failed operations that result from poor coordination. Fundamental governance reform will require a vast amount of political support.

An example of poor governance coordination of responsibilities can be found in Saint Lucia. While Saint Lucia has tried to improve water resources management by establishing the Water Resources Management Agency (WRMA), the role and responsibilities of the WRMA remain ambiguous. Most of the responsibilities of the WRMA are only advisory, but they are tasked with the responsibility of promoting sustainable water management and IWRM principles and the maintenance of a water management database. Being in an advisory role means they may not have the influence or power to make needed changes. While this agency fulfills the strategic, advisory, and regulatory needs of water management in Saint Lucia, the roles of the agency still lack clarity, and the few personnel allocated to be responsible for day-to-day operations aren't sufficient and are a potential hindrance to their goals. In addition, the Water and Sewage Act of 2004 that created the WRMA, the revenue for the agency comes from application fees, permit fees, and regulatory charges. However, these regulatory requirements are only a fraction of the agency's responsibilities, potentially leading to institutional capacity difficulties and

financial troubles. The agency may need to pick between earning money by processing permits or contributing to IWRM implementation and strategizing with ministers. The financial strains and lack of revenue for the WRMA will likely impede on the growth needed in institutional capacity to support further urbanization and increasing adverse climate change effects. This will result in stressed water resources.

In Barbados, there is a lack of oversight for the Barbados Water Authority (BWA), as there is not a governing body that directly oversees its operations. Though the BWA is a government statutory organization created to supply Barbados with potable water, treat wastewater, and protect the island's water resources (Barbados Water Authority, n.d.), the BWA is currently self-regulated. Self-regulation can be problematic because it can lead to greater operational challenges, such as attempts to monitor and reduce non-revenue water (NRW) (Emmanuel & Clayton, 2017).

4.1.2 Absence of Shared Vision

Often, governing authorities do not share a vision for cohesive water management (Lincklaen Arriëns, 2013). Dr. Adrian Cashman writes that part of the issue lies in political incentives for IWRM implementation. He states there has been a modicum of IWRM success in the Caribbean only when there is prolonged political support of IWRM policies since the change required to make IWRM a functional process is not immediate (2017). This lack of unified vision presents itself as a barrier for IWRM implementation. There is, at present, no known processes in place to help governing authorities build knowledge and technical capacity around IWRM, making it more difficult to align these separate visions without having even a baseline understanding of what IWRM is and why it needs to be prioritized (GWP-C 2015). Among these responsibilities is the need for a clear situational awareness regarding water management.

4.1.3 Limited Political Support for Water Management Reform

Changing governance structure requires significant political support, whether internal from a national political champion for water or external from international agencies such as the United Nations (UN) or World Bank. Without this support, it is difficult to restructure entire government systems to consider water a priority. Water management has been an international priority for over 30 years, and Caribbean countries have gone through multiple iterations of how to implement a regular water management strategy. Despite this, progress has been slow because it has not historically been an issue at the forefront of the political agenda. However, since the establishment of SDG 6.5.1, there has been increased international pressure to prioritize creating a cohesive governance structure to enable full IWRM implementation. Singapore is an excellent example of governance structure reform with significant political support. Singapore united water, land infrastructure, environmental policies, and a commitment to sustainable development under one planning regime. This regime was a 20-year master plan that included uniting the work of various agencies under one water agenda (Gordon, 2014). Protected water catchment areas were expanded beginning in the 1970s in order to

phase out farming (Jensen & Nair, 2019). This shows a willingness to invest in protecting water resources.

4.2 Financial Capacity

Within the theme of financial capacity, we have found that funding is one of the most significant barriers that Caribbean nations face. Currently, most major IWRM-related projects are funded by international development funds, granted on an ad hoc basis. While most national governments budget annually for water management, very few have budgets for IWRM. We believe this fragmented structure results from the key issue of poor water tariff structures.

4.2.1 Inadequate Tariff Structures

In order for IWRM to receive an annual budget for operations, water revenues must be secured and consistent. Water tariffs are the most critical part of revenue for organizations that manage water and sewage (Kaidou-Jeffrey et al., 2018). Establishing a clear, long-term revenue stream is critical to reaching full IWRM implementation. Underdeveloped revenue structures can lead to insufficient funds to cover the cost of water itself and the maintenance of the infrastructure it relies upon (Kaido-Jeffrey et al., 2018). As a result utility organizations continually are not able to meet their operational cost requirements (Emmanuel & Clayton, 2017). Because of poor cost recovery, these organizations are perpetually running on a deficit. This importance is increased because many water and sewage organizations are expected to be self-sufficient and receive little to no external funding from their parent agency or ministry. If they are unable to cover their basic operations, it will be hard for them to generate enough revenue to support sustained IWRM processes as well. This is primarily the case in most Caribbean countries. Water and sewerage organizations such as the BWA and the Water and Sewage Company (WASCO) cannot meet their current financial needs, so they also do not have the surplus funding needed to support IWRM implementation. In addition, new projects and initiatives usually funded by government subventions or international organizations are also lacking (Kaidou-Jeffrey et al., 2018). As contrasted by Singapore, where the Public Utilities Board (PUB) ensures that enough funds are secured and has the power to raise loans from the government and externally with approval from the minister responsible (Government of Singapore, 2020). The PUB earns both enough revenue and raises enough funds to run day to day operations and support long term IWRM initiatives. While Saint Lucia with the Water and Sewage Act and Barbados with the Barbados Water Authority Act enable this kind of financial operation, they still remain insufficiently funded.

The challenge for cost recovery and revenue generation is exacerbated by poor technical capacity, governance, and policy since tariffs are, with the exception of Saint Lucia, handled at a ministerial level (Cashman, 2017) rather than within a separate water department with a greater capacity to implement changes at regular intervals. Saint Lucia has a strong tariff policy in which rates are assessed annually and updated according to usage and demand. This policy strength is contrary to many other Caribbean nations where tariffs are not regularly reviewed and adjusted, sometimes leaving gaps of upwards of ten years between reviews (Government of Saint Lucia, 2008). If tariffs are not being reviewed regularly, pricing

for tariffs will likely be too low to support increasing levels of water use and needed infrastructure updates. According to a paper published in 2018, the most recent tariff review in Barbados was conducted in January 2009 (Kaidou-Jeffrey et al., 2018). In order to achieve sufficient revenue for operations, water authorities must reform their tariff policy. This reform should include regular tariff reviews so the water authority can adapt to the respective countries' changing demands and economic conditions. Economic strategies that analyze end-user willingness to pay and supply and demand are key to increasing revenue within these tariff reviews.

Achieving consistent funding for IWRM projects and processes is integral for creating a water management system that is adaptable and resilient to climate change and the water challenges that it creates; However, raising tariff rates in a way that is equitable is just as critical. While rates need to reflect the economic value of water as a vital and scarce resource, it must still be affordable and accessible to citizens regardless of their gender, class or race. Failing to do so may lead to an array of different water issues. For example, many Caribbean countries are facing NRW issues, which is inadvertently contributing to water scarcity. Barbados faces a 15% leakage rate, meaning water that goes unused and unpaid for (Emmanuel et al, 2017). This is exacerbated by both leaking pipes and broken infrastructure that are not tended to and poor monitoring and inaccuracies in metering that lead to illegal water connections. Inequitable water tariffs could lead to more intentional or unintentional NWR, especially if local citizens feel like their needs are not being prioritized before industry. Water tariffs must reflect any excessive usage, especially when it comes to water used by tourists and the tourism industry.

4.2.2 Dependency on Fragmented External Funding

As per the United Nations Environment Programme (UNEP), one of the key objectives of IWRM is to enhance economic welfare (UNEP, n.d.). While some Caribbean countries have attempted to meet this goal by seeking additional funding from non-governmental organizations (NGO) or intergovernmental organizations (IGO), this funding short term solution is insufficient and neglects the need for tariff reform(Cashman et al, 2014). Much of the funding for IWRM in the Caribbean presently comes through external sources like development grants from NGOs. Many of these sources ask that their funding be allocated towards specific projects and require detailed project descriptions. As such, this type of funding often provides single-issue solutions to water issues but does not contribute to larger IWRM strategy and once the funding runs out, the program or project also ends (Cashman et al, 2014).

Inconsistent funding is a hindrance to full IWRM implementation. CARICOM (Caribbean Community) and CARIWIN (Caribbean Water Initiative: a project funded through the Canadian McGill University) are examples of this program-specific funding. While these organizations initially perpetuated IWRM in their respective ways, their interventions deteriorated once the funding for their involvement in the Caribbean was depleted. The capacity that was built and the IWRM programming slowly faded as neither

program planned for long-term maintenance processes for their projects and working groups. Funding can end up being siloed in this type of projects-based funding and fail to support the level of integration required for IWRM. It often leads to fragmented programming, interventions and processes that are not fully integrated into the larger governing systems so that it can be sustained (Acheampong, 2016). Coordination and collaboration with external organizations can alleviate gaps in funding and attention to current and planned projects and start new projects that are needed.

4.3 Stakeholder Participation and Collaboration

The IWRM process requires participation and collaboration from all groups of water stakeholders to be considered 'integrated' (UNESCO, 2009). This participatory process includes active involvement from civil society and local community to government officials, including creating methods for active engagement, information and data flow, and transparency amongst stakeholder groups regarding visions for the future of water use and management.

4.3.1 Lack of Bottom-Up Communication Methods

Top-down stakeholder engagement does not foster the participation, collaboration, or feelings of partnership that stakeholders need in order to build and maintain IWRM processes. This barrier is evident throughout the Caribbean.

According to SDG 6.5.1, the various stages of IWRM participation are 'communication, consultation, collaboration, and co-decision making' (*UNEP-DHI, 2023*.). One of the goals for participation and collaboration is to build consensus by moving away from just consultation engagement of stakeholders (Agarwal et al., 2000), actively including them in the decision-making process, and co-deciding the future of IWRM (UN-Water, 2008). However, there can be political implications to stakeholder involvement in decision-making processes, as stakeholders can be seen as undermining the current governing powers and processes (UNEP, 2012). As such, the worry of governing powers being undermined generally keeps stakeholder engagement locked into the consultation level rather than at a collaborative or co-decision-making level that would make more of a difference (Agarwal et al., 2000).

Water authorities have historically been reluctant to bring the public into decision-making conversations, leading to public apathy and a poor relationship with, and little trust in governing bodies (Weng, 2002). It is important to provide opportunities for local and regional communities to engage in water management discussions so solutions can be devised and addressed at all levels of water management. Individual organizations and institutions conduct their research and hold their own knowledge. With stakeholders communicating, they will be able to share their knowledge and determine what needs to be done (UNESCO, 2009). Sharing lessons learned from experiences is a large part of the IWRM process (UNESCO, 2009).

Communication with the BWA is limited, and communication tends to be unidirectional, flowing from the BWA to end users. An

example of this can be seen on the BWA's Instagram page. The Instagram posts are intended to generate interactions with the community, but almost every comment observed on the posts was related to having end user's water turned back on and there were no follow-up comments made by the BWA (BWA @bwa.bb, n.d.).

Effective communication with stakeholders is vital; an example of what happens without clear and concise communication can be seen in a 2006 rainwater harvesting project, where, due to a lack of clarity, some individuals decided to use the provided rainwater storage tanks to simply store public water instead (Peters, 2016). Subsequently, later projects were able to learn from this mistake and demonstrated better outcomes (GWP-C, 2015). Another example of this can be seen in Barbados. This case of poor stakeholder engagement is between the BWA and the private sector. In 2008, with the help of the Global Environment Facility (GEF)-funded Integrating Watershed and Coastal Areas Management (IWCAM), the BWA had widespread stakeholder engagement and buy-in to create an IWRM roadmap. However, while this held great promise for change and increased IWRM attention in the country, the minister who was responsible for approving the documents did not approve the documents, and the project never came to fruition (Cashman et al, 2014). Only a few ways allow for public participation in water management issues at present (CEHI, 2008). In Barbados, there have been many attempts at including stakeholders in the water management conversation, including town hall meetings, tours of the BWA facilities, and putting water conservation messages on television, radio, and in print media (Brewster & Mwansa, 2001). Though this may seem a positive example of stakeholder engagement, there is a lack of consultation among the participating end users. Actively engaging with stakeholders and garnering their feedback would increase the likelihood of more effective water management.

Most current water management models are designed using a top-down approach where officials in water management are responsible for identifying water issues. This approach contrasts with a bottom-up approach, where the community and grassroots organizations help design water management plans. Top-down approaches leave little room for community leaders and end-users to advocate for their water management needs.

4.3.2 Sparse Engagement Opportunities Incites a Lack of IWRM Partnership

Participation on local and civil society levels encourages place-based knowledge, ownership of creating solutions, and responsibility and accountability for water issues people encounter (UNEP, 2012). This kind of accountability and ownership helps with reporting and managing water issues on an individual or household level. It can prompt people to share data and information regarding their end-user experiences. This type of accountability and ownership is considered a bottom-up approach, which is crucial to full IWRM implementation (Agarwal et al., 2000) and enables equitable, democratic participation in water issues (Figueiredo, 2013). People need to be heard because it empowers them to act and support future initiatives (Neff, 2013).

A successful example of this kind of stakeholder engagement can be found in Saint

Lucia. In partnership with the GEF IWCAM, Saint Lucia successfully educated and included end users on rainwater harvesting. According to the GWP, this initiative, along with others, "led to the establishment of a community-based organization, 'The Trust for the Management of Rivers', which has taken over responsibility for continuing the watershed management" (Cashman et al., 2014). This demonstrates the feasibility of other potential community-based initiatives in Saint Lucia. Bottom-up approaches are highly recommended but often challenging to implement because they require increased participation from civil society.

4.3.3 Inadequate Stakeholder Consultation

Increasing awareness of water issues is essential for creating effective stakeholder engagement. While various engagement strategies exist, communication is the most commonly used device (Burton, 2003). Most programming stays in this participation zone, rarely reaching the collaboration stage and failing to proceed toward the consultation stage. An ongoing water conservation awareness campaign informs the public about their water consumption behaviors (Weng, 2002). This kind of campaign is an example of how engagement stops at communication and knowledge sharing since it involves no further consultation from the public because governing bodies have already decided the best course of action for consumers and are attempting to influence their behaviors accordingly (St-Jacques, 2009). The approach demonstrated in this example includes top-down messaging with no provisions made to allow for information flow from local participants to governing bodies.

4.4 Knowledge, Data, and Capacity Building

Knowledge and technical capacity are frequent themes throughout our research. We determined that lack of available water data, knowledge, and technical capacity are barriers to IWRM implementation. Knowledge and capacity building is more than just having classes on IWRM; it also includes making the public aware of current water management issues, the collection of water data, and having the skills and technology to utilize that data. Maintaining and increasing technical capacity through training programs, academic partnerships, infrastructure development, and upkeep are also crucial. For full IWRM implementation by the SDG 6.5.1 survey standards, long-term data collection, accessibility, and utilization of data for decision-making are crucial.

4.4.1 Insufficient Water Data and Knowledge

Water data that is consistent, relevant, and timely- for example, including quantity, quality, and water basin hydrology- remains an essential aspect of the IWRM process. This data is vital for evaluating risks, such as those presented by water scarcity and pollution, and the opportunity to create new and effective holistic water management solutions. Historically, obtaining water data in the Caribbean was challenging because there was neither the proper technology nor the technical capacity required for its collection and analysis, leading to a lack of overarching water knowledge (GWP-C, 2015). Although several technological advances exist today, such as geographic information systems (GIS), computer modeling software, and remote sensing, these systems still need to be

implemented to their fullest extent within the Caribbean to aid IWRM implementation (Brewster & Mwansa, 2001). Organizations in the Caribbean, such as the Caribbean Institute for Meteorology and Hydrology (CIMH), are attempting to overcome this barrier. The CIMH has developed a drought monitor that is being employed throughout several Caribbean nations, including Barbados, and intends to create a continuous monitoring network for drought anticipation (Senecal & Madramootoo, 2013). Developing these monitoring stations will increase opportunities for data transparency and accessibility across national boundaries. In Barbados, a monitoring project regarding the impact of chemicals on groundwater reserves is taking place across five golf courses. The amount of water used across all five courses totals 11,930 cubic meters per day, assessed at over five times the amount of water strictly required to maintain the courses (Brewster & Mwansa, 2001). While this project is a starting place to understand chemical pollution on water reserves, it remains in sharp contrast to the agricultural industry, where there is a lack of monitoring systems to track the impacts of agricultural chemicals on groundwater (Brewster & Mwansa, 2001).

The limited data on water usage, water availability, and accessibility, has significant consequences. It hinders water managers from updating and maintaining infrastructure, potentially leaving the community unsupported. This lack of data can lead to ineffective solutions for issues as they arise; the absence of usage rate data can increase the progression of anticipated infrastructure degradation due to overuse, as mentioned by an interview participant (Agarwal et al., 2000).

The lack of comprehensive data is also a corresponding barrier to the theme of financial capacity. Without it, decision-makers are left without the necessary information to adjust tariff rates alongside usage rates to allow for sufficient revenue generation, an issue discussed previously in the section on financial capacity.

4.4.2 Limited Classes and Education

Increasing public awareness and institutional capacity through water education can drive increased public involvement in decision-making processes related to IWRM, which is integral to full implementation (Agarwal, 2000). In an effort to achieve this goal, Barbados has held several classes on the topic of IWRM, such as a class offered by McGill University in 2007 titled "An Introduction to IWRM" (Suchorski, 2007), and another by the CIMH in 2013 titled "Introduction to Water Resources Planning Using an Integrated Water Resources Management (IWRM) Approach" (CRCC, 2013). Unfortunately, these classes have not been held regularly, and there is a perception, as ascertained through our interviews, that there are not enough classes available to the public on IWRM. Throughout our interviews and discussions with locals in Barbados, only one person had heard about a single class on IWRM. However this individual was unable to recall the class title, and it remains unknown if it was one of the two courses mentioned above.

Constant research and development needs to be done to keep current on water issues and technology (Goharian & Burian, 2018) as the technological landscape surrounding water continues to grow and change. Academic

support must be increased, partly through creating relationships that perpetuate knowledge throughout the country (Malherbe et al., 2020). Singapore has implemented a national research and development strategy to increase knowledge (and therefore capacity) surrounding water and technology, and it has been proven successful (Luan, 2010).

4.4.3 Ineffective Communication of Water Issues

Though often effective, classes are only one of the ways to inform the public about water management. Public service announcements (PSA), educational videos, and social media posts are other methods to spread IWRM-centered messaging. The BWA is attempting to do this by using social media to post about emergency pipe repairs, water disruptions, water conservation tips, and other work on their Facebook and Instagram pages (BWA_d, n.d.; BWA_c, n.d.) At the time of writing, the BWA had over 8,000 and 13,000 followers on Facebook and Instagram, respectively, though it is unknown how many people viewed the posts.

'Water Wednesdays are television productions that air every Wednesday and are another public engagement attempt by the BWA. They are created to inform and educate the public about water and wastewater, including water emergencies, scheduled maintenance, and informational topics (BWA_a, n.d.). These segments are also posted to YouTube, and some garner between 100 and 1,000 views a piece (BWA_b, n.d.).

In contrast to this type of outreach with limited class options, Singapore actively includes water management within public education curriculums. PUB works with the Singaporean Ministry of Education to teach students about water and its importance. These lessons begin as early as preschool and continue throughout all mandatory education (Singapore National Water Agency, n.d.).

4.4.4 Inadequate Technical Capacity

Technical capacity, referring to hiring knowledgeable and trained professionals to aid in all management needs, is vital for IWRM implementation and operationalizing all water management plans (UN-Water, 2008). Capacity building is not just something that must take place in government or academia; it is vital at all levels, including professional agencies, which do much to strengthen national water knowledge (Trotman et al., 2008). Creating technical capacity is essential for all people involved in operationalizing IWRM, including providing training in data analysis, monitoring and problem-solving training for engineers, and creating maintenance teams to attend to technical problems as they arise. More qualified expertise in water management within the Caribbean is needed to achieve full IWRM implementation (Gopaul, 2004). It was identified in the early 2000s that water knowledge and technical capacity were insufficient in the Caribbean. Our interviews corroborate this because the perception is that there are not enough trained staff in Barbados and Saint Lucia to fix water-related infrastructure problems. More personnel are needed to fill vacancies in water engineering, resource management, and other related fields, and, as the situation stands, more personnel are needed to be trained to hire as vacancies arise (Cashman et al., 2014). Training deficits and lapses in hiring can lead

to people not having access to water for extended periods and result in NRW due water leakage and other infrastructure challenges. NRW is a problem in Barbados, where 45% of the pumped water is lost, and in Saint Lucia, 56% is lost (Jansons et al., 2021). For small countries with limited water supplies, this is problematic as it causes disruptions in water supply. Singapore has significantly reduced NRW to just 5% of all water produced (Singapore National Water Agency, n.d.). They have done this by fixing and replacing pipes regularly and employing a sophisticated leak detection system (Bahri, 2012).

5.0 Conclusions

5.1 The Nexus Barrier

The barriers to IWRM implementation are often interconnected which suggests that addressing one barrier might alleviate the pressures of another. We highlight Knowledge, Data, and Capacity Building as a nexus barrier that, if properly addressed, could have a positive impact on many other challenges being faced. While this barrier may not appear to be the most pressing one to resolve, we cannot underestimate its role in the IWRM process. Our research suggests that the other barriers exist partially because of the lack of knowledge, data and capacity building, implying that it could be foundational to implementing and continuing IWRM. Linkages between these barriers is demonstrated in Figure 4.

In a community facing water scarcity, basic water knowledge needs to be prioritized. Having water knowledge gives policymakers and government officials the foundation needed to understand the complexities of water resources and management (Gopaul, 2004). Without this knowledge, officials may not be fully equipped to make informed decisions, or be incentivized to engage with IWRM. This could be especially important when acquiring support for tariff reform and valuing water properly (Tortajada et al., 2013). In addition, knowledge, data, and capacity building can encourage a shared vision for a sustainable water future and lead to more collaborative problem-solving, thus creating a basis for a governance system that supports the IWRM process. Finding opportune and relevant times to provide this knowledge is also important in order to have the greatest amount of impact possible. Coupling water knowledge workshops with critical events might encourage more involvement from government officials and policy makers. For example annual or bi-annual water management workshops could be held in conjunction with SDG 6.5.1 reporting meetings, giving decision-makers an opportunity to learn and share knowledge during a pivotal moment where the IWRM process is already being evaluated and discussed.

By addressing the gaps in knowledge, data, and education within the stakeholder engagement process, we can foster strong, long-term stakeholder relationships. The process of capacity building and sharing knowledge is a valuable opportunity to form key relationships between different stakeholders. This relationship can empower stakeholders to be actively involved in IWRM processes, fostering a sense of value and importance in the IWRM process. Building technical capacity within communities helps with IWRM engagement as it empowers citizens to be involved with IWRM processes through accountability and collaboration (Griggs, 2016). A powerful way to deliver this knowledge to facilitate potential future engagement is through the education system, where water knowledge is continuously taught from primary school to high school and place-based learning is emphasized, as demonstrated by Singapore. We recognize that trying to overcome all the barriers at once is

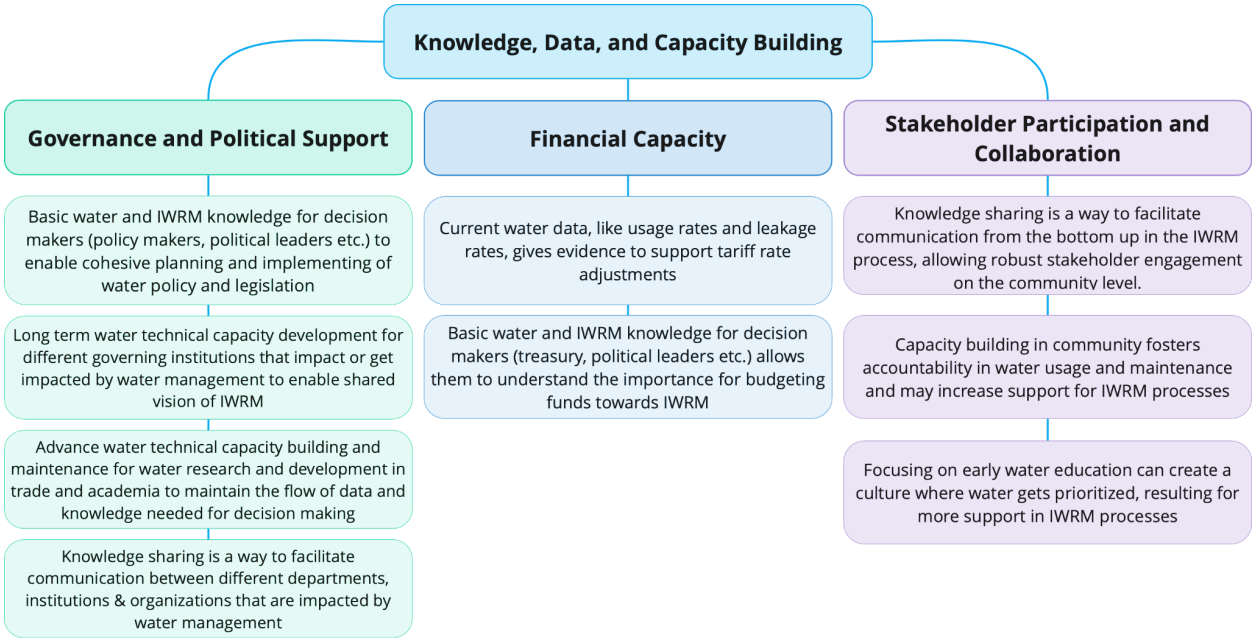

Figure 4: As a Nexus Barrier, changes within the theme of Knowledge, Data, and Capacity Building cascade throughout all other barrier themes to enact change in each one.

difficult as it is a resource-intensive task and may not be feasible for most Caribbean nations to dismantle their water governance structure overnight to incorporate IWRM, but addressing knowledge, data and capacity building gaps might be attainable in the near future. Development agencies such as GWP and UNEP recognize the value of knowledge, data, and capacity building and have offered specific programming & funding through their IWRM toolbox, providing a source of confidence in the feasibility of this initiative.

We recommend addressing this nexus barrier as it provides many opportunities for enhancing the IWRM implementation process. It may also provide a focus point for Caribbean nations who are trying to reinvigorate their IWRM efforts.

5.2 Limitations of this Study and Opportunities for Future Research

Our research did have limitations based on the sample size of our interview data, much of which was due to time constraints and the project's scope. In the future, we recommend much more on-the-ground learning about local water management practices and structures and creating relationships with end users who could provide more significant insights into the day-to-day usage of water in these countries. These are relationships that, on our timescale and budget, we were not able to create as they involve time spent in-country to garner trust and understanding.

The reviewed papers were loaded into the software NVIVO, through which one of our team members coded for keywords and concepts related to the barriers we presented in our study to provide a quantitative measurement of these concepts as they come up in the literature. We acknowledge that

having one person code does leave room for potential human error, unconscious bias, and subjectivity.

Lastly, the level at which the current literature is addressing barriers to IWRM in the Caribbean is still very high level and does not provide the depth needed to make recommendations for further solutions or inroads to full implementation. Substantially more time, capacity, and research are needed to validate the claims stated in the literature we reviewed, especially since a majority of papers are now out of date by roughly 10 years, and the present state of climate change has altered the water management landscape substantially since then. While the literature we reviewed does a great job underscoring the importance of IWRM and its challenges, it ultimately does not go deep enough into any one country within the Caribbean to provide a roadmap toward future IWRM goals. We therefore suggest a multiyear study, conducted with full funding support, to research IWRM barriers. This would give researchers a chance to build trust within the community and study the realities of the challenges they face.

5.3 Conclusion

IWRM is a promising water management process for all Caribbean nations that aims to address current and future water stresses. However, implementation does come with its challenges, as demonstrated in this paper. Siloed governance structures, ineffective tariff strategies, low stakeholder participation, and limited water knowledge are the most noteworthy barriers to IWRM implementation. Caribbean nations are, on average, halfway toward achieving their goal. While the path forward may seem complex, not having IWRM processes in place could ultimately be detrimental as water challenges persist. With climate change impacts already being felt in the region, a 'business as usual' approach is no longer an option.

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Appendix A: Interview Definitions and Questions

Readiness Indicators Definitions:	**The following 8 indicators contribute to the readiness of successful IWRM implementation.**
Political Champion	A person or group with political standing or power who initiates or takes responsibility for supporting IWRM or water management related projects. They act as an advocate for water related projects across the country or for any specific water project for the community.
Funding / Economies	Access to funding and economies that support IWRM and/or other water related projects. Funding can be through direct or indirect financing. Economies relate to water resource industries that can generate revenue to fund water management or IWRM projects.
Infrastructure	Does the community or country have the needed infrastructure in place to allow for successful implementation of IWRM or other water management plans.
Education / Knowledge	The knowledge that each country or community has about their surrounding water issues, IWRM or other water management solutions.
Technical Capacity	Whether the community or the country has the technical capacity to carry out assessment, designing, planning and implementation of a successful IWRM or other water management plan.
Cooperative Interactions: Government, Community & Industry	How the different entities involved or impacted by IWRM interact with each other. Are there synergies formed between government, communities and industries or are they often competing for water resources? This also speaks to interactions between projects and within governments. Are communication channels open, closed, or siloed? Are there key personnel that act as bridges or key connectors that liaise these interactions. We specifically look at the intersection of agriculture and tourism - both important economies in the Caribbean - and now they divvy up water use and management.

Governance	The structures and systems that are in place on an international, national, regional, and local level that support IWRM or other water management programs.
Community Will	The level that a community actually cares about water issues or are there other more demanding issues at hand that they prioritize and will advocate for.
Stakeholder involvement	The robust and inclusive stakeholder engagement that's conducted in each IWRM or other water management project. Stakeholder involvement should consider different perspectives of impacted populations and extend beyond just government and technical personnel.

Figure 5: Definitions of the categories of questions given to the interviewees

Political Champion

- How impactful is a political champion to IWRM readiness?
- Is there a political champion in your community/country that leads water management?
- What do they do that makes them a political champion and can you identify how they became a champion for water management needs?
- What political perspectives are missing from current water management planning that should be included?

Funding / Economies / Infrastructure

- How impactful is funding, economics, and infrastructure to IWRM readiness?
- What are some funding sources for IWRM implementation?
- What are barriers to obtaining funding for development and improvement of water infrastructure?
- What new technologies have you heard of that you believe would make a positive difference in current infrastructure?

Education / Knowledge / Technical Capacity

- How impactful is education, knowledge, and technical capacity is to IWRM readiness?
- Please describe any talks in classes, community meetings, pamphlets, or information online that you know of about IWRM?
- How responsive is the government to technical challenges regarding water, such as leaks or disruptions?

- Are there enough trained professionals in the country to fix infrastructure issues as they arise?

Cooperative Interactions: Government, Community and Industry

- How impactful are cooperative interactions to IWRM readiness?
- Which statement do you feel more closely aligned with: (1) Industries are competing against each other in terms of water use, or (2) Industries are cooperating with each other in terms of water use?

Industry: Agriculture / Tourism

- How impactful are the industries of agriculture and tourism to IWRM readiness?
- Specifically within the industries of tourism and agriculture, which statement do you feel more closely aligned with: (1) these industries are competing against each other in terms of water use, or (2) these industries are cooperating with each other in terms of water use
- How does the agricultural industry participate in water management conversations or decisions?
- How does the tourism industry participate in water management conversations or decisions?
- What kind of political support is there for the agricultural industry?
- What kind of political support is there for the tourism industry?
- What other industries are influential in water management?

Community Will / Stakeholder Involvement

- How impactful is community will and stakeholder engagement is to IWRM?
- Is there public support for developing a new and modernized IWRM plan to be implemented?
- Who and how are stakeholders determined? What is the identification & engagement process?
- Have you heard about any community meetings being held on topics surrounding water, water management, or IWRM?
    - [IF YES] Have you personally attended any community meetings about water, water management, or IWRM?
    - [IF NO] Do you think that there should be communities held on topics surrounding water, water management, or IWRM?
- Are there adequate ways for people to get involved with the current water management process?
    - Are there any barriers to community involvement?
- How would you like to be informed about the current water management process in the future?
- Tell us about a time when you have seen or heard of good communication and collaboration between communities and municipalities?
- Are there perspectives that could be missing that you think are critical to better stakeholder involvement in water management planning?

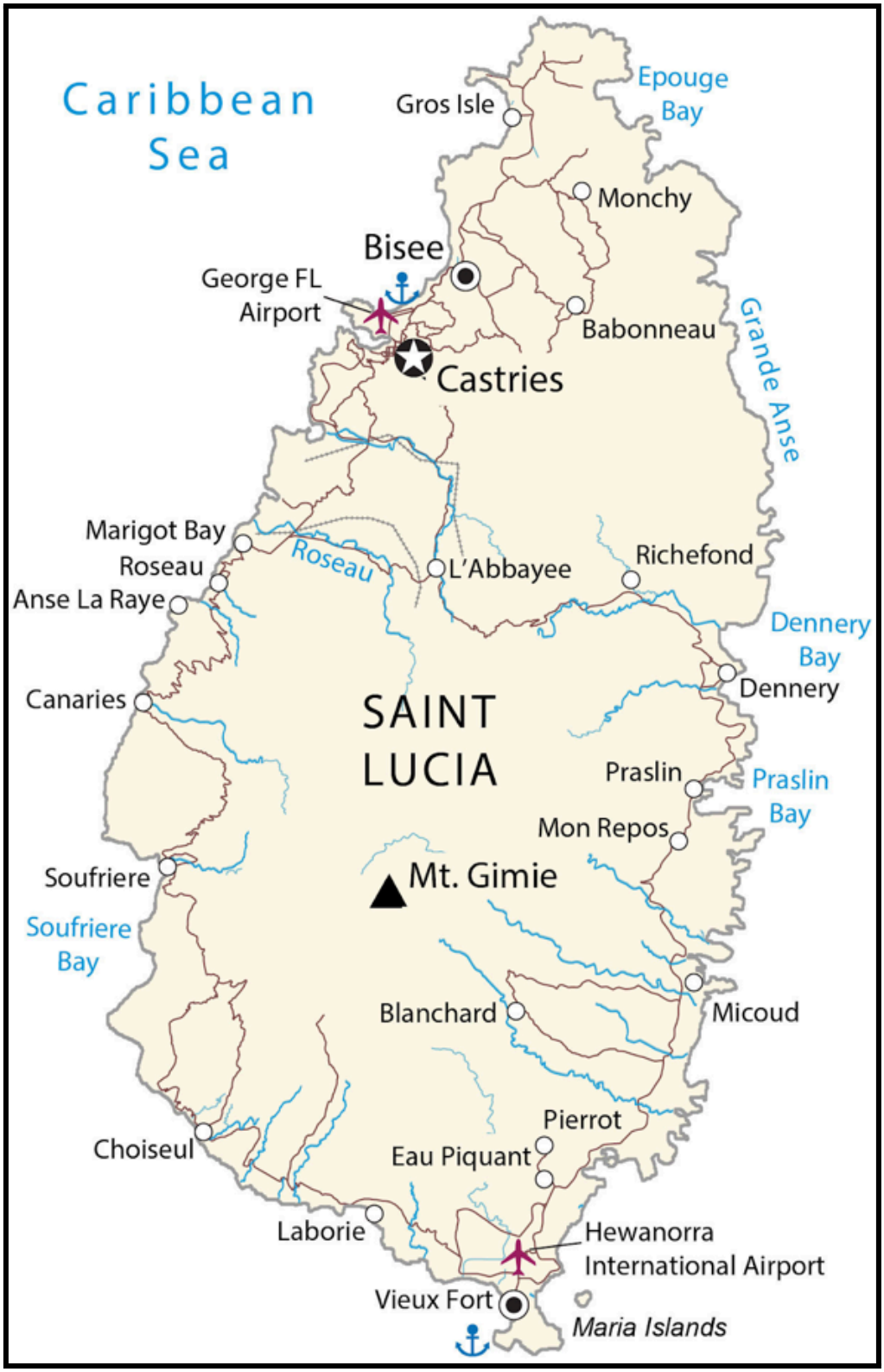
Governance

- How impactful is the concept of governance to IWRM readiness?
- Can you tell us about different water policies that are present in your country/community?
- What are some local (official or unofficial) policies that you know of in your community?
- Can you describe the multi-level (International, National, Regional & Local) governance support systems for water management or IWRM in this country?
- What are some challenges that your community faces when trying to carry out policies that are mandated on the regional and national level?
    - What are the barriers to implementing at those three different levels?
- What are the challenges that your community faces when trying to communicate local water issues up to higher levels of government for support?
- Are you aware of the concept of virtual water?
    - Are there any policies regulating the handling of virtual water?

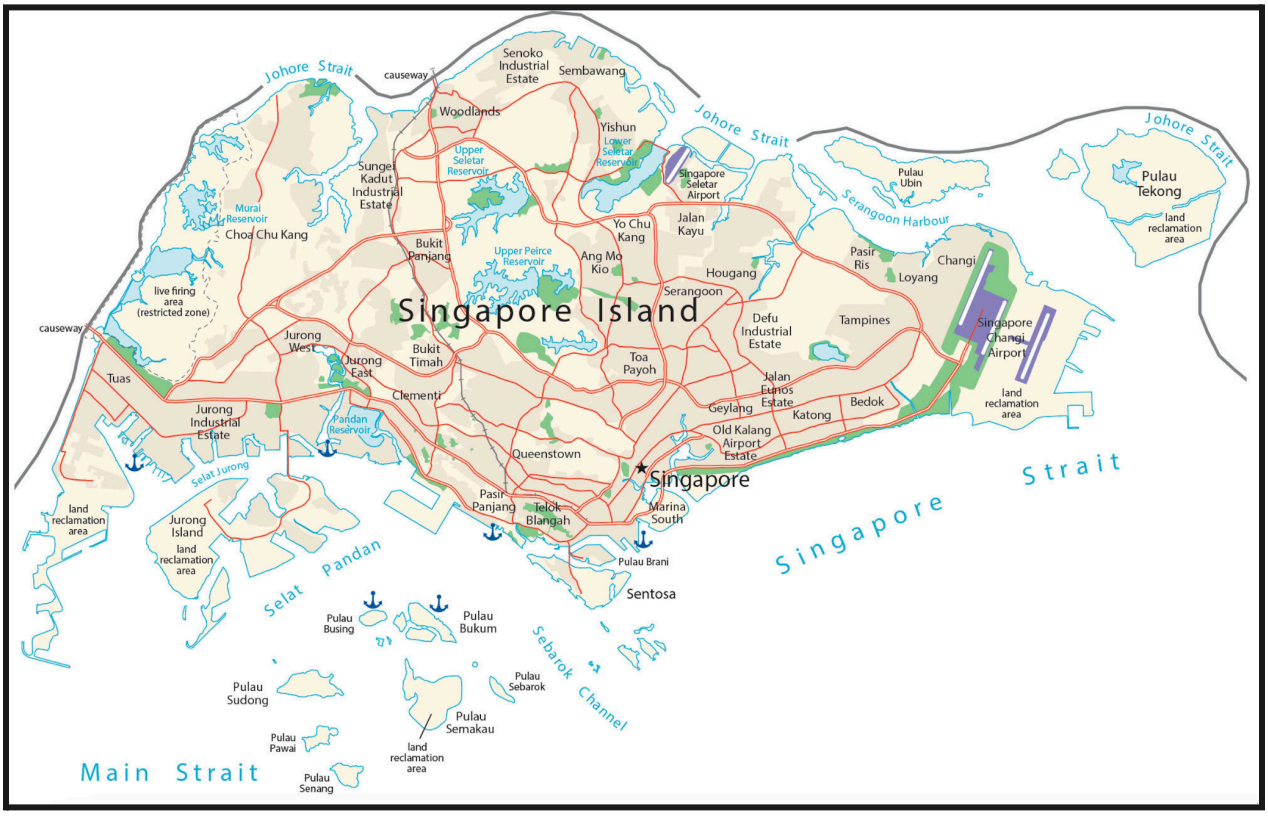
Appendix B: Regional and Country Maps of Locations Studied

Map 1: Map of the Caribbean Region. Taken from: https://gisgeography.com/west-indies-map/#Administration-Map

Map 2: Map of Barbados. Taken from: https://gisgeography.com/barbados-map/



Map 3: Map of Saint Lucia. Taken from: https://gisgeography.com/saint-lucia-map/



Map 4: Map of Singapore. Taken from: https://gisgeography.com/singapore-map/