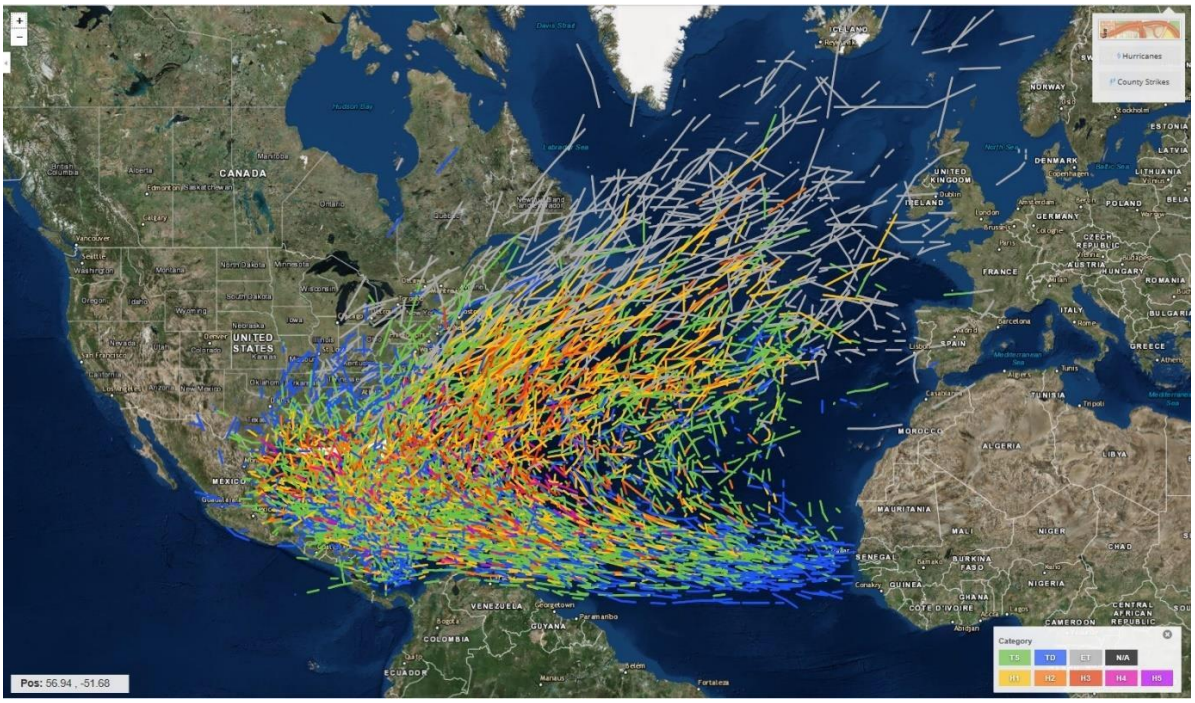
Regional Strategic Action Plan for Governance and Building Climate Resilience in the Water Sector in the Caribbean



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List of Acronyms

AR5	Fifth Assessment Report of the Intergovernmental Panel on Climate Change
CARDI	Caribbean Agricultural Research and Development Institute
CARICOM	The Caribbean Community Secretariat
CARPHA	The Caribbean Public Health Agency
CAWASA	The Caribbean Water & Sewerage Association
CCCCC	The Caribbean Community Climate Change Centre
CDB	The Caribbean Development Bank
CERMES	Centre for Resource Management and Environment Studies of the University of the West Indies
CIMH	The Caribbean Institute of Meteorology and Hydrology
COTED	CARICOM Council for Trade and Economic Development
CReW	Caribbean Regional Fund for Wastewater Management
CWWA	The Caribbean Water and Wastewater Association
DSS	Decision Support System
FAO	The Food and Agriculture Organization of the United Nations
GEF	Global Environment Facility
GWP-C	The Global Water Partnership Caribbean
IDB	The Inter-American Development Bank
IPCC	Intergovernmental Panel on Climate Change
IWCAM	Integrated Watershed and Coastal Area Management
IWRM	Integrated Water Resources Management
NRW	Non-Revenue Water
OECS	The Organisation of Eastern Caribbean States
PAHO	The Pan American Health Organization
SIDS	Small Island Developing States
UN	United Nations
UNDP	The United Nations Development Programme
UNEP-CEP	United Nations Environment: Caribbean Environment Programme
WHO	World Health Organization

Executive Summary

The water sector in the Caribbean will be seriously affected by climate change. Changes in the hydrological cycle, saline intrusion of ground water sources from sea level rise, and an increase in the intensity of extreme weather events will all have significant impacts on the supply of fresh water and on water infrastructure. These problems will compound existing challenges in water sector governance, water resources management and service delivery in many Caribbean countries.

The regional strategic action plan for governance and building climate resilience in the water sector is a response to these myriad challenges. It is the result of a series of discussions and meetings with stakeholders in the water sector in the Caribbean and a review of the literature on the sector. It seeks to identify the major issues confronting the sector and propose an action plan to address these challenges at the national and regional levels.

The plan is buttressed by five pillars of action, namely (i) water sector governance, (ii) climate-informed decision support, (iii) climate-resilient water resources management, (iv) climate-resilient water service provision, and (v) capacity building and public sensitization to build climate resilience. Underpinning the action plan is a robust base of community and stakeholder engagement. The action plan should not be seen as a government or public sector intervention. It must be viewed and implemented as a critical national activity, with support from everyone. There must also be gender sensitivity in the formulation of interventions and the execution of activities, given the disproportionate manner in which women and children are impacted by water crises.

At the governance level, the plan calls for improved legislative and institutional structures, mainstreamed climate change policies, and strong climate change adaptation plans for the water sector. The inadequacy of the information management support system is addressed through actions in support of a national water decision support system (DSS) that integrates economic, social and environmental data, and the establishment of a water resources management planning cycle to allow for more nimble and effective responsiveness to the impacts of climate change.

The plan seeks to address the deficiencies in the management of water resources by making recommendations for actions to develop national capacity to accurately assess water resources, including basin water budgets and supply-demand balances, and the adoption of integrated water resources management, with an appreciation of the need to address social and gender equity, economic efficiency and ecological sustainability.

Every Caribbean island has persistent challenges in the provision of water services and these will be exacerbated by the impacts of climate change. The regional strategic action plan proposes several interventions to optimize the efficient use of water resources, reduce the demand on municipal supplies, and increase energy efficiency in water supply and use.

Finally, the need for capacity building and public sensitization is addressed through recommendations for regional learning, replication and sharing of best practices, training and capacity building and a comprehensive and enduring public awareness campaign.

Introduction

The Caribbean belongs to a group of countries known as Small Island Developing States or SIDS. The characteristics of SIDS are best articulated in the Programme of Action for the Sustainable Development of Small Island Developing States, which was an output of the Global Conference on the Sustainable Development of Small Island Developing States (Bridgetown, Barbados, 1994).

"Small Island Developing States have valuable resources, including oceans, coastal environments, biodiversity and, most importantly, human resources. Their potential is recognized, but the challenge for Small Island Developing States is to ensure that they are used in a sustainable way for the well-being of present and future generations. Although they are afflicted by economic difficulties and confronted by development imperatives similar to those of developing countries generally, Small Island Developing States also have their own peculiar vulnerabilities and characteristics, so that the difficulties they face in the pursuit of sustainable development are particularly severe and complex.

There are many disadvantages that derive from small size, which are magnified by the fact that many island States are not only small but are themselves made up of a number of small islands. Those disadvantages include a narrow range of resources, which forces undue specialization; excessive dependence on international trade and hence vulnerability to global developments; high population density, which increases the pressure on already limited resources; overuse of resources and premature depletion; relatively small watersheds and threatened supplies of fresh water; costly public administration and infrastructure, including transportation and communication; and limited institutional capacities and domestic markets, which are too small to provide significant scale economies, while their limited export volumes, sometimes from remote locations, lead to high freight costs and reduced competitiveness. Small islands tend to have high degrees of endemism and levels of biodiversity, but the relatively small numbers of the various species impose high risks of extinction and create a need for protection.

The small size of Small Island Developing States means that development and environment are closely interrelated and interdependent. Recent human history contains examples of entire islands rendered uninhabitable through environmental destruction owing to external causes; small island developing States are fully aware that the environmental consequences of ill-conceived development can have catastrophic environmental consequences. effects. Unsustainable development threatens not only the livelihoods of people but also the islands themselves and the cultures they nurture. Climate change, climate variability and sea level rise are issues of grave concern. Similarly, the biological resources on which small island developing States depend are threatened by the large-scale exploitation of marine and terrestrial living resources.

Many Small Island Developing States are entirely or predominantly coastal entities. Due to the small size, isolation and fragility of island ecosystems, their renowned biological diversity is among the most threatened in the world. This requires that in pursuing development,

special attention be paid to protecting the environment and people's livelihoods. It also requires the integrated management of resources" (UN General Assembly, 1994).

Climate Change and SIDS

Like all other small island developing States and low-lying countries, Caribbean countries are on the frontline of the battle against climate change. The Fifth Assessment Report (AR5) of the Intergovernmental Panel on Climate Change (IPCC) provides clear evidence that the global climate is changing, and SIDS are on the frontline of these changes. It demonstrates that for SIDS, climate change represents an existential threat and the economic cost of adapting to the impacts of climate change is high. AR5 indicated that in urban areas, climate change is projected to increase risks for people, assets, economies and ecosystems, including risks from heat stress, storms and extreme precipitation, inland and coastal flooding, landslides, air pollution, drought, water scarcity, sea level rise and storm surges. These risks are amplified for SIDS that are inherently socially, economically and environmentally vulnerable and for citizens lacking access to essential infrastructure and services or living in exposed areas. Rural areas are expected to experience major impacts on water availability and supply, food security, infrastructure and agricultural incomes, including shifts in the production areas of food and non-food crops around the world (IPCC, 2014).

The Impact of Hurricanes

The islands of the Caribbean are traditionally, very heavily impacted by cyclone activity in the tropical North Atlantic (Fig 1, 2). These cyclones have caused significant damage to infrastructure, loss of lives and have had dramatic negative impacts on economic development in the Caribbean (Table 1). The severity of these hurricanes is expected to increase with warmer global temperatures.

Figure 1 Historical Hurricane Tracks 1851-2016

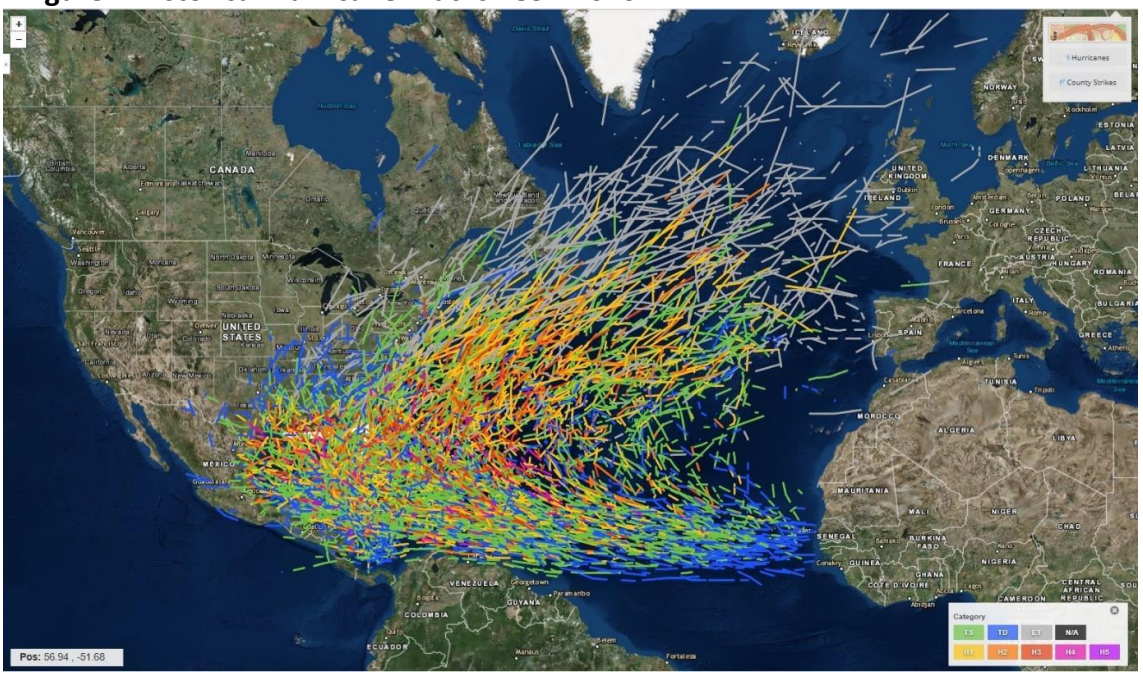
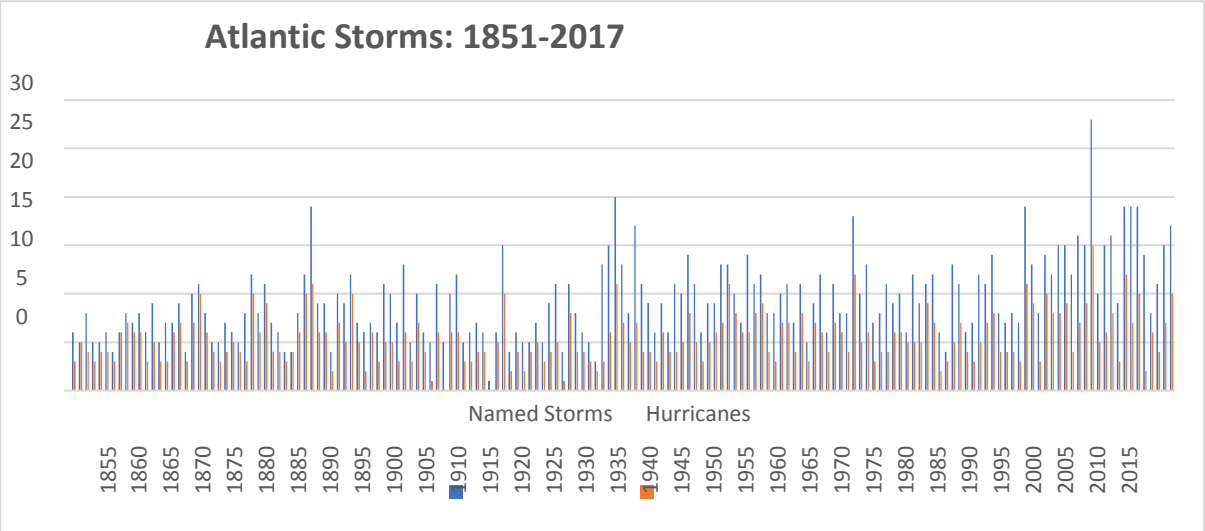


Table 1. The Economic Impact of Natural Disasters on the Caribbean (Naude et al, 2009; Unofficial Estimates Dominica Government 2018)

Country	Event	Year	Damage (%GDP)
Jamaica	Hurricane Gilbert	1988	365
Grenada	Hurricane Ivan	2004	203
Dominica	Hurricanes David & Frederick	1979	101
St Kitts and Nevis	Hurricane Luis	1995	85
Saint Lucia	Hurricane Allen	1980	66
Antigua and Barbuda	Hurricane Luis	1995	61
Guyana	Floods	2005	59
Dominica	Hurricane Maria	2017	226

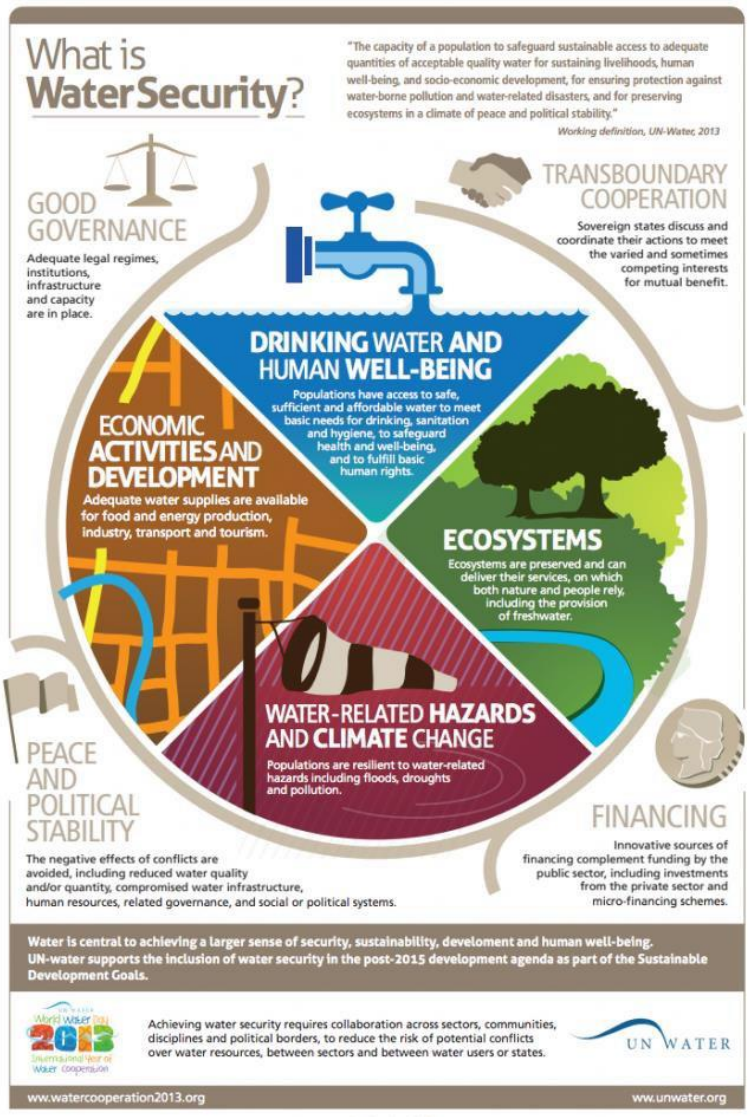
Figure 2. Number of Named Storms and Hurricanes in the Atlantic from 1851-2017



In response to the vulnerability of Caribbean SIDS to the impacts of climate change, the Heads of Government (HOG) of the Caribbean Community, CARICOM (an inter-governmental body comprising fourteen independent countries and six British Overseas Territories), in July 2009 approved a 'Regional Framework for Achieving Development Resilient to a Changing Climate.' Three years later, in 2012, the CARICOM Heads approved an implementation plan for the Regional Framework. This implementation plan identified water as the most important crosscutting issue for climate-compatible development in the Caribbean.

Water Security

UN Water defines water security as “the capacity of a population to safeguard sustainable access to adequate quantities of acceptable quality water for sustaining livelihoods, human well-being, and socio-economic development, for ensuring protection against water-borne pollution and water-related disasters, and for preserving ecosystems in a climate of peace and political stability. (UN Water, 2013)”



Within the Caribbean context, water security encompasses several objectives (Global Water Partnership-Caribbean & Caribbean Community Climate Change Centre, 2014):

- The management and allocation of water between users including the environment to balance social needs, economic development and environmental sustainability.
- The provision of clean, reliable and sustainable rural and municipal water services to support the social wellbeing of the population and economic activities including business, tourism and industry.
- The efficient and effective use of water for agricultural purposes, which supports economic growth and livelihoods while maintaining the natural environment.
- The protection of water supplies against disasters including hurricane damage, flooding and drought through design, preparedness and response to disaster events.
- The sustainable management of watersheds to preserve the quality and quantity of water available for human and environmental use against human degradation and natural disasters.
- The prevention and treatment of wastes and pollutants entering watersheds to preserve the quality of water supplies for human and environmental needs and the protection of the marine environment.

Water and Climate Change

The issues related to water and climate change are many and varied. The increased sea surface temperatures that are associated with global warming are projected to lead to more intense hurricanes and heavier precipitation. Severe hurricanes have devastating impacts on national water infrastructure, as can be seen from the impacts of Hurricane Maria on the water infrastructure of Dominica during the 2017 Atlantic Hurricane season. Similarly, more intense flooding also renders water systems, particularly in rural areas in the Caribbean, inoperable due to excessive turbidity. Climate change is also expected to result in more frequent droughts in the Caribbean, and this will negatively affect Caribbean water systems. Sea level rise, which is already being experienced in the Caribbean, will lead to the salinization of aquifers, which will pose serious problems for countries like Barbados, the Bahamas, and Antigua and Barbuda that depend primarily on groundwater sources. Moreover, climate change, by causing an intensification of weather events, can increase the risk of pollution of water supplies from damage to wastewater treatment and/or collection systems, flooding of septic tanks and the consequential contamination of groundwater sources.

Non-Climate Change-Related Challenges

The challenges confronting the water sector in the Caribbean are not limited to those caused by climate change. Another serious issue for the water sector is the weakness of the domestic water governance arrangements and the inability of these governance structures to address the water challenges that they are facing (Global Water Partnership, 2014). These challenges include water scarcity, deteriorating water quality, the impact of extreme events, and the provision and maintenance of water services (Cashman A., 2012) (United Nations Environment Programme, 2012). However, there are other critical issues, such as supply-driven management, fragmented and subsector approaches to water

management, lack of information, inadequate technical competencies, and low levels of investment in the water sector (Global Environment Facility Integrating Watershed and Coastal Area Management (GEF-IWCAM), 2008) (United Nations Development Programme-DHI, 2007).

Central to any plan or strategy for the sustainable management of water resources in the Caribbean is an appreciation of the unique characteristics of small island ecosystems and the important role that watersheds play in these systems. The definition of a watershed in SIDS as "a dynamic and interactive complex of ecosystems and other socio-cultural and economic systems extending from and operating within the ridge to the near shore waters" (Chase, 2010) perhaps best describes the special circumstances of water sector management in small island developing States. This complex interplay of environmental, economic, political and social systems and the proximity of services requires that even greater attention be paid to stakeholder engagement and support at all levels and in all strata of the society.

This Regional Strategic Action Plan for Climate Resilience in the Water Sector in the Caribbean draws from several comprehensive reports on the water sector in the region, as well as inputs from the member States of the Caribbean Community on the issues impacting the sector domestically and regionally. It is meant to provide a succinct summary of the challenges, with clear recommendations on actions that need to be taken to ensure water security in the Caribbean. It is underpinned by an appreciation that water insecurity is one of the most serious developmental challenges facing many countries in the Caribbean and to address this challenge in an enduring manner will require resolute, coordinated action from a wide variety of stakeholders.

The Current Situation

Water Sector Governance

Ownership

In most of the countries in the English-speaking Caribbean, the governments own the water utility companies. In some countries, particularly where desalination plants operate, there are also quasi-government type arrangements (Cole Engineering Group, 2015).

Regulation

Regulation of the water sector is still in its nascent stages in most of the countries in the Caribbean. Because most of the utility companies are State-owned monopolies, regulation is usually left to the parent ministry with responsibility for the water sector. Most of the regulators, where they exist, serve primarily in an advisory capacity to the Minister. Their statutory mandate (Cole Engineering Group, 2015) can be described as:

- To promote or protect consumer interests;
- To publish information;
- To promote competition and promote the relevant Ministries on any applicable matters, as well as other duties and functions; and
- To promote tariffs based on standards for operation and good economic practice.

The water sector regulatory authorities operating in the region are: (i) the Public Utilities Commission in Guyana, (ii) the Office of Utility Regulation in Jamaica, (iii) the Public Utilities Commission in Belize, (iv) the Public Utilities Commission in the Bahamas, (v) the Regulated Industries Commission in Trinidad and Tobago, (vi) the National Utilities Regulatory Commission in Saint Lucia, and (vii) the Fair Trading Commission in Barbados.

Regional Institutions

There are several regional and international institutions operating within the Caribbean, with programmes or mandates that impact the water sector.

- The Caribbean Water & Sewerage Association (CAWASA)
- The Caribbean Public Health Agency (CARPHA)
- The Caribbean Community Climate Change Centre (CCCCC)
- The Global Water Partnership Caribbean (GWP-C)
- The Caribbean Institute of Meteorology and Hydrology (CIMH)
- The Caribbean Water and Wastewater Association (CWWA)
- Caribbean Agricultural Research and Development Institute (CARDI)
- The Organisation of Eastern Caribbean States (OECS)
- The Caribbean Community (CARICOM) Secretariat
- Centre for Resource Management and Environment Studies (CERMES) of the University of the West Indies.

- The Caribbean Development Bank (CDB)
- The United Nations Development Programme (UNDP)
- The United Nations Environment: Caribbean Environment Programme (UN Environment CEP) and the Caribbean Sub-Regional Office (UN Environment CSRO)
- The Inter-American Development Bank (IDB)
- The Food and Agriculture Organization of the United Nations (FAO)
- The Pan American Health Organization (PAHO)/World Health Organization (WHO)

Governance of the water sector at the regional level is not well organised or coordinated. The Organisation of Eastern Caribbean States (OECS) has sought to develop a common water policy and legislation for the Member States of the OECS[1]. The Caribbean Community (CARICOM)[2] has not managed to coordinate a regional water sector development agenda through its Sustainable Development Directorate, which has responsibility for the water portfolio. An initiative to form the Consortium of CARICOM Institutions on Water, which was approved by CARICOM and which sought to develop a common regional water framework for water resources management, has not progressed (Cashman, Cox, Daniel, & Smith, 2014).

In recent years, the Caribbean Water and Wastewater Association (CWWA) has attempted, through its annual High-Level Forum, to provide a mechanism for discussion of the critical issues confronting the water sector at the highest political and policy levels. As commendable and necessary as this initiative by the CWWA has been, it lacks the requisite anchor within CARICOM's legal and institutional infrastructure. To ensure the appropriate political commitment and follow-through of the important, often cross-sectoral issues presented at the CWWA High Level Forum, there is a need for the outputs and recommendations of this Forum to feed into an annual meeting of the CARICOM Council for Trade and Economic Development (COTED) on the Environment, where binding policy decisions can be taken.

[1] OECS Member States are Anguilla, Antigua and Barbuda, British Virgin Islands, Dominica, Grenada, Montserrat, St Kitts and Nevis, Saint Lucia, and St. Vincent and the Grenadines

[2] CARICOM Member States are Antigua and Barbuda, the Bahamas, Barbados, Belize, Dominica, Grenada, Guyana, Haiti, Jamaica, Montserrat, St. Kitts and Nevis, Saint Lucia, St. Vincent and the Grenadines, Suriname, and Trinidad and Tobago

Main Challenges

Institutional Arrangements

A study on the Governance of the Caribbean Water and Wastewater Sector (Castalia, 2017) identified the multiplicity of agencies charged with responsibility for the sector as a glaring institutional deficiency. This Study found that unfortunately, in some instances, responsibilities between bodies are not clearly established, which makes it difficult to create policies, regulate, and fund the sector. Additionally, there is no coordination at the national level of the closely inter-related issues of finance, agriculture, tourism, health, water and wastewater.

National Policy

At the national policy level, the following institutional deficiencies exist (Castalia, 2017):

- Multiple ministries are generally involved in making policies for the water and sanitation sector, without obvious coordination or cohesion.
- In several countries, the regulatory authority does not have full regulatory responsibilities over the water and sanitation sector. The Ministry with responsibility for water is often the agency where the final decision-making authority resides.
- All countries have a ministry of finance that allocates funding to the public water utility. Nevertheless, some countries also grant responsibility for approving finances to other ministries.

Governance Arrangements

- At the overall governance level, the following deficiencies were observed (Castalia, 2017):

- Long-term financial plans are seldom included in sector policies.
- Many countries do not have established measurable targets for meeting their policy objectives in the water and sanitation sector.
- Legal and institutional frameworks are often poorly developed and outdated.
- Tariff regimes are often not well developed. The absence of long-term plans prevents tariffs from factoring in future costs.
- Managerial autonomy is limited in some water utilities.
- Responsibilities and procedures are not well defined.
- There is a lack of transparency and consumer involvement.
- Financial planning does not consider the costs for expanding and improving services.
- There are weak incentives for operating efficiency.
- There is limited competence, resources, and credibility for effective utility supervision.

It was also observed that there is seldom coherence between water sector plans and national physical development plans, and more importantly, national development plans.

Land Use and Water Resource Management

In several Caribbean countries, the absence of effective land use policies and robust, empowered water resource management authorities, have resulted in degradation of watersheds and the compromising of the integrity of water sources. Where land use policies exist, they are seldom implemented effectively. Also, contamination of water sources from upstream agricultural activity has impacted negatively on the quality of water available for use. The conversion of catchments for development and agriculture poses an increasing threat to stream flows (Cashman, Cox, Daniel, & Smith, 2014). There is increasing evidence of solid wastes, including plastics, in drinking water resources, and the emergence of contaminants such as hormones, endocrine disruptors and drugs in the water supply. Industrial activities, such as mining, and inappropriate sewage disposal have caused contamination of groundwater supplies in countries such as Jamaica and Barbados (Cashman A., 2013). It is clear, therefore, that countries need to adopt integrated water resources management (IWRM) for a more comprehensive and sustainable approach to the management of land use and water resources.

Integrated Water Resources Management

Article 26 of the Plan of Implementation of the 2002 World Summit for Sustainable Development established a clear role for Integrated Water Resources Management (IWRM), based on the four Dublin Principles, as the framework at the international level through which countries should seek to organize and manage their water sectors (Global Water Partnership, 2014). The Dublin Principles are:

1. Fresh water is a finite and vulnerable resource, essential to sustain life, development and the environment.
2. Water development and management should be based on a participatory approach, involving users, planners and policy-makers at all levels.
3. Women play a central role in the provision, management and safeguarding of water.
4. Water has an economic value in all its competing uses and should be recognized as an economic good.

Integrated water resources management is a political process in which societal, developmental and ideological factors must be reconciled, and one that will involve the resolution of conflicts of interests at many different levels. IWRM stresses cross-sector integration, not only as a support to development, but as a process and framework that is sensitive to country-specific geographic, historical, cultural, social, and economic conditions (Global Water Partnership, 2014).

Wastewater Management

The management of wastewater has, for a long time, been an issue of serious concern in the Caribbean. Untreated sewage is one of the major threats to public health and biodiversity in the Caribbean. It has been observed that 85% of the wastewater entering the Caribbean Sea is untreated (GEF Caribbean Regional Fund for Wastewater Management (CReW), 2016). Additionally, 51.5% of households lacked sewer connections, and only 17% of households were connected to acceptable wastewater collection and treatment systems (Pan American Health Organization (PAHO), 2001). Moreover, in many communities there are no wastewater collection and treatment systems with which they may connect.

Increasingly however, treated wastewater and sewage sludge are viewed as a potential resource. This presents an opportunity to improve waste management, but even more importantly, a valuable medium to attract investment in sewage and wastewater management by the public and private sectors (Sustainability Managers, 2016). The safe reuse of treated effluent can make more water available for agriculture, aquifer recharge, aquaculture, firefighting, flushing of toilets, industrial cooling, park and golf course irrigation, formation of wetlands for wildlife habitats, and other non-potable needs. Additionally, wastewater sludge can be used as fertilizer, to manufacture construction materials and to generate biogas and biofuels (Sustainability Managers, 2016).

Freshwater and Coastal Zone Management

In the Caribbean Member countries, there is a very close relationship between the management of fresh water and the management of the coastal zone. This 'continuum' of freshwater and coastal waters (Global Water Partnership, 2000) requires that the managers of water resources pay close attention to the impacts of their actions on the coastal resources. Again, as with land and water resources management, there needs to be an integration of freshwater resources management and coastal zone management.

Data Management

The collection and analysis of empirical data on the water sector has been identified as a major deficiency. In many of the Member States of the region there is very little certainty of the volume of the available water resource. The notable exception is Jamaica, where the Jamaica Water Resources Agency (WRA) manages the water resources of the country through a Water Resources Development Master Plan, which is mandated by law. This Master Plan defines and quantifies the total water resources of the country, the estimated available supply and the demand by users. However, in the rest of the region, the lack of an evidence-based culture for decision-making has often resulted in sub-optimal use of existing resources and the prolonged execution of ineffective policies. When this is combined with the absence of a national water plan that considers the needs of other sectors, the result is decision-making and policy formulation that appear arbitrary and improperly focused.

Community Engagement

It is not possible for any government to manage the national water resources effectively without the engagement and participation of the public, individually and through community-

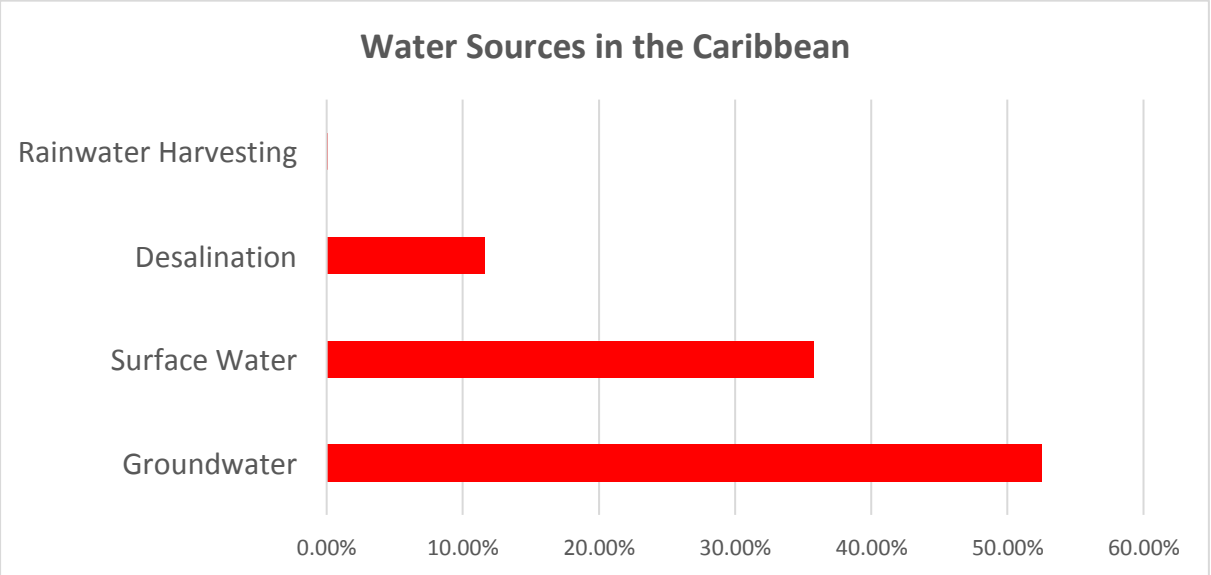
based and other civil society organisations. Therefore, local communities should be enlisted as essential allies in protecting water resources, and they should be given meaningful roles in helping to shape the decisions that are made concerning the management of the resource**.** Every effort must be made to educate consumers and communities and involve them in managing their water resources. Creative communications and messaging is necessary, encouraging school children and communities to learn and act, including advocating with politicians on this issue (Moss, 2015).

Water Availability

Water Resources

The primary water supply sources in the Caribbean are groundwater, surface water, springs and desalination. The abstraction of groundwater represents the largest proportion of water supply, accounting for approximately 52.5% of supply, while surface water accounts for 35.8%, desalination 11.6%, and rainwater harvesting less than 1% (Cole Engineering Group, 2015). Recently, there have been efforts to explore the potential for the use of wastewater and biosolids/sewage sludge as a resource, specifically for irrigation of agricultural land, small farms, hotel grounds and golf courses (Sustainability Managers, 2016).

Figure 3 Main Water Sources in the Caribbean



There is a growing gap in several Caribbean countries between demand for freshwater and the ability to meet that demand. Barbados is using almost 100 percent of its available water resources, Saint Lucia has a 35 percent water deficit, and in Nevis the deficit is 40 percent. While Trinidad and Tobago has been operating at a deficit since 2000, this deficiency is not the result of insufficient volumes of water produced, but is caused by high per capita consumption, no metering of residential customers, high non-revenue water volumes and a very low tariff that does not encourage water use efficiency (Cashman, Cox, Daniel, & Smith, 2014).

Surface water accounts for the larger proportion of water supply in Dominica (100%), Grenada (100%), Saint Lucia (100%), St. Vincent and the Grenadines (89%), Belize (62%) and Trinidad and Tobago (59%), while desalination is the main source in Anguilla (100%), Bahamas (100%), British Virgin Islands (100%), Cayman Islands (100%), Turks and Caicos (100%) and Antigua and Barbuda (66%) (Cole Engineering Group, 2015).

Challenges

Among the challenges identified with respect to water availability and distribution are the following:

- There are seasonal shortages in some countries, resulting in piped water coverage in some countries being below the average coverage for Latin America and the Caribbean.
- Collection and treatment of wastewater in most jurisdictions in the Caribbean is noticeably lacking.
- The quality of service provided by State-owned utilities is not adequate.
- Information regarding quality of service and operating efficiency is poor in many of the water utilities.
- Non-revenue water volumes are high.
- Some groundwater sources have become unusable because of over-abstraction, which in turn has hastened saline intrusion.
- Some groundwater sources have become too polluted because of contamination from mining activity, agricultural chemicals and sewage.
- Reductions in groundwater recharge and flows have reduced the availability of water in aquifers.
- Tariffs do not cover the cost of service.
- Many water utilities in the Caribbean are not investing enough in their assets, a problem that is compounded by the fact that very few water utilities generate any profits because the tariff does not represent the economic cost of producing water.

Water and Health

Developing countries face significant health risks from water-borne infectious diseases. It has been determined that infectious diseases are the largest water-related mortality risks faced by households in these countries (Whittington, 2013). In countries with inadequate potable water distribution or poor sanitation services, the likelihood of increased mortality from water and sanitation-related diseases increases.

There is also the potential for contamination of water sources from agricultural and mining activity, which can have very significant negative health impacts.

Water for Agriculture

Due to the inconsistent performance of the agriculture sector in the Caribbean over the past decade or more, the demand for water for agriculture has declined. There are some countries, however, such as Guyana, Belize and Jamaica, where this need is still significant. Climate change models for the Caribbean suggest that at a 2 ^{o}C global warming threshold, the total annual rainfall for CARICOM countries is expected to decrease by ten to twenty percent, compared to the present (Simpson, 2010). This will place significant constraints on the availability of water for agriculture, which historically has been an inefficient user of water. Additionally, there is the possibility that as rainfall levels decrease, more farmers will begin to invest in supplementary irrigation to maintain yields. This will place even greater demands on

a dwindling resource.

In the Caribbean, food production systems are still based mainly on rain-fed agriculture. This has led to seasonality in the production of certain crops. As rainfall patterns become more variable and unpredictable, this will lead to a change in the yields of certain crops. Research will need to be conducted into cultivars that are more drought-tolerant. Where irrigation is employed, the form of irrigation will have to be as water-efficient as possible.

It has been suggested that water-constrained countries will exacerbate their water security issues if they strive for food self-sufficiency, rather than achieving food security through trade. This has led to the concept of 'virtual water', where by importing food, water- constrained countries will in effect be importing water from more water-endowed countries (Global Water Partnership, 2000). It is clear, therefore, that considerations over water for agriculture will have significant impacts on agriculture policy and domestic and regional food security.

Water for Tourism

The tourism sector is an important driver of economic growth in almost every Caribbean island. It has been reported that tourists may consume up to three times as much water as the local population and the supply of water to hotels can account for between 10% and 15% of all water supplied by municipal distribution systems (Cashman A., Water Security and Services in the Caribbean, 2013). The countries that experience the highest rates of water scarcity, such as Antigua and Barbuda, and the Bahamas, are the ones that are most attractive to mass tourism, resulting in an even greater need for water (Brown, 2007). During low rainfall periods, the issue of water allocation to the tourism industry becomes a problematic one for water companies and governments. As the tourism industry continues to grow in Caribbean jurisdictions, its demand for water will continue to pose a challenge for national authorities.

Climate Change Impacts

Background

Freshwater systems are among the systems that are most vulnerable to climate change (IPCC, 2007). According to the UNDP (Simpson, 2010), climate change will lead to increased water insecurity in most CARICOM nations. This will manifest as a decline in rainfall levels, less reliability of surface water reserves, sub-optimal groundwater recharge, and an increase in the frequency and severity of drought. Moreover, the increased variability in the hydrological cycle will necessitate a re-evaluation of assumptions on stream flows, aquifer recharge rates, sustainable levels of abstraction, and yields from surface and groundwater sources (Cashman A. , 2013).

Higher global temperatures will cause more rapid melting of Polar ice caps and thermal expansion of the oceans, which will result in sea level rise. For countries in the Caribbean that depend primarily on aquifers or groundwater sources for their water supply, this saline water intrusion of aquifers from sea level rise, in some instances worsened by over- abstraction and lower rates of recharge, will have serious negative repercussions for the water supply.

Increases in average global temperatures higher than 1.5 degrees Celsius will result in stronger hurricanes, carrying greater levels of precipitation. Therefore, the damage to national water and wastewater/sanitation infrastructure that accompanies severe storms and the more frequent flooding and debris flows that are expected in the Caribbean because of climate change, will place water resources and water and wastewater infrastructure, which have not been designed or built to withstand these more extreme conditions, under severe stress.

Changes in the volume and quality of surface water and groundwater will impact on the reliability of safe water supplies, on exposure to damaging flood events, on the availability of water for industrial purposes, on water-borne transport, water-related diseases, and aquatic ecosystems and the services they provide (Kundzewicz, 2008). In effect, climate change will negatively impact both water resources and water services.

Anticipated Climate Change Impacts

The effect of Climate Change on the water sector in the Caribbean is expected to range from impacts on water resources to damage to water and wastewater infrastructure (Global Water Partnership-Caribbean & Caribbean Community Climate Change Centre, 2014):

- Drought risk to surface water reservoirs, river base flows and aquifers, leading to supply deficits for water services
- Drought leading to salinization of aquifers (compounded by over-abstraction)
- Drought reducing dilution of pollutants and wastes, causing water quality problems for service providers
- Drought causing a reliance on water trucking and desalination, increasing the cost of water provision to consumers
- Coastal, river and surface water flood risk to water infrastructure, causing water supply contamination, service outage and damage to assets
- Long term sea level rise and coastal erosion, presenting a risk to water infrastructure
- River flooding causing turbidity and sedimentation, damaging infrastructure and causing treatment problems
- More intense rainfall events, leading to higher rates of runoff
- Storm rainfall mobilizing polluted runoff, leading to water treatment problems and public health risks.
- Intense rainfall causes overloading of wastewater systems and this may cause raw sewage to flow into receiving systems
- Lower rates of recharge of aquifers

Broadly categorized, these climate-induced water security challenges may be identified as (Global Water Partnership-Caribbean and Caribbean Community Climate Change Centre, 2016):

1. Water sector infrastructure exposed to damage and disruption from water-related hazards
2. Effectiveness of community and urban water supply systems exposed to increasing climate vulnerability
3. Effective management of water resource quantity and quality threatened by a changing climate
4. Increasing demand and insufficient water use exacerbating the vulnerability of existing water supply systems and sources
5. Agricultural production vulnerable to seasonal rainfall and drought
6. Escalating costs of flood-related damage and losses
7. Diversion of funds to deal with damage and to provide short-term relief
8. Bush fires during droughts lead to denuding of terrain, which in turn leads to higher runoff rates during heavy rains and transportation of burnt debris

Vulnerability Issues

Climate-related vulnerability issues in specific Caribbean countries associated with the water supply include the following (Cole Engineering Group, 2015):

- **Water scheduling**: Anguilla, Guyana, Saint Lucia, and Trinidad and Tobago;
- **Drought events**: Anguilla, Antigua and Barbuda, Barbados, Dominica, Grenada, Jamaica, Saint Lucia, St. Vincent and the Grenadines, and Turks and Caicos;
- **Flooding**: Anguilla, Guyana, Saint Lucia, Trinidad and Tobago, British Virgin Islands, and St. Vincent and the Grenadines;
- **Contamination, saline intrusion**: Anguilla, Antigua and Barbuda, Cayman Islands, Barbados, Belize, Guyana, St. Kitts and Nevis, and Turks and Caicos;
- **Turbidity problems**: Dominica and Trinidad and Tobago Saint Lucia; and,
- **Landslides and Debris Flows**: Dominica, Saint Lucia, St. Vincent and the Grenadines and British Virgin Islands.

The reality for the Caribbean is that while it is a relatively negligible contributor to global greenhouse gas emissions, it stands to be dramatically impacted by failure on the part of the international community to keep global warming below 1.5 degrees Celsius. This is why the Caribbean has played such a leading role in advocacy and negotiations at the international level in trying to secure ambitious commitments from developed countries to limit greenhouse gas emissions. A 2008 Study (Bueno, 2008) found that for three categories - increased storm damage, loss of tourism revenue, and infrastructure damage – the cost of inaction in limiting global warming could reach $22 billion annually by 2050 and $46 billion by 2100, equivalent to 10.3% and 21.7% of Caribbean GDP respectively.

Table 2 Cost to the Caribbean of Global Inaction on Climate Change

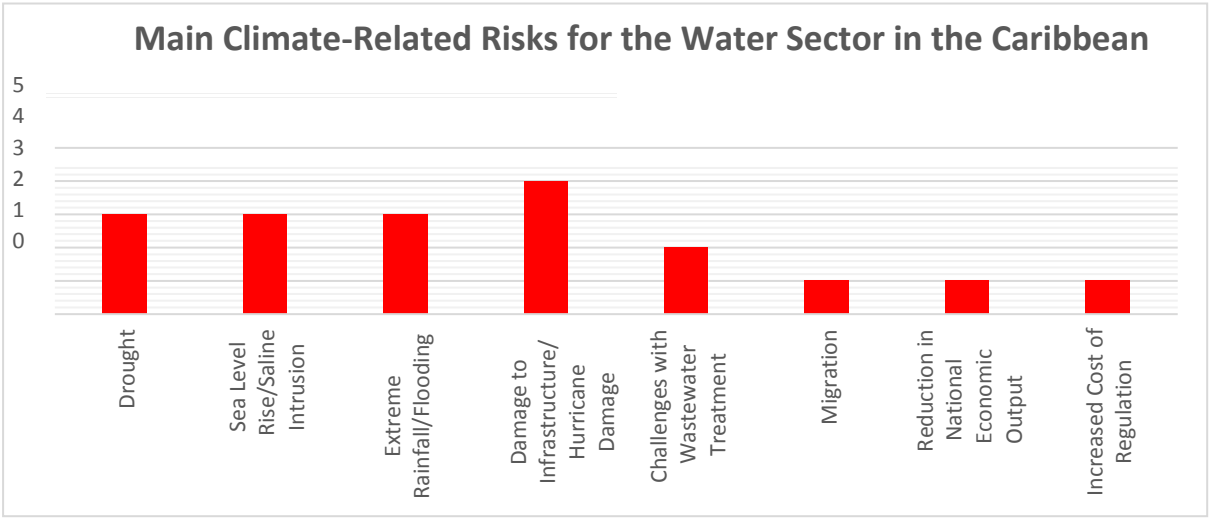
Cost of Inaction as Percentage of Current GDP				
Country	**2025**	**2050**	**2075**	**2100**
Anguilla	10.4	20.7	31.1	41.4
Antigua & Barbuda	12.2	25.8	41.0	58.4
Aruba	5.0	10.1	15.1	20.1
Bahamas	6.6	13.9	22.2	31.7
Barbados	6.9	13.9	20.8	27.7
British Virgin Islands	4.5	9.0	13.5	18.1
Cayman Islands	8.8	20.1	34.7	53.4
Cuba	6.1	12.5	19.4	26.8
Dominica	16.3	34.3	54.4	77.3
Dominican Republic	9.7	19.6	29.8	40.3
Grenada	21.3	46.2	75.8	111.5
Guadeloupe	2.3	4.6	7.0	9.5
Haiti	30.5	61.2	92.1	123.2
Jamaica	13.9	27.9	42.3	56.9
Martinique	1.9	3.8	5.9	8.1
Montserrat	10.2	21.7	34.6	49.5
Netherlands Antilles	7.7	16.1	25.5	36.0
Puerto Rico	1.4	2.8	4.4	6.0
Saint Kitts & Nevis	16.0	35.5	59.5	89.3
Saint Lucia	12.1	24.3	36.6	49.1
Saint Vincent & the Grenadines	11.8	23.6	35.4	47.2
Trinidad & Tobago	4.0	8.0	12.0	16.0
Turks & Caicos	19.0	37.9	56.9	75.9
U.S. Virgin Islands	6.7	14.2	22.6	32.4
TOTAL CARIBBEAN	5.0%	10.3%	15.9%	21.7%

Table 3 Cost of Global Climate Change Inaction on the Caribbean Region

Cost of Inaction in $US Billions				
	2025	**2050**	**2075**	**2100**
Storms	1.1	2.8	4.9	7.9
Tourism	1.6	3.2	4.8	6.4
Infrastructure	8.0	15.9	23.9	31.9
Total	$10.7	$21.9	$33.7	$46.2
% Current GDP	5.0%	10.3%	15.9%	21.7%

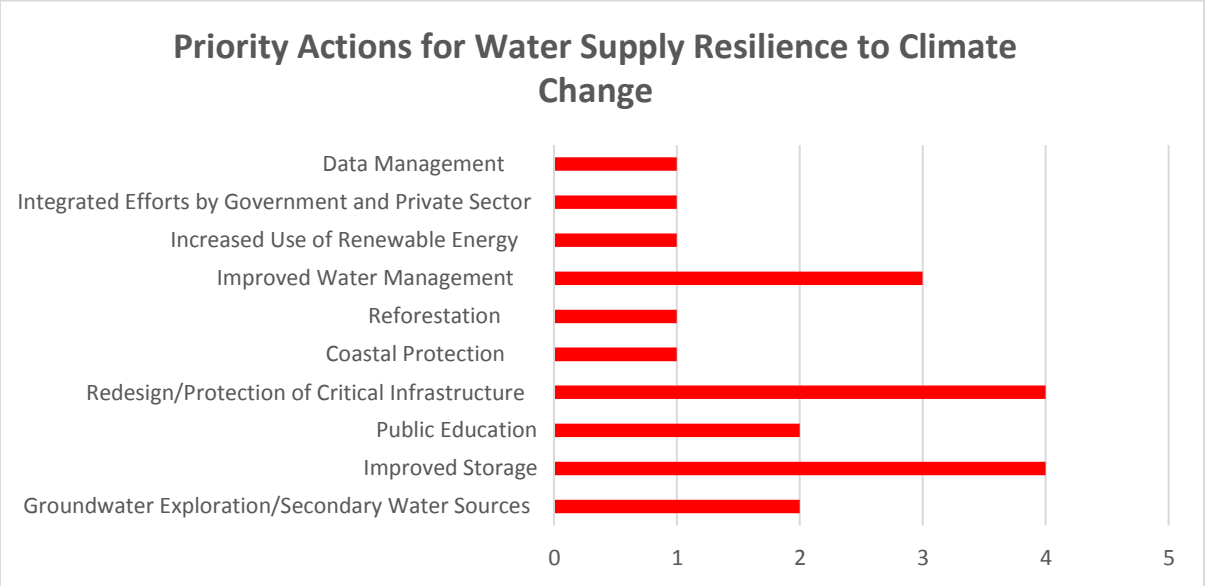
A survey of water utility companies and ministries with responsibility for water, conducted by HR Wallingford, as part of a study on Planning for the Integration of Climate Resilience in the Water Sector in the Caribbean, identified damage to infrastructure, saline intrusion, drought and extreme flooding as the primary threats perceived by these stakeholders to the water sector from climate change. A similar study by Moss (Moss, 2015) found almost identical results, with the greatest vulnerabilities to climate change from a utility perspective being longer periods of drought, the effects of floods and extreme weather events on water infrastructure and salinization of aquifers as the three most critical concerns.

Figure 4 Climate-Related Risks to the Water Sector *(HR Wallingford)*



The Wallingford Study also identified (i) redesign and protection of critical water infrastructure, (ii) improved water management, and (iii) improved water storage as the critical priority actions to secure water supply resilience.

Figure 5 Priority Actions for Water Supply Resilience *(HR Wallingford)*



The Action Plan

Pillars of Plan

The Regional Strategic Action Plan for climate resilience in the water sector in the Caribbean is built along six main pillars, namely (i) water sector governance, (ii) decision support, (iii) water resources management, (iv) research, development and innovation, (v) provision of water services, and (vi) capacity building and public sensitization. Given the disproportionate impacts of water scarcity and extreme weather events on women in the Caribbean, it is very important that all interventions in the water sector recognize and cater to the need for gender sensitivity in planning, implementation, monitoring and evaluation. This is particularly the case with respect to intervention that are designed at increasing resilience to the impacts of climate change or reducing exposure to natural disasters.

Stakeholder Engagement

An important first step in the implementation of the plan should be the comprehensive identification and categorization of the myriad stakeholders who must be engaged. It is vitally important that stakeholder input and support is obtained at all levels. This is particularly the case at the community level, which is often the neglected component in national policy formulation and decision-making. There must be broad-based and committed stakeholder buy-in and engagement throughout and every effort must be made to solicit the perspectives of the myriad stakeholders. While this is at the core of pillar five, which speaks to public sensitization, it must also be a recurring theme in the implementation of the plan.

Another important stakeholder group that must be engaged and from which buy-in is essential is the political directorate. High-level political support is critical to the success of this action plan. The minister with responsibility for water must champion this action plan. However, support will also be required from the Minister for Finance and the Minister for Planning, given the important role of resource mobilization and resource allocation in this process. The support of the Office of the Prime Minister must also be enlisted because of the need to have water sector planning and a sensitivity to water management issues at the core of all decision making at the highest policy levels. Ministers with responsibility for sectors that depend on a reliable supply of water for their smooth functioning, such as the ministers of tourism, agriculture, industry, health and education, must also be engaged very early on in the development and execution of the plan.

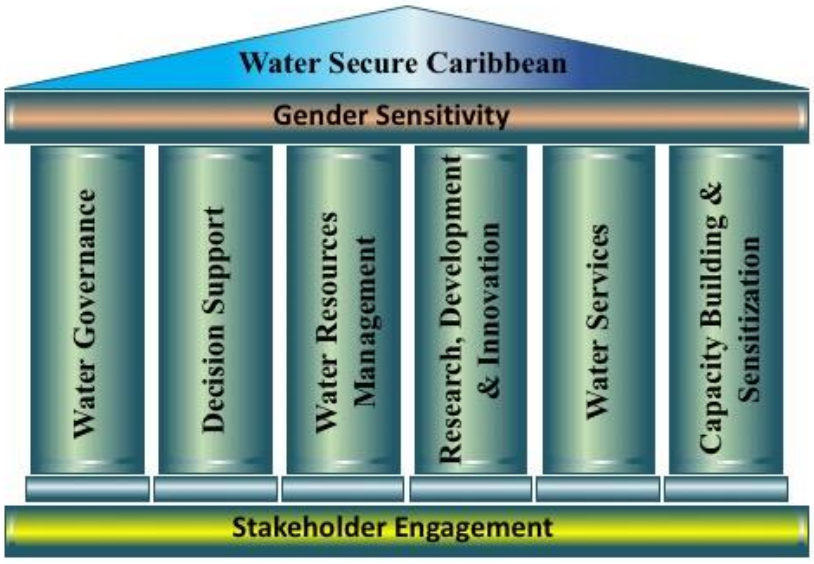
Evidence Based Action

A robust, comprehensive and accurate evidence base must underpin the policy making process in the water sector. Resources are limited at all levels (natural, human, technical and financial) and Caribbean countries do not have the luxury of time in addressing the critical needs of the water sector. Therefore, interventions must be targeted, effective, efficient and coordinated. The only way this can be assured is through a strong evidence base that will allow for accurate identification of the problem, and effective design and implementation of the intervention.

Another critical component of the Water Action Plan must be its reliance on continuous monitoring and evaluation. Naturally, this is predicated on the existence of sound and current databases. Because the water sector impacts so many economic, social and environmental processes and also because both resources and time are constrained, the authorities executing the plan must build in a planning, monitoring and evaluation architecture into the management of the plan. In other words, management of the Water Action Plan must always be results-based, with continuous monitoring to determine the efficacy of the programme and the flexibility to make any necessary adjustments to ensure the optimal effectiveness of the respective interventions.

As in the case of stakeholder engagement, this imperative is fundamental to one of the pillars of the plan – climate-informed decision support, but it is also a requirement for every one of the elements of the action plan.

Figure 6. Structure of Regional Water Policy



Communication and Education

An important pre-requisite for the success of the Action Plan is a well-thought-out communications strategy and plan. To succeed, the Action Plan will require stakeholders at all levels to deviate from business as usual. It will be necessary to do different things from what they have been doing, and to do many of the things they have been doing differently. This change in culture, attitudes and practice will not happen overnight. It will require constant public education, encouragement and reinforcement. The sellers of the Plan must be credible and relatable and must, whenever possible, be prepared to lead by example.

Most Critical Component

Finally, perhaps the most critical ingredient for the successful implementation of the Water Action Plan will be inter-agency and inter-sector coordination and collaboration, which speaks directly to the issue of governance. As previously explained, the effective management of our water resources requires many agencies at the public sector and the private sector, and at the national and the community levels, to share information and to work together, with a common purpose. It might be useful to adopt an approach that was used successfully in the battle against HIV-AIDS known as the Three Ones Approach. That scenario called for One agreed action framework that formed the basis for coordinating the work of all development partners; One national AIDS coordinating authority, with a broad-based multi-sector mandate; and one agreed country-level monitoring and evaluation system (World Health Organization, 2004).

In the case of the water sector, it is proposed that there be ONE nationally and regionally agreed action plan for addressing the challenges in the water sector, for which this Action Plan can lay the foundation. There would then need to be agreement on the establishment of ONE national water action coordinating committee, which would bring together all the water stakeholders, across the various sectors, to agree on the steps that must be taken collectively and individually, but always in synergy, to address the myriad challenges causing water insecurity in the country. At the regional level, the High-Level Forum of the Caribbean Water and Wastewater Association should serve as the regional coordinating authority, with the blessing and endorsement of the Heads of Government of the Caribbean Community. This will also require an enhancement of the technical capacity and the resources that are available to support the Caribbean Water and Wastewater Association in the execution of this official mandate. Finally, there should be ONE monitoring and evaluation system, at the country level, that would allow for the continuous monitoring and evaluation, with adjustments and refinement where necessary, to ensure that Action Plan, with its various activities and interventions, is having the desired impact. At the regional level, the Caribbean Water and Wastewater Association should be charged with the responsibility for establishing the common platform for monitoring and evaluation of those activities of the programme that have a regional focus. This approach would lend itself to a minimization of duplication of effort, it would create the synergies and the critical mass that are necessary for transformational change in the water sector, and it would give development partners a clear

platform for technical and financial support as well as a transparent mechanism for evaluating the efficacy of their interventions.

Figure 7. Water Sector Action Plan Coordination

Methodology

The approach taken with the articulation of the action plan is to coalesce the activities under the five broad pillars. That way, there will be synergy of action and commonality of purpose, which are prerequisites for success. While it may not always be possible for resources to be mobilized to address all the imperatives under a programme area, it is hoped that even when individual projects are pursued, they will align with the activities identified under the programme and consequently, will contribute to the achievement of the overall programme outcome.

Addressing the growing water insecurity of the Caribbean is one of the biggest developmental challenges confronting the citizens of the region. This Action Plan seeks to present a practicable road map for dealing with this challenge.

Component 1: Climate-Resilient Water Governance

The overall objective of the interventions in this component is to develop the enabling environment for the sustainable management of water resources at national and regional levels, through a participatory process involving stakeholders in the public and private sectors, with the aim of increasing resilience to the impacts of climate change.

Sub-component 1.1: Improve national and regional institutional and legislative frameworks.

- Activity 1.1.1: Develop national water policies in Member States where they do not exist and review all water policies against international best practice. Set targets to ensure that the objectives of the national water policy are met and the targets of Goal 6, Clean Water and Sanitation, of the 2030 Development Agenda are achieved.
- Activity 1.1.2: Establish a water resources agency in each Member State, with a mandate to protect and enhance the water environment and facilitate Integrated Water Resources Management (IWRM).
- Activity 1.1.3: Develop a mechanism for effective coordination among water management agencies, agencies responsible for policy formulation and programme implementation in climate change and disaster risk reduction, and the sectors that have a nexus with the water sector (such as energy, agriculture, and tourism).
- Activity 1.1.4: Develop review and modernise legislation to facilitate the requisite institutional architecture and the pursuit of policies and programmes that will ensure sustainable management of water resources and pollution control.
- Activity 1.1.5: Establish an independent national water utility regulator in each Member State, with a mandate to establish and monitor standards and benchmarks, protect consumer interests and set tariffs based on good economic practice and reflective of social and environmental sustainability considerations.
- Activity 1.1.6: Develop a mechanism to engage with private sector stakeholders to ensure their commitment to the actions necessary for the effective management of water and wastewater.
- Activity 1.1.7: Establish a sustainable regional coordinating mechanism for the water sector.

Sub-component 1.2: Mainstream climate change policies in the water sector

- Activity 1.2.1: Incorporate climate resilience and disaster risk reduction policies and plans into sector and national development plans by implementing the priority action areas and principles of the Sendai Framework for Disaster Risk Reduction, the 2030 Development Agenda and the Paris Agreement.
- Activity 1.2.2 Establish a mechanism at the national level to ensure coherence and synergies between national water sector plans and all other sector or national development plans or public sector investment programmes.

Box 1. Elements of Good Poverty and Social Impact Analysis for Policy Formulation

Ten Elements of Good Poverty and Social Impact Analysis (PSIA) (Holland, 2007)

Asking the right questions: The choice of questions for PSIA is influenced by the expected size and direction of poverty and social impacts, the prominence of the issue in the government's policy agenda, the timing and urgency of the underlying policy or reform, and the level of national debate surrounding the reform.

1. **Identifying stakeholders:** Stakeholder analysis identifies the people, groups, and organizations that are important to consider when looking at poverty and social impacts of reforms.
2. **Understanding transmission channels:** The expected impact of a policy change takes place through five main transmission channels: employment, prices (production, consumption, and wages), access to goods and services, assets, and transfers and taxes.
3. **Assessing institutions:** Institutions determine the framework in which policy reforms might affect stakeholders in government, private sector, and civil society and are the main arenas in which stakeholders interact with one another. Assessing institutions identifies how institutions are being affected by policy changes and how they, as carrier and transmitter of change, affect social relations and reform outcomes.
4. **Gathering data and information:** Assessing data needs and availability and planning the phasing of future data collection are an important part of PSIA, including ensuring data availability for future PSIA.
5. **Analyzing impacts:** Impact analysis involves organizing research questions to test critical links among the policy objectives, policy actions, and their impacts on key stakeholder groups, with a focus on winners and losers.
6. **Contemplating enhancement and compensation measures:** To the extent that there are losers from reform, PSIA can inform the identification of options to limit negative impacts through the design of appropriate compensation mechanisms. If the findings of PSIA suggest that the costs of reform—in terms of both poverty impacts and the cost of mitigation or compensation— outweigh the benefits, then consideration should be given to resequencing the reform or abandoning or suspending implementation of the policy.
7. **Assessing risks:** Some of the assumptions underlying the analysis might not be realized, including institutional risks, political risks, exogenous risks, and other country risks.
8. **Monitoring and evaluating impacts:** PSIA provides an opportunity to set up systems at an early stage for monitoring, social accountability, and evaluation of the impacts.
9. **Fostering policy debate and feeding back into policy choice:** Evidence-based policy making is able to draw on PSIA data and analysis. For low-income countries, for example, PSIA has been conceptualized as an integral part of the PRSP process and as an element of the dialogue on the country's poverty reduction strategy.

Box 2: Targets for SDG Goal 6

1. By 2030, achieve universal and equitable access to safe and affordable drinking water for all

2. By 2030, achieve access to adequate and equitable sanitation and hygiene for all and end open defecation, paying special attention to the needs of women and girls and those in vulnerable situations

3. By 2030, improve water quality by reducing pollution, eliminating dumping and minimizing release of hazardous chemicals and materials, halving the proportion of untreated wastewater and substantially increasing recycling and safe reuse globally

4. By 2030, substantially increase water-use efficiency across all sectors and ensure sustainable withdrawals and supply of freshwater to address water scarcity and substantially reduce the number of people suffering from water scarcity

5. By 2030, implement integrated water resources management at all levels, including through transboundary cooperation as appropriate

6. By 2020, protect and restore water-related ecosystems, including mountains, forests, wetlands, rivers, aquifers and lakes

7. By 2030, expand international cooperation and capacity -building support to developing countries in water- and sanitation-related activities and programmes, including water harvesting, desalination, water efficiency, wastewater treatment, recycling and reuse technologies

8. Support and strengthen the participation of local communities in improving water and sanitation management

Component 2: Climate-Resilient Water Resources Management

The objective of this component is to ensure the sustainable and efficient management of the water resources, from ridge to reef, through the adoption of IWRM principles. IWRM is an adaptation response to a reduction in water resource and requires the incorporation of indigenous and local knowledge on water use and management with scientific knowledge to ensure the cultural appropriateness of the approaches being proposed and greater potential for successful implementation.

Sub-component 2.1: Comprehensively quantify water resources, including basin water budgets and supply-demand balances. These assessments should consider current (baseline) and future conditions, factoring in both climate change and different socio-economic development scenarios.

- Activity 2.1.1: Undertake a programme of surface and groundwater modeling to estimate water resources from different sources and the capacity of these resources to meet projected future demands.

Sub-component 2.2: Develop and adopt an IWRM plan, which incorporates social and gender equity, economic efficiency and ecological sustainability.

- Activity 2.2.1: Develop a watershed management programme that includes restoration of forest cover, establishment of new forest cover where needed to help improve the integrity of watersheds and assist with slope stabilization, and establishment of buffer protection areas.
- Activity 2.2.2: Reduce the sources of pollution of water sources, through enactment, where necessary, and enforcement of legislation and rigorous public education.
- Activity 2.2.3: Involve communities as active players in watershed protection, given the key role that local communities and small farmers play in the management of watershed ecosystems.
- Activity 2.2.4: Explore the feasibility of using Payment for Environmental Services schemes.
- Activity 2.2.5: Develop robust water sharing protocols that are applicable across all sectors

Box 3: An Alternative to the Integrated Watershed Management Plan for SIDS

Formulation of a Sustainable Development Matrix

Chase and Louisy (Chase, 2010) posit that integrated watershed management in a small island developing State is difficult due to the absence of the necessary policy and legislative framework to support inter-sector and inter-agency watershed planning and management. They indicate "it is impossible to develop an integrated watershed management plan given the extent of data to be processed into a single inter-sector and multi-sector plan. The difficulties stem primarily from (a) definition of the watershed as a complex assortment of physical and socio- economic processes, and (b) lack of the necessary enabling environment (institutional and policy frameworks that will allow for inter-sector, inter-agency and multi-stakeholder planning). Instead, they propose the substitution of a Sustainable Development Matrix (SDM) for the integrated watershed management plan.

According to Chase & Louisy, the Sustainable Development Matrix:(a) identifies the major sustainable development issues in the watershed, (b) provides a framework for organizing development activities in the watershed and supporting activities at the national level, and (c) helps to integrate the different dimensions of development within six identified thematic areas – land, water, biodiversity, vulnerability, infrastructure and services, and livelihoods. The matrix also identifies appropriate modalities for (i) strengthening existing coping capabilities and strategies of the communities and persons in the watershed, and (ii) creating or strengthening formalized adaptive capabilities that will assist the population in the watershed to better respond to the various challenges posed by the watershed.

Template for Creating a Sustainable Development Matrix

Dimensions of Development					
Thematic Areas	Physical	Economic	Socio-Cultural	Environmental	Institutional
Land					
Water					
Biodiversity					
Vulnerability					
Infrastructure and Services					
Livelihoods					
Governance					

Component 3: Climate-Informed Decision Support

The overall objective of this component is to facilitate the development of the robust evidence base that will be used to underpin all policy formulation and decision-making in the water sector at the domestic and regional levels. The intention here is to make the decision support mechanism open to all stakeholders, at different levels of input and access.

Sub-component 3.1: Develop a National Water Decision Support System (DSS) for climate informed decision making that integrates environmental, social and economic data.

- Activity 3.1.1: Develop data and information management protocols for the National DSS to set out the processes and procedures for data collection, storage, analysis and dissemination, archive and disposal within the DSS.
- Activity 3.1.2: Establish a data centre to host the DSS and provide the computing capacity for big data analytics within the DSS. Develop the DSS architecture for storage, access and analysis of disaggregated data for all relevant stakeholders.
- Activity 3.1.3: Develop monitoring system for data collection and integrate this within the DSS. Deploy instrumentation and equipment for data collection on sea level rise, the status of aquifers, stream flow, flood mapping and wastewater. Include collection of satellite data and LiDAR. This will provide an evidence base to determine the existing and potential future impacts of climate change on the water sector.
- Activity 3.1.4: Develop accurate models to predict the impacts of extreme weather events and slow onset events including sea level rise on the water sector.
- Activity 3.1.5: Map water supply system assets, undertake hydraulic modeling of the supply network and modeling of water resources and use GIS to develop, manage and analyze the requisite datasets.
- Activity 3.1.5: Analysis and interpretation of water data within the DSS to assess social, economic and environmental impacts on water resources, including impacts from climate, land use, demographics and economic development.
- Activity 3.1.6: Develop national early warning systems (e.g. drought and flood forecasting) that will facilitate forecasting of pending water-related crises
- Activity 3.1.7: Training and capacity building for all relevant personnel in data entry, analysis and dissemination.

Sub-component 3.2: Establish a water resources management planning cycle for improving responsiveness to climate impacts

- Activity 3.2.1: Establish a periodic national water census to quantify and value water resources as part of the work programme of the national statistics department.
- Activity 3.2.2: Set standards and benchmarks to allow for accurate measurement of progress in relation to climate impacted variables (supply demand deficit, deployable output) and comparison with international best practice. Set standards for reduction in demand.

- Activity 3.2.3: Institutionalise the production of an annual, national State of the Water Sector Report as a joint undertaking by the government, the regulator and the water utility company. To inform policy makers, water users and the water utility about where investments need to be made to manage climate related risks
- Activity 3.2.4: Develop a national level requirement for water resource management planning, which takes possible future development scenarios into account.
- Activity 3.2.5: Establish and monitor operational resilience metrics (such as duration of service interruption, time to repair) as a first step toward agreement on Levels of Service. This will be important in estimating the ability of the water system to cope with climate variability and planning climate change adaptation options.

Figure 8 Example of Water Industry Standards *(WATER UK, 2011)*

Industry priority	Indicator	Measure	Units	Result 2010/11	Result 2009/10	Progress
Protect and promote public health	Drinking water (DW) quality	Compliance with DW standards, England & Wales	percentage	99.96	99.95	↑
		Compliance with DW standards, Scotland	percentage	99.83	99.78	↑
		Compliance with DW standards, Northern Ireland	percentage	99.79	99.74	↑
	Incidents of sewer flooding	Properties actually affected by sewer flooding	count	7,295	6,476	↓
	Reported accidents	Major/fatal accidents to employees arising whilst undertaking water company related activities	count per 1000 employees	1.20	1.20	Stable
Provide a high quality, reliable, and value for money service	**Water supply interruptions**	Properties with interruptions to supply (in excess of 6 hours in duration)	count	700,255	119,880	↓
	Water into supply	Total volume of water put into supply	Megalitre/day	17,395	17,261	↓
	Domestic water demand	Domestic water demand (measured)	litres/person/day	129.0	-	N/A
		Domestic water demand (unmeasured)	litres/person/day	159.2	-	N/A
	Cash interest cover	Sector cash interest cover ratio	Ratio	4.4	4.9	↓
Respond to climate change	Total energy use	Total energy used (annual)	Gigawatt Hour	9,016	9,012	Stable
	Renewable energy generation	Renewable energy generated by water and wastewater companies	Gigawatt Hour	877	665.0	↑
	Greenhouse Gas (GHG) emissions	Total GHG (from water supply, wastewater treatment, offices and transport)	Million tonnes CO_2 equivalent	5.01	4.95	↓
Reduce our impacts on the environment	Sludge management	Total waste water sludge	thousand tonnes of dried solids	1,464	1,698	↑
	Sludge use	Waste water sludge sent for recycling (agriculture, land reclamation, other)	percentage	80.3	70.8	↑
	Non-sludge waste	Other waste recycled	percentage	80.1	67.3	↑
	Total loss of water from the Supply Network	Total leakage	Megalitre/day	3,908	4,251	↑
	Status of Sites of Special Scientific Interest (SSSIs)	SSSIs in target condition (England only)	percentage	98.5	96.0	↑
		SSSIs in target condition (Scotland only)	percentage	69.3	70.3	↓
Earn the trust of the Community	**Convictions for environmental and public health offences**	Number of convictions (sector total)	count	47	42	↓
	Community investment	Total value of financial contributions to community during reporting year	£ thousands	8,359	8,742	↓

Component 4: Research, Development and Innovation to Increase Resilience

This component of the Action Plan seeks to encourage applied research and development and the use of technology and innovation to improve the management of water resources, facilitate better informed decision-making, improve the cost-effectiveness of operations and create greater resilience to the impacts of climate change.

Sub-component 4.1: Develop new tools or use existing technologies to assist decision making and resource management.

- Activity 4.1.1: Develop model planning tools to:
  - Determine water balances;
  - Manage energy demands;
  - Incorporate agriculture, industry and tourism into water resource management planning;
  - Provide a fast risk assessment strategy for the resource and for distribution networks based on seasonal forecasts;
  - Create simplified hydrological models that incorporate climate change and climate vulnerability as inputs into medium and long-term planning;
- Activity 4.1.2: Develop virtual reality (VR) and augmented reality (AR) platforms to support management and decision-making and prepare water demand projections.
- Activity 4.1.3: Use drone technology to monitor the resource, particularly in difficult-to-reach watersheds and after the passage of a storm.
- Activity 4.1.4: Explore the feasibility of using synthetic-aperture radar (SAR) and interferometric synthetic-aperture radar (InSAR) satellite-based techniques for resource and network management, particularly to identify when land movement is occurring that could impact network and resource management;

Sub-component 4.2: Use technology to assist with information management.

- Activity 4.2.1: Develop hydro-informatics data analytics - best practice for the collection of monitoring data and the development of analytical tools that can be used to provide relevant information to resource managers;
- Activity 4.2.2: Develop open-source, low cost technologies for monitoring and observation of resource and network conditions.
- Activity 4.2.3: Create a mobile app to allow for crowd-sourcing information to enhance information gathering and decision-making for water utilities.

Sub-component 4.3: Use 3-D printing technology to improve the cost-effectiveness of operations.

- Activity 4.3.1: Explore the use of 3-D printable technologies by water utilities to fabricate parts they normally purchase overseas and collaborate with universities to fabricate new devices.
- Activity 4.3.2: Investigate the possibility of creating and using 3-D printable automatic weather stations and stream flow stations to reduce the cost of station deployment and to expand the monitoring network.

Component 5: Climate-Resilient Water Services

This series of interventions is focused on developing resilience to the impacts of climate change and extreme weather events in the delivery of water services.

Sub-component 5.1: Reduce water demand to acceptable levels to adapt to climate related water scarcity

- Activity 5.1.1: Reduce levels of non-revenue water (NRW), through a programme to repair and replace damaged or aging infrastructure, metering of water supplies and measures to reduce theft of water.
- Activity 5.1.2: Establish appropriate incentives that encourage water use efficiency or sanctions that penalize inefficient or unhelpful behaviour.

Sub-component 5.2: Optimize efficient use of water resources to adapt to climate related water scarcity

- Activity 5.2.1: Improve water storage infrastructure, both for untreated and treated water at the national level, municipal level and encouraging investments in increased water storage at the domestic and commercial levels.
- Activity 5.2.2: Effectively manage recycled wastewater and water from other sources such as rainwater and untreated surface water, including its use as a resource in sectors such as tourism (landscape irrigation) and agriculture (irrigation and fertilizer).
- Activity 5.2.3: Climate-proof water storage, treatment and distribution infrastructure to better withstand the impacts of climate change and extreme weather events.
- Activity 5.2.4: Develop and implement contingency plans, including but not limited to desalination facilities that can be deployed in situations of acute water scarcity.

Sub-component 5.3: Improve energy efficiency in water use

- Activity 5.3.1: Reduce energy costs of the water utility by employing energy efficiency measures and by making use of cheaper renewable energy sources where possible.
- Activity 5.3.2: Explore the feasibility of installing back-up energy sources for water utility companies to act as a contingency for when electricity supply is interrupted after an extreme weather event.

Component 6: Capacity Building and Public Education for Climate Resilience

This component aims to increase learning and develop capacity within utility companies and stakeholders in Member States to be able to develop climate-resilient water sector strategies across the Caribbean and address the myriad impacts of climate change.

Sub-component 6.1: Promote and encourage regional learning and replication

- Activity 6.1.1: Develop a regional community of practice that will allow for sharing of experiences and information and replication of best practice and strategies that have proven useful or successful in other jurisdictions.
- Activity 6.1.2: Develop and maintain a database of water professionals in the Caribbean who may be called upon to assist at the national or regional level when a problem arises, or capacity needs to be augmented.

Sub-component 6.2: Support training and capacity building

- Activity 6.2.1: Develop and execute a training programme, informed by a comprehensive capacity needs assessment, at the national and regional levels, to improve technical capacity in the government, the water utility and the private sector to understand and manage climate impacts on the water sector.

Sub-component 6.3: Engage in a comprehensive public awareness campaign

- Activity 6.3.1: Raising public awareness to promote and encourage action to adapt water use and wastewater management behaviour to climate variability and change.

Resource Mobilization

The magnitude of the interventions that are required at the national level to address the multiplicity of challenges facing the water sector necessitate a very focused approach to resource mobilization.

Some important questions need to be addressed in determining the approach to mobilizing resources for the water sector in the region. These include:

- What are the major challenges to opening the water sector to new sources of finance?
- Does the focus need to be on improving the capacity and efficiency of utilities so that they are better able to access private investment?
- What actions should be taken to leverage more public and private capital?
- How can we ensure that development finance is directed mostly at projects that promote water security and sustainable growth and not merely at bankable projects?
- How can countries ensure that public and private sector investments, particularly in major infrastructure projects are water-sensitive and do not contribute to greater water scarcity or resource limitation?

A strategy that has been proposed in other jurisdictions and which appears appropriate for the Caribbean context is to prioritize no regret/low regret and win-win investment options within a balanced portfolio of investments (African Ministers' Council on Water, Global Water Partnership, Climate & Development Knowledge Network, 2012). 'No regret' investment options are measures that are worth implementing because their benefits are significant, regardless whether other events, in this case the impacts of climate change, occur. No regret options do not necessarily involve trade-offs with other policy objectives. 'Low regret' options are low cost actions that provide relatively large potential benefits under expected climate change scenarios. A win-win action is one that contributes to climate change adaptation while also realizing other economic, social and environmental policy benefits.

The United Kingdom's Climate Impacts Programme (UKCIP) identifies a useful set of criteria that may be used to evaluate investment options to determine their attractiveness to development partners (UKCIP, 2010).

- Effectiveness – will the action meet your objectives?
- Efficiency – do the benefits exceed the costs?
- Equity – does the action adversely affect other areas or vulnerable groups?
- Flexibility – is it flexible and will it allow for adjustments and incremental implementation?
- Sustainability – does it contribute to sustainability objectives, and are they themselves sustainable?
- Practicability – can the action be implemented on relevant timescales?
- Legitimacy – is it politically and socially acceptable?
- Urgency – how soon could it be implemented?

- Costs – Are there social, economic and environmental costs?
- Robustness – is the option able to cope with a range of future climate projections?
- Coherence – does it help to achieve other objectives?
- Any other factors which your organisation regards as important

Among the agencies that may be considered to finance water sector development projects in the Caribbean are The World Bank, the Global Environment Facility, The Global Climate Change Alliance, The Adaptation Fund, The Pilot Program for Climate Resilience, The Green Climate Fund, The Caribbean Development Bank and the Inter-American Development Bank. An option being explored by the IDB in cooperation with the CDB is the need for Water Utility Companies to consider the need for an insurance facility as a cushion in times of disasters. It is a risk management approach under the climate resilience chapeau. The Caribbean Catastrophic Risk Facility (CCRIF) is the partner engaged with the IDB, the CDB and the Caribbean Water and Sewerage Association (CAWASA) whose main constituency is the Water Utility Companies, especially but not limited to the smaller countries of the OECS.

Conclusion

The water sector in the Caribbean requires urgent and comprehensive action to ensure that residents and visitors will be guaranteed a regular supply of fresh water for the foreseeable future. For a long time, the sector faced serious challenges as a result of watershed degradation, insufficient investments, weak supporting legislation, inadequate tariff regimes, poor information management, high levels of non-revenue water and the overall absence of integrated water resources management as a planning tool. These issues are now being compounded by the varied impacts of climate change on the water sector.

The regional strategic action plan for climate resilience in the water sector proposes a wide-ranging and multi-faceted approach to addressing the myriad challenges confronting the sector. The interventions proposed represent the broad consensus of the stakeholders in the sector. Not all of the actions are priorities for all of the countries (Annex 1). Some countries have addressed or are in the process of addressing a few of the issues that have been raised. However, there are many areas of commonality and many challenges that are unanimously accepted as critical and in need of immediate attention.

Two critical impediments that have repeatedly been identified by stakeholders are (i) access to financial resources and (ii) political recognition of the problems and willingness to resolve these problems. It is in recognition of the first impediment that this report was structured as an action plan that coalesces around five main streams of action. Several activities are identified under each stream, which assist with achieving the overall objective of a climate resilient, resource-efficient water sector that is able to meet the present and future needs of the Caribbean. The expectation is that these streams of action and related actions will be quickly converted into discrete project concepts that may be presented to development partners and funding instruments for financial and technical support. This is an imperative, because the required interventions are very critical and time-sensitive.

The projects that are developed from this regional strategic action plan should be both of a national and a regional scope. Attention must be paid to areas where capacity development at the regional level will help to achieve economies of scale or improve the durability of the intervention. Where several countries have similar needs, and there are several examples of this throughout this action plan, as can be seen clearly in Annex 1, there is wisdom in consolidating the projects into a multi-country intervention. Every effort should be made to develop local and regional capacity for the management of water resources in the Caribbean.

Although the regional strategic action plan was developed with a focus on building climate resilience, many of the interventions proposed would have been required in the absence of climate change impacts. Therefore, the efforts to mobilize financing for this action plan should not be confined to climate finance mechanisms. The regional strategic action plan would benefit best from a comprehensive resource mobilization architecture, which matches interventions with the mechanism or development partner best suited, through its mandate, to provide the requisite support.

The second impediment of political support must be overcome if water resources management is to be elevated to the place of prominence in national policy and decision making that it deserves. It is cliché to say 'water is life'. Some water utility companies actually use this phrase as their corporate slogan. However, it is an inescapable fact that every economic sector in the Caribbean depends on a reliable supply of water for its viability. It is also undeniable that a regular supply of fresh water is critical for the maintenance of social services in our region. And, no one can question the importance of water in maintaining the integrity and viability of our terrestrial and marine ecosystems. Therefore, there should be no argument that water is an important constituency for political focus and support. Interestingly, this has not been the practice in the Caribbean. Perhaps this is because most of the countries in the Caribbean experience a water deficit for only a limited period every year, and there is a certainty among national policy makers that the rains will always come. Moreover, the current modus operandi in most Caribbean countries revolves around governments holding on to water supply as a public service under direct government control. Despite the many successful examples in the electricity sector in the region, where corporatization has resulted in greater efficiencies and better service delivery, governments have been loathe to change the business model of the water utility companies.

Heads of Government and Cabinet Ministers are usually oblivious to the fact that groundwater recharge rates are decreasing, hydrological cycles are changing, and water sources are being contaminated by saline intrusion, agricultural activity, human activity and in some countries, industrial activity. Therefore, there is a need for a comprehensive and sustained information sharing process with policy makers at the highest levels of the public and the private sectors to sensitize them to the gravity of the situation facing the water sector, and by extension, the sectors, the communities and the countries for which they have responsibility. There has long been a call for a national champion for the water sector. However, it is the position of this report that the water sector in the Caribbean does not need a few national champions; it requires a country of champions, a region of champions. Everyone must see the efficient management of our water resources as their personal responsibility. Water is a limiting resource that will become even more limited with climate change, and to manage it effectively will require a national effort.

The water sector in the Caribbean, like many other sectors, is replete with reports that are the result of painstaking consultation and analysis, with well thought out recommendations that, if implemented, can help to bring the sector to a position of growth and viability. Unfortunately, many of these reports are united by one component – few of their recommendations have ever been implemented. Given the increasing urgency of the situation and the serious challenges caused by the environment and the period in which this regional strategic action plan for climate resilience in the water sector is developed, there is a sincere hope and expectation that the response to this report will be different. We do not have the luxury of time to act to protect our water resources and assure our residents of a reliable and safe supply of water.

Annex 1: Country Priorities

Components	Activities	ANG	ANB	BAH	BEL	BVI	CAY	DOM	GRN	GUY	JAM	MON	SKN	SLU	SVG	SUR	TNT
Component 1: Climate-resilient water governance																	
Sub- component 1.1: Develop or review climate mitigation and adaptation plans of action for the water sector	Activity 1.1.1: Develop or review climate mitigation plans of action for the water sector	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x
	Activity 1.1.2: Develop or review climate adaptation plans of action for the water sector	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x

Sub- component 1.2: Improve national and regional institutional and legislative frameworks	Activity 1.2.1: Development of national water policies in each Member State where these do not exist. Setting of targets to ensure that the objectives of the national water policy are met and the targets of Goal 6, Clean Water and Sanitation, of the 2030 Development Agenda are achieved.		x	x	x	x	x	x	x	x	x	x	x	x	x	x	
	Activity 1.2.2: Establish a national water resources agency in each Member State, with a mandate to protect and enhance the water environment and facilitate Integrated Water Resources Management (IWRM).			x				x	x	x	x		x		x	x	x

	Activity 1.2.3: Establish a mechanism for effective coordination between water management agencies and agencies responsible for policy formulation and programme implementation in climate change and disaster risk reduction.			x	x	x		x	x	x	x	x	x		x	x	x
	Activity 1.2.4: Development, review and modernization of legislation to facilitate the requisite institutional architecture and the pursuit of policies and programmes that will ensure sustainable management of water resources and pollution control.	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x

	Activity 1.2.5: Establish an independent national water utility regulator in each Member State, with a mandate to establish and monitor standards and benchmarks, protect consumer interests and set tariffs based on good economic practice.	x		x				x	x		x	x			x	x	
	Activity 1.2.6: Development of a mechanism to engage with private sector stakeholders to ensure their commitment to the actions necessary for the effective management of water and wastewater.	x	x	x	x	x		x	x	x	x	x		x	x	x	x
	Activity 1.2.7: Establish a sustainable regional coordinating mechanism for the water sector.	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x

Sub- component 1.3: Mainstream climate change policies in the water sector	Activity1.3.1: Incorporate climate resilience and disaster risk reduction policies and plans into sectoral and national development plans byimplementing the priority action areas and principles of the Sendai Framework for Disaster Risk Reduction.			x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
	Activity1.3.2 Establish a mechanism at the national level to ensure coherence and synergies between the national water sector plans and all other sectoral or national development plans or public sector investment programmes.		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x

Component 2: Climate-resilient water resources management																	
Sub-component 2.1: Comprehensively quantify water resources, including basin water budgets and supply-demand balances	Activity 2.1.1: Undertake a programme of surface and groundwater modelling to estimate water resource from different sources.	x		x	x	x			x	x	x	x	x	x	x	x	x
Sub-component 2.2: Development and adoption of an IWRM plan, with an appreciation of the need to address social and gender equity, economic efficiency and ecological sustainability	Activity 2.2.1: Develop a watershed management programme including a programme for restoration of forest cover and establishment of new forest cover where needed to help improve the integrity of watersheds and assist with slope stabilization.		x		x	x		x	x	x	x		x	x	x	x	x

	Activity 2.2.2: Reduction in the sources of pollution of water sources, through enactment, where necessary, and enforcement of legislation and rigorous public education.	x		x	x	x	x	x	x	x	x		x	x	x	x	
Component 3: Climate-informed decision support																	
Sub-component 3.1: Develop a National Water Decision Support System (DSS) for climate informed decision making that integrates environmental, social and economic data.	Activity 3.1.1: Develop data and information management protocols for the National DSS to set out the processes and procedures for data collection, storage, analysis and dissemination, archive and disposal within the DSS.	x	x	x		x		x	x	x		x	x	x	x	x	x

	Activity3.1.2: Establish a data centre to host the DSS and provide the computing capacity for big data analytics within the DSS. Develop the DSS architecture for storage, access and analysis of disaggregated data for all relevant stakeholders.			x		x		x	x	x			x	x		x	x
	Activity3.1.3: Develop monitoring system for data collection and integrate this within the DSS. Deploy instrumentation and equipment for data collection on sea level rise, the status of aquifers, streamflow, flood mapping and wastewater. Include collection of satellite data and LiDAR. This will provide an evidence base to determine the existing and	x		x	x	x			x	x		x	x	x	x	x	x

	potential future impacts of climate change on the water sector.																
	Activity 3.1.4: Develop accurate models to predict the impacts of extreme weather events and slow onset events including sea level rise on the water sector.	x		x	x	x		x	x	x		x	x	x	x	x	x
	Activity3.1.5: Analysis and interpretation of water data within the DSS to assess social, economic and environmental impacts on water resources, including impacts from climate, land use, demographics and economic development.	x		x		x		x	x	x		x	x	x	x	x	x

	Activity3.1.6: Development of national early warning systems (e.g. drought forecasting) that will facilitate forecasting of pending water-related crises.	x	x	x	x	x			x	x	x	x	x	x	x	x	x	x
	Activity 3.1.7: Training and capacity building for all relevant personnel in data entry, analysis and dissemination.	x	x	x	x	x		x	x	x		x	x	x	x	x	x	x
Sub-component 3.2: Establish a water resources management planning cycle for improving responsiveness to climate impacts	Activity3.2.1: Establish a periodic national water census to quantify and value water resources as part of the work programme of the national statistics department.	x		x	x	x		x	x	x		x		x	x	x	x	x

	Activity 3.2.2: Set standards and benchmarks to allow for accurate measurement of progress in relation to climate impacted variables (supply demand deficit, deployable output and comparison with international best practice. Set standards for reduction in demand.	x		x	x	x	x	x	x	x		x	x	x	x	x	x
	Activity 3.2.3: Institutionalize the production of an annual, national State of the Water Sector Report as a joint undertaking by the government, the regulator and the water utility company, to inform policy makers, water users and the water utility about where investments should be made to manage climate related risks		x	x	x	x		x	x	x		x	x	x	x	x	

Component 5: Building climate resilience in the provision of water services																	
Sub-component 5.1: Reduce water demand to adapt to climate related water scarcity	Activity 5.1.1: Reduction in the levels of non-revenue water (NRW), through programme to repair and replace damaged or aging infrastructure, metering of water supplies and Measures to reduce theft of water.	x	x		x	x	x	x	x	x	x	x	x	x	x	x	x
Sub-component 5.2: Optimize efficient use of water resources to adapt to climate related water scarcity	Activity5.1.2: Establish appropriate incentives that encourage water use efficiency or sanctions that penalize inefficient or unhelpful behaviour.		x	x		x	x	x	x	x	x		x	x	x	x	x

	Activity 5.2.1: Improve water storage infrastructure, both for untreated and treated water at the national level, municipal level and encouraging investments in increased water storage at the domestic and commercial levels.	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
	Activity 5.2.2: Effective management of wastewater, including its use as a resource in sectors such as tourism (landscape irrigation) and agriculture (irrigation and fertilizer).		x	x	x	x	x	x	x	x		x	x	x	x	x	x
	Activity 5.2.3: Retrofitting of water storage, treatment and distribution infrastructure to better withstand the impacts of climate change and extreme weather events.	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x

	Activity 5.2.4: Develop and implement contingency plans, including but not limited to desalination facilities that can be deployed in situations of acute water scarcity		x	x	x	x			x	x		x	x	x	x	x	x
Sub-component 5.3: Energy efficiency in water use	Activity 5.3.1: Reduce energy costs of the water utility by employing energy efficiency measures and by making use of cheaper renewable energy sources where possible.	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Component 6: Capacity building and public education for climate resilience																		
Sub-component 6.1: Regional learning and replication	Activity 6.1.1: Engagement activities between Caribbean islands and countries	x	x	x	x	x	x		x	x	x	x	x	x	x	x	x	x

Sub-component 6.2: Training and capacity building	Activity 6.2.1: Develop and execute a training programme, at the national and regional levels, to improve technical capacity in the government, the water utility and the private sector to understand and manage climate impacts on the water sector	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Sub-component 6.3: Public awareness campaign	Activity 6.3.1: Public awareness raising to promote and encourage action to adapt water use and wastewater management behaviours to climate variability and change	x		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x

Annex 2: Agencies Involved in the Management of Water Resources in the Caribbean

(Moss, 2015)

Country	Water Governance / Policy	Private Providers	Water Resource Regulators	Main Stakeholders
Anguilla	• The Water Corporation of Anguilla • The Water Department of the Ministry of Infrastructure, Communications, Utilities, • Housing, Agriculture and Fisheries	Agua Design	N/A	N/A
Antigua and Barbuda	• Antigua Public Utilities Authority (APUA) • Ministry of Health and Social Improvement	ENERSERVE (Viola Water Company)	N/A	• Ministry of Lands, Agriculture and Fisheries • The Development Control Authority • Ministry of Tourism
Bahamas	• The Water and Sewerage Corporation • The Ministry of Public Works • The Ministry of Environment and Housing • The Ministry of Agriculture and Marine Resources • Office of the Prime Minister	• Consolidated Water Co Ltd, Aqua Design and its subsidiaries • Farmers and Other Associations • Bahamas Agriculture and Industrial Corporation • Farmers Association of Exuma, Bahamas Livestock and Farmers Association	The Public Utilities Commission (PUC)	• Department of Physical Planning • Joint Water Quality and Pollution Control Unit

Country	Water Governance / Policy	Private Providers	Water Resource Regulators	Main Stakeholders
Barbados	• Barbados Water Authority • Ministry of Energy and Water Resources • Ministry of Health and Wellness • Ministry of the Environment and National Beautification • Coastal Zone Management Unit	Ionics Freshwater Ltd	Fair Trade Commission (pending legislation)	• Drainage Unit of the Ministry of Transport, Works and Maintenance • Town and Country • Development Planning Office of the Economic Affairs Division of the • Ministry of Finance and • Economic Affairs • Soils Conservation Unit (SCU) of the Ministry of Agriculture and Food Security • Coastal Zone Management Unit Development
Belize	• The Belize Water Services (BWS) Ltd. • Water Industry Amendment Act 2009, entitled *National Integrated Water Resources Act* (NIWRA)	CW Belize (subsidiary of Consolidated Water)	Public Utilities Commission of Belize	Water Resources Agency
British Virgin Islands	• Water and Sewerage Department • Ministry of Natural Resources and Labour • Ministry of Communications and Works • Town and Country Planning Department • Development Control Authority	• Aqua Design (BVI) Ltd. • Ocean Conversion (BVI) Ltd.	N/A	N/A

Country	Water Governance / Policy	Private Providers	Water Resource Regulators	Main Stakeholders
Cayman Islands	Water Authority Cayman (WAC)	Cayman Water (subsidiary of Consolidated Water Co)	N/A	N/A
Commonwealth of Dominica	• Dominica Water and Sewerage Authority • Ministry of Public Works, Water Resource Management and Ports • Ministry of Health and Social Services • Ministry of the Environment, Climate Resilience, Disaster Management and Urban Renewal	N/A	N/A	• Forestry and Wildlife Division of the Ministry of Agriculture, Food and Fisheries • Development and Planning Corporation • Pesticide Control Board • Physical Planning Division • Department of Land and Surveys • Local Government and • Community Department • Division • Dominica Port Authority
Grenada	• National Water and Sewerage Authority • Ministry of Works, Physical Development and Public Utilities • Ministry of Health • Ministry of Agriculture (Land Use Division Department of Forestry and National • Parks, Department of Fisheries Agriculture Extension • Land Development Control Authority in the Ministry of Finance	N/A	N/A	Meteorological Office in the Ministry of Finance

Country	Water Governance / Policy	Private Providers	Water Resource Regulators	Main Stakeholders
Guyana	• Guyana Water Inc (GWI) • Ministry of Housing and Water • Ministry of Agriculture • Ministry of Amerindian Affairs • Ministry of Health • Ministry of Local Government and Regional Development • Ministry of Public Works • Ministry of Natural Resources and the Environment	N/A	• Public Utilities Commission • Ministry of Natural Resources (2011): • HydroMet (responsible for licenses) and • East Demerara Conservancy	N/A
Jamaica	• National Water Commission (NWC) • National Irrigation Commission • Ministry of Health and the Environment • Ministry of Water and Housing • Rural Water Supply Ltd • Ministry of Agriculture • National Environment and Planning • Agency, Town Planning Department • Natural Resources Conservation Authority Land Development Utilization Commission Ministry of Transport and Works	N/A	Water Resources Authority Office of Utilities Regulation	• Office of Disaster Preparedness • National Meteorological Service • Planning Institute of Jamaica • Jamaica Conservation Development Trust • National Environmental Societies Trust • Negril Area Environmental Protection Trust • Parish Councils
Montserrat	• Montserrat Water Authority • Ministry of Agriculture Land Housing and the Environment • Physical Planning Unit	N/A	N/A	N/A

Country	Water Governance / Policy	Private Providers	Water Resource Regulators	Main Stakeholders
St. Kitts and Nevis	• Ministry of Communication, Works, Public Utilities, Post, Natural Resources and Environment • Water Department • Public Health Department • Physical Planning Unit Department of the Environment	N/A	N/A	N/A
Saint Lucia	• Water and Sewerage Company • Ministry of Agriculture, Fisheries, Physical Planning, Natural Resources and Cooperatives • Development Control Authority • Ministry of Health	N/A	•National Utilities Regulatory Commission •Water Resources Management Agency (WRMA)	• National Conservation Authority • Water Catchment Groups
St. Vincent and the Grenadines	• Central Water and Sewerage Authority • Ministry of Health and the Environment • Ministry of Agriculture, Forestry and Fisheries	N/A	N/A	Ministry of Finance
Trinidad and Tobago	• Water and Sewerage Authority • Ministry of Public Utilities • Drainage Division of the Ministry of Works and Transport • Forestry Division, Ministry of Agriculture, Land and Fisheries • Tobago House of Assembly	DesalCott (Desalination Company of Trinidad and Tobago)	• Regulated Industries Commission Water Resources Agency (WRA) is under the Ministry of Water and the Environment, but is a Department of the Utility.	• Town and Country Planning Division, Ministry of Housing • Environmental Management Agency • Institute of Marine Affairs • Central Statistical Office • Meteorological Services • Tourism and Industrial Development • National Emergency Management Agency

Country	Water Governance / Policy	Private Providers	Water Resource Regulators	Main Stakeholders
Turks and Caicos	• Water and Sewerage Board • Public Works Department • Department of Health • Department of Engineering and Maintenance Services • Department of Planning	Provo Water Company Ltd.	N/A	N/A

Annex 3: Water Regulatory Agencies in the Caribbean (Moss, 2015)

Country	Regulatory Agency
Guyana	The Public Utilities Commission (PUC) was established under PUC Act 25.01 to regulate water and sewerage services, telecommunications and electricity.
Jamaica	The Office of Utilities Regulation (OUR) was established by an Act of Parliament (1995) to regulate the provision of utility services, including electricity, telecommunications, water and sewerage, and public passenger transport by road, rail and ferry.
Bahamas	The Public Utilities Commission (PUC) was established by an Act of Parliament (2000) to regulate rates and standards for public utilities.
Belize	The Public Utilities Commission (PUC) of Belize became the regulator of the water sector in September 2000
Trinidad and Tobago	The Regulated Industries Commission (RIC) is the economic regulator for the Water and Sewerage Authority and the Trinidad and Tobago Electricity Commission. The RIC was established by the RIC Act of 26 of 1998 (Chapter 54:73).
Saint Lucia	The National Utilities Regulatory Commission (NURC) is a multi-sector independent regulatory body, established by the National Utilities Regulatory Commission Act No. 3 of 2016, with a mandate to regulate water supply and sewerage services.
Barbados	The Fair Trading Commission was established in January 2001 (Cap 326B) to regulate utility services supplied by service providers. Its Utility Regulation Department regulates the Barbados Water Authority.

Annex 4: Ongoing Interventions in the Water Sector

Several countries in the Caribbean have already embarked on interventions aimed at addressing some of the challenges that were identified in the previous section. These initiatives may be broadly categorized as (i) governance related, (ii) water supply and availability related, and (iii) climate resilience related. As can be expected, some interventions are cross-cutting in nature and address issues across these three main categories.

While by no means exhaustive, as there are several countries for which information is not available, the following listing provides general information on the nature of the interventions currently being undertaken in the water sector in Caribbean countries.

COUNTRY NAME: Anguilla				
Thematic Area	**Programme Name**	**Description of Intervention**	**Duration of Programme**	**Required Follow-Up Actions not Covered by Programme**
Governance	There is no definitive name for this process	The introduction and subsequent revision of the wells and water act; 1998; serves to regulate and abstraction of ground water by the Government of Anguilla. Its purpose is to regulate quantity and quality of water removed from underlying aquifers as well as proximity to “prime” abstraction locations.	There is no definitive timeline for this process	

Water Availability		Initiatives such as rain water harvesting have been a part of Anguillan culture for generations and do not have to be promoted by the government. Approximately 95% of homes in Anguilla have water storage capacities of over 10,000 ImpG. Potable water is also available to 100% of the island however many persons elect not to utilize it and opt to be fully dependent on rain water harvesting. Due to the culture of being water cautious this is a reality for a vast number of Anguillan homes.		
Climate Resilience & Disaster Risk Reduction		Anguilla is distinctly different to other Caribbean islands with regards to climate resilience and DRR as it relates to the water sector, as Anguilla has always been a water scarce island. Due to the lack of surface water, the WCA produces from two source SWRO and BWRO therefore initiatives to fortify against disasters include sourcing back up power for plants and increasing the number of underground distribution lines		

COUNTRY NAME:	**Belize**			
Thematic Area	**Programme Name**	**Description of Intervention**	**Duration of Programme**	**Required Follow-Up Actions not Covered by Programme**
Governance	Codes of Practice	Revising of the Codes of Practice with Regulator	On-going	All follow-up actions are covered by the programme
Water Availability	National Integrated Water Resource Authority (NIWRA)	Responsible for all aspects of water resource management including water allocation, water quality, water conservation and public awareness	On-going	Enforcement
Climate Resilience & Disaster Risk Reduction	Projects (5C's) Enterprise Risk Management	Climate resilience in Energy Sector (solar and wind), Water Sector (allocation, conservation and quality) Identification of all risks and placing priority of highest risks elimination or reduction	On-going On-going	Expansion to all facilities None

COUNTRY NAME: Cayman Islands				
Thematic Area	**Programme Name**	**Description of Intervention**	**Duration of Programme**	**Required follow-up Actions not Covered by Programme**
Governance	June 2017: Adopted legislation to establish OfReg – Utility Regulation and Competition Office	Independent economic regulator for water and wastewater sector	Ongoing - OfReg is becoming operational as economic regulator	Not determined
Water Availability	Water Authority (Government owned) and Cayman Water Company (privately owned) are the water utilities. Water source is desalinated water, piped water supply infrastructure covers majority of Cayman Islands	Both utilities are not dependent on Government funding. Providing piped water supply to most of the Cayman Islands has been materialized over last 30 years. Ongoing expansion in more remote areas	Ongoing - Both utilities will transition to regulatory framework of OfReg	Not determined
Climate Resilience & Disaster Risk Reduction	Climate Change: Draft Climate Change Policy completed in 2011. Policy has not been adopted. National Energy Policy updated and adopted in 2017	Climate Change: No driver for Climate Change Policy. OfReg is the driver of the National Energy Policy	Climate Change: No specific programme to implement Climate Change policy Implementation of National	Climate Change: Need for national driver for Climate Change Policy

	Disaster Risk Reduction: Hazard Management Cayman Islands (HMCI) developed in 2007 in the wake of hurricane Ivan.	Disaster Risk Reduction: HMCI is the dedicated agency to coordinate and manage hazards	Energy Policy is ongoing Disaster Risk Reduction: Ongoing	Disaster Risk Reduction: Not determined

COUNTRY NAME:	Commonwealth of Dominica			
Thematic Area	**Programme Name**	**Description of Intervention**	**Duration of Programme**	**Required Follow-Up Actions not Covered by Programme**
Governance	Development of Water Safety Plan (WSP) supported by CARPHA	Development of a WSP for the Water Area 1 (WA-1), the largest WA on island serving about 33% of total demand. The purpose is to develop protocols for the collaborative management of water resources within WA-1 "From Catchment to Cup"	Jun 2016 – Jun 2018	Roll-out of WSP's for all Water Areas (WA's) on island using format and lessons learned from the WA-1 WSP development
	Hydro-met Project (in collaboration with the World Bank-funded DVRP Project)	Installation of Hydro-met stations at select locations to gather continuous rainfall, stream flow and other data to inform decision-making as well as infrastructure design	Jun 2017 – Jun 2018	Installation of country-wide Hydro-met stations for island-wide coverage Development of hydrological models for the entire island with precipitation data (together with input from other

	Implementation of National Water System Development Plan	Increase of potable water service coverage to 100%, water quality improvement and service reliability, integration of water systems/redundancy, improvement of management and operational efficiency, exploration of alternative water sources, bulk water export	2009 - ongoing	interventions under DVRP and other source including soils survey, LiDAR mapping, land use / land cover data) Development of complete water resources inventory (surface and ground) Hydro-met and hydrological training Revision and adoption of draft IWRM policy prepared in 2011 Development of National Master Plan for the management of potable water and sewerage services and the management of the water resources for the Commonwealth of Dominica
Water Availability	Third Water Supply Project: Water Area 1 Network Upgrade (funded by the Government of the Commonwealth of Dominica, CDB and IDB)	Institutional capacity building through Water Audit and Cost of Service and Tariff (CSTS) Study T/A consultancies, and upgrade of laboratory facilities, construction of new water intake and transmission pipeline, improvement and expansion of water treatment facilities, and increase to treated water storage	Feb 2013 – Dec 2018	Implementation of the Non-Revenue Water (NRW) Reduction Action Plan prepared during the Water Audit assignment Roll-out of the tariff review recommendations developed as part of the CSTS assignment

	West Coast Storage Tanks Project (funded by the World Bank / Climate Investments Fund)	Construction of water storage tanks to augment capacity for 9 communities on the West Coast of Dominica	Mar 2017 – Mar 2018	Rehabilitation / augmentation of the source of water for the West Coast due to impact of Hurricane Maria
Climate Resilience & Disaster Risk Reduction	Third Water Supply Project: Water Area 1 Network Upgrade (funded by the Government of the Commonwealth of Dominica, CDB and IDB)	Improvement to climate resilience of the water supply infrastructure within WA-1 through improvement to design and construction methodology of new infrastructure, relative to vulnerable existing infrastructure	Feb 2013 – Dec 2018	Review of designs of infrastructure in other WA's as well as the abstraction and transmission solutions/options in general
	Strategic Climate Vulnerability Assessment (funded under the ACP-EU EPA)	Conduct of a Strategic Climate Vulnerability Assessment (SCVA) of the DOWASCO institutional operations and infrastructure to establish register or relevant risks, determine exposure to those risks and to develop an action plan to mitigate vulnerabilities	Jan 2018 – Jul 2018	Organizational restructuring and Engineering works that may be deemed necessary arising from the assignment

COUNTRY NAME:	Jamaica			
Thematic Area	**Programme Name**	**Description of Intervention**	**Duration of Programme**	**Required Follow-Up Actions not Covered by Programme**
Governance	Improvements in Corporatization & Institutional Strengthening, and Tariff Study	Develop an appropriate Corporate Governance Framework and Business Model for NWC to facilitate significantly improved performance and to engender greater private sector confidence to partner with the utility in PPP arrangements and prepare action plan to achieve this Approval of 2018 Water Sector Policy by Cabinet and Parliament Update of the Water Resources Development Master	April 2018 to March 2019	Implementation of the agreed actions that arise from the recommendations of the study.
Water Availability	Rio Cobre basin water resource study	The main objective of this assignment is to identify a solution that enables the mutually beneficial use of the Rio Cobre basin for potable water use and irrigation use. Activities aimed at addressing some of the institutional weaknesses, including policy formulation, data data gathering and processing capabilities, and low capacity for implementing and enforcing policies that support a more integrated Water Resources Management (IWRM)	June 2017 to March 2018 April 2015 to December 2019	

Climate Resilience & Disaster Risk Reduction	1) Integrated Management of the Yallahs-Hope Watershed Management Area Project	a) Building capacity to design & install water adaptation measures b) Demonstrating the business case for water efficiency for developers and construction companies and the financial case for water adaptation in households c) Supporting a climate resilience entrepreneurship program d) Raising awareness of the threats of climate change and the related opportunities presented by businesses, financial institutions, civil society and the Government of Jamaica	March 2017 to February 2021	Expansion of the area of the Yallahs-Hope watershed that will benefit from the implementation of actions identified as needed for this watershed

COUNTRY NAME:	Saint Lucia			
Thematic Area	**Programme Name**	**Description of Intervention**	**Duration of Programme**	**Required Follow-Up Actions not Covered by Programme**
Governance				
Water Availability				
Climate Resilience & Disaster Risk Reduction	Disaster Reduction and Vulnerability Project John Compton Dam Rehabilitation Project	Feasibility Study and Detailed Design for Development of the Millet Intake within the John Compton Dam Raw Supply - ongoing; De-silting of John Compton Dam	2.5 years 2 years	Monitoring Equipment; Non-Revenue Water Reduction Programme, including replacement and upgrading of Raw Water and transmission lines supplying the North of Saint Lucia Dam monitoring equipment

COUNTRY NAME:	**Saint Vincent and the Grenadines**			
Thematic Area	**Programme Name**	**Description of Intervention**	**Duration of Programme**	**Required Follow-Up Actions not Covered by Programme**
Governance	Not Available			
Water Availability	Adapting to the Effects of Drought Through Increasing Water Storage Capacity to Address Climate Change on Mayreau	• The purchase of fifty water tanks with a capacity of 1,000- gallons each for a total increased volume of 50,000 gallons; • Repair of the 10,000-gallon cistern located at Mayreau Primary School; • The establishment of a tank farm of ten, 1000-gallon tanks at the site of the communal CWSA cistern; Capacity building activities for the 150 residents, including female headed households to equip them with hands-on knowledge of the maintenance and operation of water storage tanks to ensure high quality water and conservation techniques.	10 Months	Sanitary surveys will be instrumental once these systems are installed and rehabilitated to ensure a suitable water quality. However, there are no provisions made under this programme to address this. It is important to note that the Central Water and Sewerage Authority is a statutory body that owns and maintains water supply infrastructure on St. Vincent only. Therefore, the Grenadines falls outside of its water supply purview.

Climate Resilience & Disaster Risk Reduction	Improving access to climate resilient water services in a vulnerable community, Sandy Bay project	To improve the reliability of water supplies, both in terms of quality and quantity for the residents of Sandy Bay (inclusive of Sandy Bay, Sion Hill and Overland). To improve the management and reverse degradation in the Sandy Bay watershed to maintain sustainable water supply quality and quantity and ecosystems services. To reduce the risks to the community posed by natural disasters by improving disaster risk management for the water supply and the community. To share the knowledge and lessons generated from the project and to identify opportunities for upscaling and/or replicating project components in SVG and across the wider Caribbean region.	18 months	Component 2 of the project aims to improve the sustainable management of watershed, the local ecosystem and livelihood opportunities. These will be implemented by the Forestry Department. However, there are no immediate provisions in place to continue this process at the end of the project cycle.

COUNTRY NAME:	**Trinidad and Tobago**			
Thematic Area	**Programme Name**	**Description of Intervention**	**Duration of Programme**	**Required Follow-Up Actions not Covered by Programme**
Governance	Corporate Governance Services for the Multi-Phase Wastewater Rehabilitation Programme	Institutional strengthening of the Water and Sewerage Authority through the improvement of its Corporate Governance.	3 years (end February 2018)	1. Government approval for implementing the new "Corporate Governance" model. 2. Revision of the Water and Sewerage Act and Regulated Industries Commission Act 3. Implementation of Roadmap
Water Availability	Adoption and Implementation of Integrated Water Resources Management (IWRM)	1. Updated National IWRM Policy	1 year	Cabinet approval
		2. Creation of a separate independent entity to manage water resources.	4 years (end September 2020)	Parliamentary approval
		3. Development of a Dry Season and Drought Management Plan.	2 years (end September 2018)	Implementation
		4. Development of a Water Security Programme for Tobago	2 years (end September 2018)	Implementation
Climate Resilience & Disaster Risk Reduction	Development of a Water Security Programme for Tobago	Development of a Water Security Framework and Action Plan	2 years (end September 2018)	Implementation for Tobago. No Plan being established for Trinidad.

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