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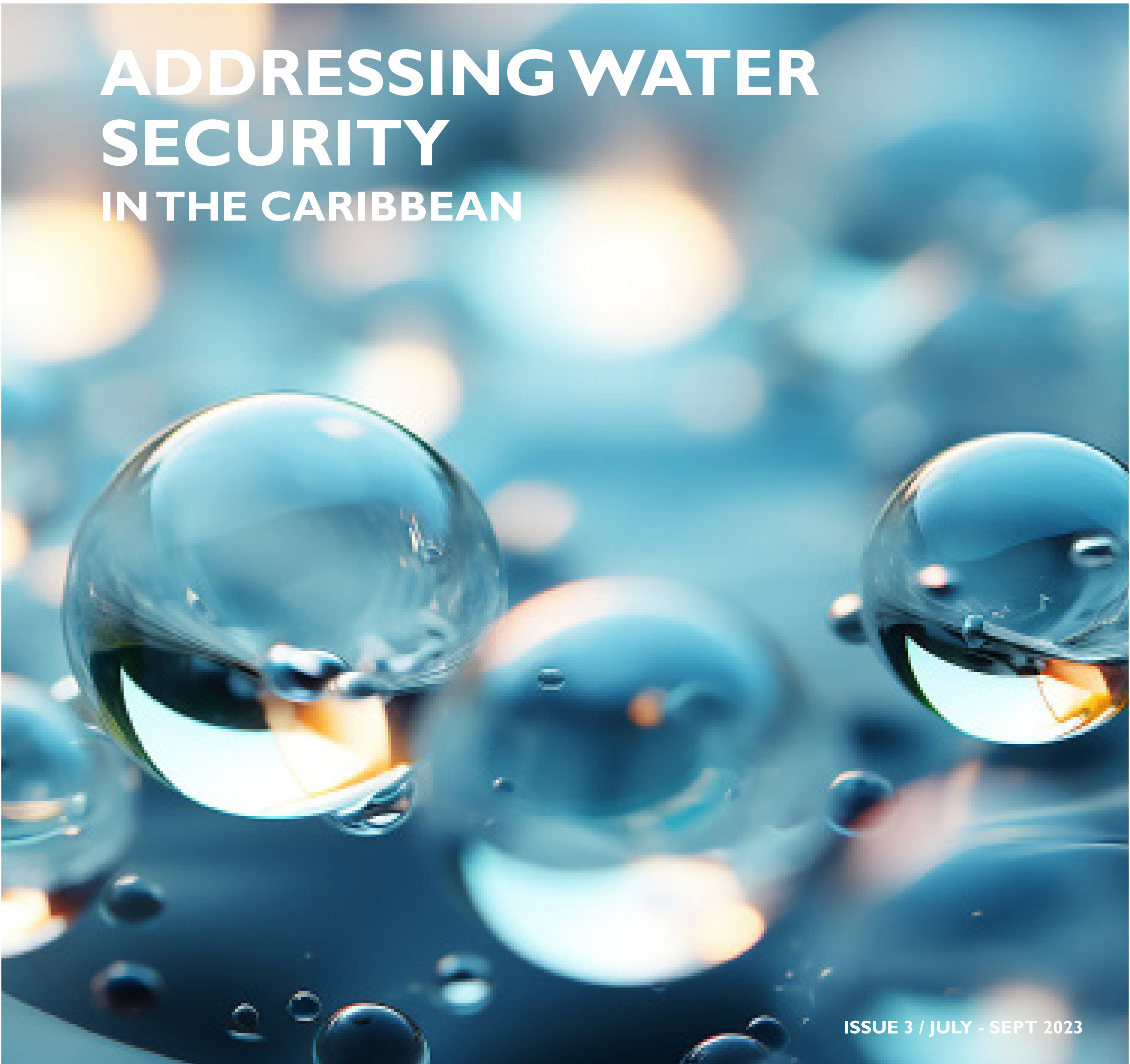
FOCUS

Magazine of the Caribbean Development and Cooperation Committee (CDCC)

ADDRESSING WATER SECURITY
IN THE CARIBBEAN



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ABOUT ECLAC and the CDCC

The Economic Commission for Latin America and the Caribbean (ECLAC) is one of five regional commissions of the United Nations Economic and Social Council (ECOSOC). It was established in 1948 to support Latin American governments in the economic and social development of that region. Subsequently, in 1966, the Commission (ECLA, at that time) established the subregional headquarters for the Caribbean in Port of Spain to serve all countries of the insular Caribbean, as well as Belize, Guyana and Suriname, making it the largest United Nations body in the subregion.

At its sixteenth session in 1975, the Commission agreed to create the Caribbean Development and Cooperation Committee (CDCC) as a permanent subsidiary body, which would function within the ECLA structure to promote development cooperation among Caribbean countries. Secretariat services to the CDCC would be provided by the subregional headquarters for the Caribbean. Nine years later, the Commission's widened role was officially acknowledged when the Economic Commission for Latin America (ECLA) modified its title to the Economic Commission for Latin America and the Caribbean (ECLAC).

Key Areas of Activity

The ECLAC subregional headquarters for the Caribbean (ECLAC/CDCC secretariat) functions as a subregional think-tank and facilitates increased contact and cooperation among its membership. Complementing the ECLAC/CDCC work programme framework, are the broader directives issued by the United Nations General Assembly when in session, which constitute the Organisation's mandate. At present, the overarching articulation of this mandate is the United Nations Sustainable Development Goals.

Towards meeting these objectives, the Secretariat conducts research; provides technical advice to governments upon request; organizes intergovernmental and expert group meetings; helps to formulate and articulate a regional perspective within global forums; and introduces global concerns at the regional and subregional levels.

Areas of specialization include trade, statistics, social development, science and technology, and sustainable development, while actual operational activities extend to economic and development planning, demography, economic surveys, assessment of the socio-economic impacts of natural disasters, climate change, data collection and analysis, training, and assistance with the management of national economies.

The ECLAC subregional headquarters for the Caribbean also functions as the Secretariat for coordinating the implementation of the Programme of Action for the Sustainable Development of Small Island Developing States. The scope of ECLAC/CDCC activities is documented in the wide range of publications produced by the subregional headquarters in Port of Spain.

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CONTENTS

FOCUS: ECLAC in the Caribbean is a publication of the Economic Commission for Latin America and the Caribbean (ECLAC) subregional headquarters for the Caribbean/Caribbean Development and Cooperation Committee (CDCC).

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ADDRESSING WATER SECURITY IN THE CARIBBEAN SUBREGION

As the impacts of climate change continue to be felt globally, there is increasing recognition of the central role of water as a critical resource for securing the long-term development needs of the Caribbean. Indeed, the primacy of water in the development discourse is seen in the United Nations' identification of water as a specific Sustainable Development Goal (SDG's) - Goal 6 - which seeks to "ensure access to water and sanitation for all".

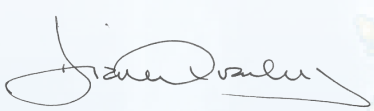
Although water is well recognized as critical for the sustenance of life, other aspects relating to its role in supporting a sustainable economy and society are not always apparent. According to UN Water (2021), failure to achieve Goal 6, would put at risk several other SDGs related to 'poverty reduction, food and nutrition, and the environment' among others. Moreover, the recent pandemic, alongside increasing frequencies of droughts, wildfires and extreme flooding events, point to the important role that sustainably managed water resources could play in the wellbeing of people.

One of the key challenges in implementing sustainable water management policies is addressing the gap between limited water resources and innumerable human needs. UN Water estimates that currently, more than 2 billion people live in areas with water stress, while as much as 45% of the global population do not have access to safe and adequately managed sanitation facilities. More alarming is the projection that by 2030, the world would likely face a global water deficit approaching 40%, aggravated by the threat of climate change, and the anticipation of future health pandemics.

In the Caribbean, there is evidence of many of these dynamics at work. Although the subregion is not naturally water scarce, given that it receives between 1,500 – 4,000mm of rainfall annually, it still grapples with many management issues which pose challenges for sustainability over the medium to long-term.

In this issue, we seek to highlight some of these matters. We first outline current multilateral initiatives related to the issue of sustainable water and explore how water pollution could likely affect costs of water harnessing and distribution. The issue of water pricing among small water utilities is also explored, as well as implications for integrated water resource management (IWRM) within the current urbanization dynamic of Caribbean SIDS. It is my hope that the issues raised would stimulate further discussion among the subregion's policy makers, and provide a basis for solutions which address the critical role of water in the sustainable development of our subregion.

Yours in focus,



6 CLEAN WATER AND SANITATION

WATER FOR SUSTAINABLE DEVELOPMENT

Artie Dubrie, Coordinator - Sustainable Development and Disaster Unit

"As humanity's most precious global common good, water unites us all. That is why water needs to be at the centre of the global political agenda" United Nations Secretary-General António Guterres, 2023.[1]

The United Nations General Assembly declared 2018-2028 the International Decade for Action "Water for Sustainable Development" to accelerate efforts towards meeting water-related challenges.[2] This UN resolution encouraged accelerated integration of the management of water resources with the social, economic and environmental development objectives. In 2019, the United Nations General Assembly resolution 73/226[3] [4] mandated the convening of a conference (UN 2023 Water Conference) to undertake a comprehensive midterm review of this International Decade for Action. This UN conference on water was held in New York from 22 to 24 March 2023. Its summary proceedings will be presented to the SDG Summit during the High Level Segment of the UN General Assembly in September this year.[5]

The UN 2023 Water Conference assessed the progress, identified challenges, and agreed on actions to meet the decade's Water for Sustainable Development objectives. It considered the status of implementation of the objectives articulated and identified best practices and challenges for achieving the Sustainable Development Goal 6 (SDG 6) targets of the 2030 Agenda. The concluding recommendations reiterated the fact that this goal is a required lever in all dimensions of sustainable development.

This article advocates that the sustainable management of water resources is essential to the achievement of all other development priorities. Based on available data, the article presents and analyses the implementation status of SDG 6 for the Caribbean Small Island Developing States (SIDS). It lists the outcomes of the UN 2023 Water Conference and makes recommendations for the SIDS.

WATER RESOURCES MANAGEMENT IN THE CARIBBEAN SIDS

The sustainable management of water resources, including access to safe fresh water and sanitation, is indispensable for human health and well-being. It is a key driver of economic and social development, and in maintaining a healthy natural environment and productive ecosystems. Meeting current and future demands calls for effective governance, including integrated management of water resources across all dimensions of sustainable development.

Caribbean countries, through the SIDS-Accelerated Modalities of Action (SAMOA Pathway)[6], recognized numerous challenges concerning the sustainable management of freshwater resources. SIDS depend on rainfall as their primary source of freshwater. This is obtained from direct rain, surface and groundwater systems. The quality and volume of available freshwater are affected by factors such as high pollution load, overexploitation of surface, ground and coastal waters, salination of groundwater, drought and water scarcity, soil erosion, and the lack of access to effective sewerage systems. Other factors, including the demands of urbanization growth and tourism and agriculture industries, further impact freshwater availability. Furthermore, changes in rainfall patterns related to climate change significantly impact water supply.

Caribbean SIDS are therefore at high risk for water stress and scarcity). Seven countries are listed as having "extremely high" levels of water stress: Antigua and Barbuda, Barbados, Dominica, Jamaica, Saint Lucia (SLU), Saint Vincent and the Grenadines (SVG) and Trinidad and Tobago (TTO). Barbados, Saint Kitts and Nevis, SLU, SVG and TTO are also designated as water scarce (OHRLLS 2015).

[1] UN Secretary-General's closing remarks at the United Nations Water Conference, link: https://www.un.org/sg/en/content/sg/speeches/2023-03-24/secretary-generals-closing-remarks-the-united-nations-water-conference, cited July 1, 2023.
[2] See UNGA A/RES/71/222
[3] See UNGA A/RES/73/226
[4] A/RES/75.212: United Nations Conference on the Midterm Comprehensive Review of the Implementation of the Objectives of the International Decade for Action, "Water for Sustainable Development", 2018–2028.
[5] 2023 SDG Summit, see link at: https://www.un.org/en/conferences/SDGSummit2023, cited July 16, 2023
[6] The goal of SDG 6 is to ensure the availability and sustainable management of water and sanitation for all by 2030.

Figure 1: SDG 6: Ensure availability and sustainable management of water and sanitation for all

Reference: Goal 6: Clean Water and Sanitation, cited July 10, 2023

STATUS OF ACHIEVING THE TARGETS OF SDG 6

The 2030 Agenda for Sustainable Development asserts that water and sanitation are at the core of sustainable development (UN DESA, 2021). SDG 6 of the 2023 Agenda aims to ensure the availability and sustainable management of water and sanitation for all.

The targets of SDG 6 address water availability, access and use; water quality and affordability; ecosystem and anthropogenic influences, and their sustainable development linkages. This is illustrated in Figure 1.

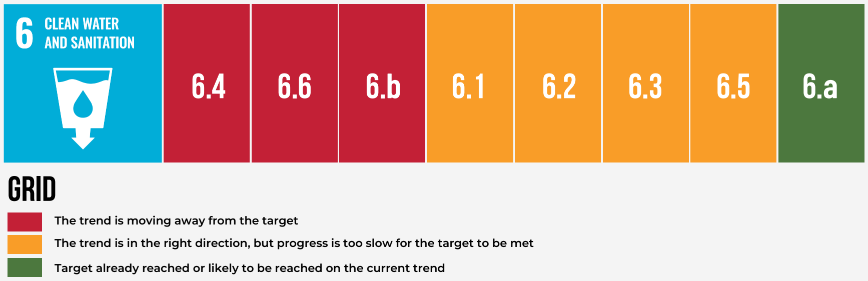
Based on the 2018 data assessment, UN-Water concluded that the world is not on track to achieve the SDG 6 targets of the 2030 Agenda on Sustainable Development by 2030 (UN Water 2018). The analysis of available data for Latin America and the Caribbean (LAC) supports that this region is not on course to achieve SDG 6 (ECLAC 2023). This is illustrated in Figure 2 following.

With specific reference to SDG indicator 6.5.1[7]," Degree of integrated water resources management implementation", the UN SDG 6 Synthesis Report 2018 on water and sanitation noted that of 172 countries surveyed, 80 per cent have a medium-to-low implementation of IWRM, and noted that 60 per cent of countries are unlikely to reach the target of full implementation by 2030 (UN-Water, 2018). This similar trend is also demonstrated in the case of the Caribbean SIDS, and based on 2017 and 2020 data, only Cuba was reported as having high implementation rates for this same period.

Table 1 provides the status of the implementation of SDG 6.5.1[7] for Caribbean SIDS and for the reporting years 2017 and 2020.

▸ (continued on page 12)

Figure 2: Latin America and the Caribbean: Goal 6 targets by likelihood of achieving the defined threshold by 2030.



Source: Economic Commission for Latin America and the Caribbean (ECLAC), 2023

[7] SDG 6.5.1 tracks the degree of integrated water resources management.

WATER POLLUTION AND THE ECONOMY

Elizabeth Thorne and Laverne Walker

Many of us have heard the phrase – water is life. Yet, how many of us have stopped to consider what this really entails. Water is critical to supporting the socio-economic development of countries. More specifically water is necessary for food production, sanitation, industry, energy production, healthy ecosystems and for human survival itself.

Many of us have heard the phrase – water is life. Yet, how many of us have stopped to consider what this really entails. Water is critical to supporting the socio-economic development of healthy societies. More specifically, water is necessary for food production, sanitation, industry, energy production, healthy ecosystems and for human survival itself.

Despite this importance, water quality is under continued threat from pollutants. There are primarily two sources of water: surface water[1] and groundwater[2] and both are prone to contamination from economic and social development activities (Tientenberg and Lewis, 2016). Groundwater has been found to be even more susceptible to contamination from chemicals that leach into soil and rocks, thereby finding their way into this natural resource. Water pollution is a major problem world-wide. It affects drinking water, rivers, lakes and oceans and impacts human health and wellbeing as well as the state of the natural environment (Khatun 2017). Pollutants entering water systems are often described as point or non-point sources of pollutants. Point sources of pollutants are often identified through a single source of pollution, such as a pipe or a drain. Industrial waste is commonly discharged into rivers and the sea in this way. Non-point pollutants usually enter a system or the environment through a wide area and are usually not attributed to a single source.

Sources of non-point pollutants can be from urban land-use, agricultural land-use and are often more difficult to manage than point sources of pollution. Nonpoint sources of pollution are typically associated with a number of activities. These include: (1) agricultural activities such as the use of fertilizers, pesticides, and improper management of animal waste; (2) sewage; (3) natural events such as hurricanes, earthquakes and volcanic eruptions which can result in

Source: https://www.ozmo.io/water-pollution-the-devastating-impact-of-personal-habits/

water pollution through sedimentation and ash fall; (4) mining; and (5) urbanization (Madhav et al, 2019).

Economic growth and water pollution are intrinsically linked, as most forms of production generate waste as a by-product, which could affect economic stakeholders. In the case of a river system for example, waste generated from economic activities upstream may impact negatively on downstream users. Eliminating water pollution is often prohibitively costly in many instances, and as such, it is important that regulators and policy makers make decisions about an appropriate level of water pollution. In strictly economic terms, this means weighing the benefits from the polluting activity against the social costs of pollution (Desbureaux et al, 2019).

WATER POLLUTION IN THE ECOSYSTEM AND ECONOMY

The environment is considered an asset providing ecosystem goods and services such as air, food, protection (either directly or indirectly) and benefits including biodiversity, fresh air, wetlands, good water quality, carbon sequestration, and recreation.

These ecosystem goods and services are transformed into consumable products through the process of production and consumption, inevitably generating waste in the process. But these assets can depreciate due to pollutants. The volume of waste or pollutants defines the load that enters the environment, and the extent of the damage to the environment is dependent on both the load and the environment's ability to assimilate these substances. This is the environment's absorptive capacity. In the event the load is greater than the environment's absorptive capacity, the pollutants[3] will accumulate in the environment causing serious damage. The nature of the pollutants will also determine the appropriate strategy for redress. The threat to water quality can be abated through the implementation of strategies to treat wastewater and alleviate its negative impact on the environment. Such abatement strategies also give rise to higher economic costs for the production and consumption of goods and services.

MODELS FOR MEASURING THE ECONOMIC IMPACTS OF WATER POLLUTION

Costing environmental impacts calls for more accountability regarding the disposal of waste, and several companies are seeking sustainable ways to operate within this context. The Caribbean, like other SIDS, struggle with managing water pollution, due to several challenges including, but not limited to financial constraints; inadequate regulatory frameworks;

fragmented responsibility for wastewater management; limited technical and operational expertise and a lack of awareness of alternative low-cost treatment technologies. Considering these challenges, the examination of the following two models

[1] Surface water includes rivers, lakes and oceans.
[2] Groundwater is that body of water found beneath the earth's surface in rocks and other geological formations.
[3] There are two types of pollution - fund and stock pollutants. Fund pollutants are those that the environment has some level of absorptive capacity these include biodegradable materials. Conversely, stock pollutants are those for which the environment does not have absorptive capacity, resulting in their accumulation in the environment.

is discussed from the perspective of water pollution management. Although the full adoption of these methodologies is not expected, it is considered that these different approaches defined under these models, offer prospects for transferability to the Caribbean subregion. The first by Durán and Durán (2018) seeks to track and accurately cost the related production activities to the specific types of waste that these generate. The second proposed by Zeng et al (2020) uses dynamic simulations to track real water environment systems which facilitates the identification of the most cost-effective option weighing the economic cost and water quality in managing water pollution. Currently, there is an increasing demand for companies to become more attentive to creating environmentally sensitive products. While accurately costing environmental impact can be tricky, it is critical to developing and implementing the most strategic and cost-effective approaches for mitigating water pollution.

The Durán and Durán study utilized a Fuzzy ABC model[4] which ascribes or tracks the cost of specific activities in a production system and its specific waste. This approach presents an alternative methodology to cost allocation related to wastewater management. This study highlights the application of the Fuzzy ABC model in which the wastewater produced by a firm from its surface water treatment was reused as part of its recovery process creating a closed loop. The model allowed the costing of the surface water treatment, and other treatments allocated to each activity and its waste, resulting in waste that was less harmful to the environment.

The model by Zeng et al (2020) developed an integrated hydrodynamic-water based, multi-response surface method (HWWQS-MRSM) which provided decision makers with the information to determine the optimal combination of measures that can be explored to improve the overall quality of water. This study incorporated the cost-effective analysis (CEA) and simulation models which analyse the main effects and interaction of factors involved in water quality mitigation measures. These results were fed into the simulation to reveal the optimal and most cost-effective combination of measures needed to improve urban water quality. This model weighs the economic cost and water quality goals (e.g. SDGs targets or national targets).

Apart from these models, there have also been innovative initiatives undertaken in the subregion to address water pollution. One such example is the Global Environment Facility-funded Integrating Watershed and Coastal Areas Management (GEF-IWCAM) Project - Case study of Saint Lucia Demonstration Project which applied the Wastewater Wetland Filtration Systems (WWFS) model to cleanse domestic "black water" at the community level. Mimicking natural processes involved in cleansing water, rendering the "black" water safer for release into the environment. The model was also applied to a community fish plant in Tobago to treat its wastewater. Although there were problems that arose in this case there is great potential for raising this to the national level across the subregion.

Perhaps the ideology of the first two models could inform the development of cost-effective water pollution management strategies and even assist in expanding the WWFS model. The Durán and Durán Fuzzy ABC model focused on containing waste through treatment and reuse of its wastewater and the remaining sludge to reduce the environmental impact. The Zeng et al model, on the other hand, identified and tracked specific waste streams to particular activities, allowing a more accurate costing of each production activity, which could then guide decision makers to the most cost-effective water pollution management strategy, thereby enhancing subregional strategies.

POLICY RECOMMENDATIONS

On the basis of the above, the following policy recommendations to address the issue of water pollution within Caribbean SIDS are being proposed for consideration:

1. Consider adopting mechanisms/approaches which would allow for costing the environmental impacts of production and consumption.

2. Caribbean governments should consider the benefits of costing and incorporating wastewater reuse strategies into production systems

3. Investigate the possibility of utilizing low technology, low cost and fit for purpose[5] wastewater treatment options.

4. Ensure that relevant policies and legal frameworks are in place to promote the cost effective establishment, operation, and maintenance of wastewater treatment plants.

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[4] Fuzzy ABC is a modelling approach for categorizing items based on incomplete information about characteristics or behaviors.
[5] That the technology is applicable to the environment that it is introduced to and will function effectively.

PRICING WATER FOR SUSTAINABLE USE – ISSUES FOR THE CARIBBEAN

Willard Phillips

Apart from its critical role in the sustenance of life, water is important in almost all economic activities, and a significant contributor to economic and social development. Hence, water scarcity, contamination, wastage and management all have significant impacts on public health, economic well-being, and the quality of the natural environment (García-López, Montano and Melgarejo, 2020).

Source: Water and Sewerage Authority (WASA) Trinidad and Tobago

Hence, early human civilizations made public investments in the building of water collection, treatment, distribution and sanitization systems. According to Mala-Jetmarova, Barton and Bagirov (2015), formally engineered water distribution systems were first established in Mesopotamia between 3200 – 1100 BC. These systems varied in scope and degree of complexity, and often comprised hundreds of wells which supplied water for domestic use and for private and public baths. Further, by as early as the second millennium B.C., the Greeks were already using pressurized pipes for the distribution of water.

Naturally, such extensive public works required capital investments and ongoing expenditure for their construction, maintenance and operation. Given the need to guarantee the supply of water to the public as a basic need, all societies have confronted the challenge of providing water at an affordable price to all its peoples, while at the same time raising the necessary revenue to ensure a safe and reliable long-term water supply. This is the fundamental issue which makes water pricing such a major challenge in crafting social welfare policies (Cashman, 2014).

This challenge also obtains in the Caribbean and is further complicated by the peculiarities of small geographic space, limited markets, and the growing competition for water use among several interests, including domestic or municipal use, industry, tourism and agriculture. Today the reality of climate change and related water scarcity has also added to the challenge of setting water prices to attain sustainable water use with the additional requirement for recyclability[1].

In this article, the issue of water-pricing in the context of Caribbean SIDS is cursorily explored. A brief theoretical overview of water-pricing and tariff setting mechanisms is first discussed, after which the status of water distribution systems in the subregion is summarized. This is followed by a review of evolving cost dynamics related to climate change, water scarcity, intersectoral competition for water, desalination, and energy transition in affecting future water pricing and tariffs, before drawing some broad conclusions.

WATER PRICING – A THEORETICAL OVERVIEW:

For any firm to be economically viable, its long-term average cost must be minimized. Assuming a perfectly competitive market, profits are maximized at an equilibrium price which gives the maximum economic surplus to both consumers and producers, at the minimum production cost. The equilibrium price is determined by the market through interaction between buyers and sellers.

Water production utilities, however, do not fall into the perfectly competitive market model, given that these services are usually provided by a few – or often only a single supplier - thus making these markets monopolistic, or monopolistically competitive. This is because the high capitalization costs of such firms require that they recoup their fixed costs over a long period and have large markets to be profitable. In the absence of these opportunities, water services would either not be provided at all, or provided at prices that are unaffordable to most consumers.

Ultimately, the total economic surplus would be reduced, with the majority of such surplus captured by the producer. Mindful of this market dynamic, governments normally intervene in water utility markets either as sole service providers, investors in mixed capital enterprises, and/or market regulators to guarantee the provision of affordable water as a public good to all consumers.

[1] This refers to the management of wastewater so as to enhance safe and efficient reusability.

Such interventions might be through the establishment of legal monopolies, and the determination of pricing mechanisms which balance out the cost of capitalization over time, with affordability to all consumers. There are several approaches to setting water prices under regulated conditions, and the choice depends on key assumptions such as the availability of information, the dynamics of consumer demand, and the cost structure of the water utility. Wolak (2008) summarizes two broad approaches: 1) Full cost pricing – a price which covers the firm's operating costs plus a return on capital stock; and 2) Marginal cost pricing or two-part tariffs which include a cost of each unit consumed, and a fixed charge per customer served by the utility. For the Caribbean, these monopoly arrangements are widespread given the small size of markets in the subregion. Set prices and tariffs also reflect some of the above considerations adjusted for the economic and institutional peculiarities of the subregion (Table 1).

Table 1: Tariffs for water utilities in the Caribbean

Country	Utility (year)	Average water tariff (USD/M^3)	Average residential water tariff (USD/M^3)	Residential monthly water bill in 2019 (USD at 15 M^3)
Bahamas	WSC – Water and Sewerage Corporation (2015)	0.06	N/A	37.21
Barbados	BWA – Barbados Water Authority (2019)	N/A	N/A	20.77
Belize	BWS – Belize Water Services Limited (2019)	1.89	2.25	33.90
Cayman Islands	WAC – The Water Authority of the Cayman Islands (2019)	N/A	N/A	59.83
Dominica	DOWASCO – Dominica Water and Sewerage Company Limited (2020)	0.89	0.81	19.11
Grenada	NAWASA – National Water and Sewerage Authority (2019)	N/A	N/A	21.32
Guyana	GWI – Guyana Water Incorporated (2020)	0.54	N/A	6.78
Jamaica	NWC - National Water Commission (2020) -	2.35	1.92	21.40
Saint Lucia	WASCO – Water and Sewerage Company (2016)	N/A	N/A	16.33
Suriname	SWM – Surinaamsche Waterleiding Maatschappij (2018)	0.61	0.61	21.46
Trinidad and Tobago	WASA – Water and Sewerage Authority (2020)	0.51	0.38	4.42
Average		**1.08**	**1.19**	**23.87**

Source: IDB (2021)

Table 2: General service and operation characteristics – Caribbean water utilities

Utility	Jurisdiction	Sole provider of piped water	Annual revenue in USD millions	Non-Revenue Water - % (ear)	Number of water customers	Annual volume of water billed in M^3 x '000
WSC (2015)	Bahamas	No	46	37% (2015)	59,001	14,343
BWA (2018)	Barbados	Yes	66	45% (2018)	110,855	144,128
BWS (2020)	Belize	No	25	20% (2021)	62,104	12,595
WAC (2019)	Cayman Islands	No	42	N/A	N/A	N/A
DOWASCO (2020)	Dominica	Yes	8	53% (2020)	23,821	6,138
NAWASA (2018)	Grenada	Yes	13	26% (2018)	N/A	N/A
GWI (2020)	Guyana	Yes	37	68% (2020)	52,000	52,000
NWC (2020)	Jamaica	No	218	73% (2021)	79,600	79,600
WASCO (2016)	Saint Lucia	Yes	21	56% (2014)	8,456	8,456
SWM (2017)	Suriname	No	19	30% (2019)	28,442	28,442
WASA (2020)	Trinidad and Tobago	Yes	104	50% (2020)	187,656	187,656

Source: Compiled from IDB (2021)

WATER DISTRIBUTION SYSTEMS IN THE CARIBBEAN:

The Caribbean receives a mean annual rainfall ranging from 1,127mm for Antigua and Barbuda to 4,500mm for Dominica (Ekwue, 2010). This rainfall is split at roughly 25% for the earlier dry season months (December – May), and 75% for the latter rainy season months (June – November) of the year.

More recent trends, however, suggest an earlier onset of the dry season towards the end of the year (Climate Studies Group, Mona, 2020). Hence, the main task of water utilities is to manage this supply to ensure a reliable supply throughout the year. But despite adequate annual rainfall, subregional peculiarities such as small size, geology, topography, inadequate reservoir storage facilities, scarce financial resources and emerging climatic variations result in only a low volume of rainfall being captured and stored in ground water aquifers and surface reservoirs in the Caribbean (Ekwue, 2010). Additionally, over time there has been a proliferation of impervious surfaces which also limit the percolation of water through the soil into aquifers. In the subregion, water is used principally for domestic consumption (90%), industry (5%), and irrigation and other uses (5%). There are exceptions however, with Jamaica having its largest share of water being applied to irrigation.

In terms of scale, water utilities in the Caribbean are relatively small, with a customer base ranging between 23,000 to just under 400,000 customers (IDB, 2022). These numbers represent an average share of national population receiving a piped water supply of 91%, with the highest being 99% (Barbados), while the lowest was 79% (Suriname). These customer bases generate annual revenues to the water utilities of between USD 8 – USD 218 million. These revenues are however substantially compromised owing to the high percentage of Non-Revenue Water (NRW)[2] which averages 46% for the subregion (Table 2).

▸ (continued on page 14)

[2] Non-Revenue Water is the share of water losses due to leakage during distribution. Global performance standard is between 30 – 40% (IDB, 2021).

MANAGING WATER RESOURCES IN CARIBBEAN CITIES: THE ROLE OF LAND USE PLANNING

Jônatas de Paula

Land use planning can directly influence the quantity, quality, and availability of water resources in a geographic area, and plays a crucial role in Integrated Water Resources Management (IWRM)[1]. The spatial allocation of land to human economic activities - such as agriculture, human settlements, industry, energy production, and others - determines the geographical patterns of demand for water resources. Preservation measures implemented through land use regulation are essential to support the conservation of water catchment areas, such as forests, hills, and wetlands.

These measures can contribute to increasing water availability, regulating water flows, maintaining aquifer recharge, preventing sedimentation, reducing nutrient runoff, and supporting many other natural services. Proper zoning and regulation of industrial activities can minimize the risk of contamination and safeguard the quality of water resources and natural habitats. Therefore, integrating land use planning and IWRM are critical to best address competing economic and social demands for water resources, thereby allowing for enhanced resilience of water systems in the face of environmental challenges.

IWRM has been included in some of the national sustainable development policies in Caribbean SIDS, with a spatial perspective represented in some of these policy instruments. Jamaica's National Water Sector Policy and Implementation Plan proposes coordinating water resources management and land use planning to achieve environmental and ecosystem protection and conservation.

It also lists policy linkages with various land use planning-related instruments, such as the National Land Policy, the draft National Building Code, the draft National Spatial Plan, and others (GoJ, 2019). The draft National Integrated Water Resources Management Policy of Trinidad and Tobago acknowledges that "water resources management and land use planning are intrinsically linked" and includes land use planning and regulation authorities as key implementation stakeholders (GoT&T, 2016). However, at a subregional level, formal mechanisms that ensure cross-sectoral coordination among water, land, and development priorities are still generally deficient (GWP, 2014).

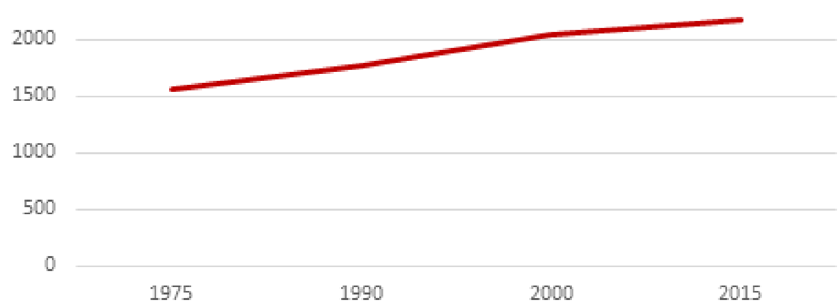
Considering the intricate nexus between land use planning and IWRM, this article explores the process of land use change resulting from urbanization, especially the transformation of previously undeveloped or agricultural areas into impervious surfaces allocated to human settlements, as a crucial factor to be considered in managing the water resources in the subregion's cities.

URBANIZATION IN THE CARIBBEAN AND THE LAND - WATER NEXUS

In 2018, around 70% of the Caribbean[2] population lived in urban areas, an indicator projected to reach 82.5% by 2050 (UNDESA, 2018). Data from the Global Human Settlement Layer (GHSL)[3] platform indicates that the built-up area of urban settlements in Caribbean SIDS has increased by 40 per cent from 1975 to 2015.

This represents an expansion of urbanized land of 621.3 km² - an area larger than Saint Lucia. In the three periods available in the GHSL platform used in this analysis (1975 - 1990, 1990 - 2000, and 2000 - 2015), the fastest urban growth occurred between 1990 and 2000, with a variation of more than 15

Figure 1 - Built-up area in Caribbean SIDS urban centres between 1975 and 2015 (km2)



Note: the analysis included all independent countries and overseas territories in the Caribbean, except for the French overseas territories of Guadeloupe and Martinique, which did not have country profiles in the GHSL platform.

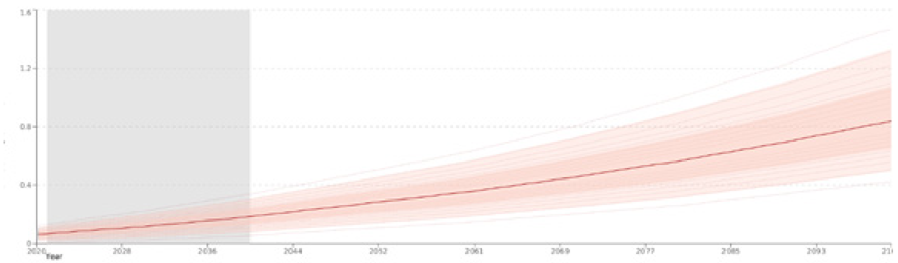
Source: Author's compilation analysis of data from country profiles of the Global Human Settlement Layer.

[1] The Global Water Partnership defines Integrated Water Resources Management (IWRM) as "a process which promotes the coordinated development and management of water, land, and related resources in order to maximise economic and social welfare in an equitable manner without compromising the sustainability of ecosystems." (GWP, n/d).

[2] Indicator "annual percentage of population residing in urban areas" of the subregion comprising the following countries: Anguilla, Antigua and Barbuda, Aruba, Bahamas, Barbados, British Virgin Islands, Caribbean Netherlands, Cayman Islands, Cuba, Curaçao, Dominica, Dominican Republic, Grenada, Guadeloupe, Haiti, Jamaica, Martinique, Montserrat, Puerto Rico, Saint Kitts and Nevis, Saint Lucia, Saint Vincent and the Grenadines, Sint Maarten (Dutch part), Trinidad and Tobago, Turks and Caicos Islands, United States Virgin Islands.

[3] The Global Human Settlement Layer (GHSL) is an open and free data platform that has implemented the methodology DEGURBA (Degree of Urbanisation) (OECD et at, 2021) at a global level. Endorsed at the 51st Session of United Nations Statistical Commission, the methodology allows for international statistical comparisons of urbanization patterns at a global scale. Using the DEGURBA methodology, the GHSL classifies settlements according to variables of density, contiguity, and population thresholds. More information can be found at this link: https://ghsl.jrc.ec.europa.eu/degurbaDefinitions.php.

Figure 2 – Projections of sea level rise in the Caribbean, scenario SSP5-8.5 (change in meters)



Source: Gutiérrez et al. (2021).

per cent in total urbanized land. That trend slowed down in the period 2000 – 2015, when a variation below 7 per cent was recorded.

This urbanization trend is expected to continue over coming decades. A study by Angel et al. (2010) projects that 15 CARICOM member states will have converted between 1,200 and 5,100 km² of agricultural land to urban uses by 2050, increasing urban areas by two to five times. In Trinidad and Tobago only, the study estimates that urban areas will increase up to seven times by 2050. New region-cities and urban corridors are expected to develop in the subregion, connecting urban settlements across large portions of countries' national territories (Mc. Hardy and Donovan, 2016).

Urbanization can lead to both positive and negative externalities to water security, depending on how well urban development is planned and implemented in practice. Some of the positive externalities are linked with the effects of economies of agglomeration[4] that result from higher densities. The higher concentration of demand for water and sanitation services in urban areas, relative to rural areas, allows for sharing fixed initial investment costs-for example, in water treatment plants, distribution networks, and wastewater treatment facilities - over a larger customer base. The geographical proximity of users can also make service operation and maintenance more efficient, thus contributing to reduced service costs over time. While extensive service networks spread over large rural areas can be relatively more exposed to disasters, the concentration of services in urban areas - when covered by adequate disaster risk reduction measures and infrastructure - can lead to fewer service disruption events and reduced maintenance costs[5]. Harnessing the benefits of urbanization has allowed the expansion and universalization of water and sanitation services coverage in many countries.

Unplanned development associated with the growth of cities and human settlements can also lead to negative environmental externalities that can affect water security. Studies indicate that the urbanization of upper watershed areas in Port of Spain, Trinidad and Tobago, and Castries, Saint Lucia, has affected water flows, leading to downstream flooding, overall decrease in base stream flows, and higher sediment loads.

These changes have resulted in a reduction in water availability and higher vulnerabilities to extreme weather events (GWP, 2014). This phenomenon is a typical example of how fast expansion of impervious areas can negatively impact water resource availability and flood management in urban areas. In addition, studies in Jamaica (Kingston and Saint Andrew) and Barbados (Belle area) show that the lack of appropriate sewage connections or adequate disposal into water bodies in urban areas have undesirable impacts on freshwater quality and water security, being another negative externality of unplanned urbanization (GWP, 2014).

Caribbean urbanization is also characterized as being predominantly concentrated in low-elevated coastal zones. These areas are particularly prone to some of the effects of slow onset climate events, such as decrease in precipitation levels, land loss resulting from rising sea levels (see Figure 2) and coastal erosion. Mycoo and Donovan (2017) suggest that Caribbean countries face a "coastal squeeze" where most of the population and critical infrastructure are situated in a narrow coastal belt, where further development will be constrained by coastal geomorphology and the need to build adaptation infrastructure, such as seawall defences. The scarcity of land and the expected population increase in new and established settlements will lead to more conflicting and competing demands, which will, in turn, add pressure to green areas that are crucial for protecting the quality of water bodies.

LAND AND WATER POLICIES IN CARIBBEAN URBAN SETTLEMENTS – INTEGRATION APPROACHES

Achieving efficient land allocation requires a holistic approach among authorities responsible for IWRM, coastal zone management, environmental protection, land use planning and urban development, and disaster risk management. The spatial characteristics of different areas and communities need to be at the centre of all policy coordination efforts, thereby requiring that generic sectoral policies be integrated through territorial development plans.

Using the territory as a means of integration of sectoral policies allows specific solutions and investment plans to be designed to better respond to local needs. An approach that seeks to link different policy priorities with the territory is the Integrated Urban Water Management (IUWM), which calls for coordination between urban development and basin management (see Figure 3). Using the drainage basin as a territorial planning unit for town planning is a strategy that puts the strategic needs of IWRM at the centre of land use planning and urban development.

▸ (continued on page 16)

[4] Economies of agglomeration are generally understood as the advantages associated with economies of scale resulting from the geographic concentration of business and economic activities. Proximity leads to reduced transactional costs in the exchange of goods, services, and information between individuals, firms, and economic sectors, leading to an overall reduction of production and transportation costs. Other positive externalities of economic agglomeration are the pooling of skilled labour, which reduces the cost of recruitment to businesses and increases firms' and individuals' exposure to knowledge and information spillover. Economic concentration also allows for general business specialization, leading to more innovation and higher productivity. When economies of agglomeration are associated with increasing population and economic densities in urban areas, it is often referred to as economies of urbanization.

[5] Although smaller than other infrastructure sectors, water and sanitation represent an important share of the damages and losses resulting from geophysical and climatic disasters in the Caribbean. Between 1972 and 2010, the subsector represented 5% of the damages and 5% of the losses resulting from climatic disasters subregion, and 6% of the damages and 30% of the losses resulting from climatic disasters (ECLAC, 2015).

▸ (continued from page 5)

WATER FOR SUSTAINABLE DEVELOPMENT (CONTINUED)

OUTCOMES OF UN2023 WATER CONFERENCE.

The UN 2023 Water Conference recognised the importance of water in all elements of sustainability, underscoring that access to safe water, sanitation, and hygiene is a basic human need for health and well-being. It also highlighted the need to accelerate progress on SDG 6. To this end, the Conference highlighted the importance of engaging multisectoral, multi-agency cooperation models and of including the private sector (UN Water Conference, 2023). The UN 2023 water conference concluded with a vision statement punctuating nine priority areas. These are given in Figure 2 below.

CONCLUSIONS AND RECOMMENDATIONS

To achieve the objectives of SDG 6 by 2030 and in line with the priority areas identified by the UN 2023 Water Conference, the Caribbean will need to reverse current water resource management trends. In this regard, the following recommendations are provided:

1. Integrated Water Resources Management (IWRM) and institutional arrangements. In Caribbean SIDS, IWRM is administered under various legislative and institutional arrangements and administered as a function of potable water and sewerage services (A. Dubrie, et al, 2021). To achieve SDG 6, water resources management should be mainstreamed and integrated with such priorities as climate change adaptation. This integration should be data-driven and systemized at all levels, including, inter alia, the protection and restoration of watersheds, water use efficiency, forestry management, land-

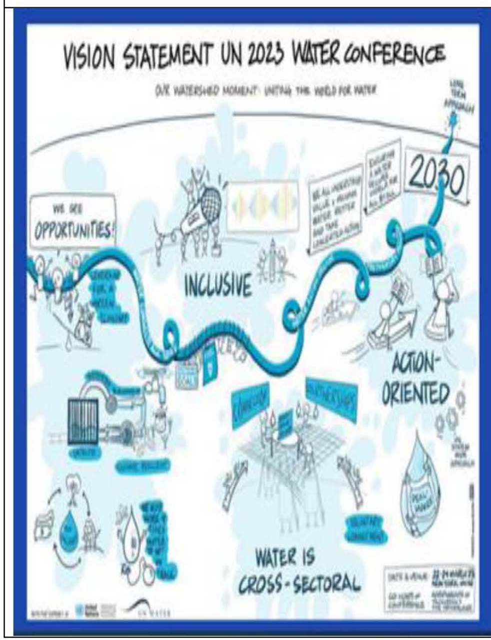
Table 1
Caribbean SIDS implementation of SDG indicator 6.5.1 for reporting years 2017 and 2020

Caribbean SIDS	SDG 6.5.1 Status of implementation 2020	SDG 6.5.1 Status of implementation 2017
Antigua and Barbuda	Medium-low	Low
The Bahamas	Medium-low	Medium-low
Barbados	Medium-low	Medium-low
Belize	Low	Low
Cuba	High	High
Dominica	Medium-low	Medium-low
Dominican Republic	Medium-low	Medium-low
Grenada	Medium-low	Low
Guyana	Low	Low
Haiti	Low	Low
Jamaica	Medium-low	Medium-low
Saint Kitts and Nevis	Low	Low
Saint Lucia	Medium-low	Medium-low
Saint Vincent and the Grenadines	Low	No data
Suriname	Low	Low
Trinidad and Tobago	Medium-low	Low

Source: IWRM data portal: http://iwrmdataportal.unepdhi.org/, 2021.
Note:Table 1 guide: A listed grade of high indicates that this country is achieving IWRM policy objectives and is likely to reach the 2030 target for this indicator. Medium-low indicates that there exist most of the institutionalised elements for IWRM. Low indicates that countries have started developing elements of IWRM. In medium-low and low grades, countries are unlikely to meet the global targets unless progress significantly accelerates.

Figure 2:
UN 2023 Water Conference Vision Statement and concluded priority areas:

Vision Statement-UN 2023 Water Conference



Concluded **Priority Areas**

1. Integrating water and climate policy at the national and global levels by 2030.
2. Early Warnings for All to help safeguard lives and property by 2027.
3. Operational Global Water Information System to support water, climate and land management for socioeconomic resilience, ecological sustainability and social inclusion by 2030.
4. Overcoming the dependence on ever-rising water consumption to provide nutrition and power
5. Re-defined financial principles to make our economies water-, climate-, land-, and ecosystem smart and people-centric.
6. Global Water Education Network to build the capacity of institutions and people, especially to support developing countries.
7. Inclusive, comprehensive transboundary agreements to support countries, on the basis of the 1992 Convention on the Protection and Use of Transboundary Watercourses and International Lakes (Water Convention) and the 1997 Convention on the Law of the Non-navigational Uses of International Watercourses (Watercourses Convention).
8. Institutional architecture to support transformation: a board of UN agencies under the leadership of the UN Secretary-General, managed by a UN Special Envoy for Water, supported by a reformed UN-Water coordinating body and an independent scientific and advisory panel, in addition to the arrangement for discussing water policy at the United Nations in New York to be developed by the General Assembly
9. Intergovernmental processes on water are to be convened on a regular basis.

Ref: Summary of Proceedings by the President of the UN General Assembly, link: https://www.un.org/pga/77/wp-content/uploads/sites/105/2023/05/PGA77-Summary-for-Water-Conference-2023.pdf, cited July 10, 2023 use and coastal zones planning and management, pollution prevention and control, health and sanitation, human and institutional capacity building.

2. Disaster Risk Management, including early warning and assessment. Fresh-water resources management must be a defined component in the planning, preparedness, response and recovery stages of disaster risk management. This integrated approach is necessary considering that most climate change related hazards and impacts in the Caribbean are water-related. Flooding and storms are, for example, the most reported weather-related disasters in this region (L. Fontes de Meira and W. Phillips, 2019).

3. Research and scientific assessments and adaptation. There is urgent need for research addressing the issues and challenges of the Caribbean on freshwater resources management, including vulnerability assessment, disaster preparedness and resilience building. This will require strengthening collaboration and cooperation through instruments such as SIDS-SIDS and south/south cooperation. In the case of Belize, Guyana and Suriname, this will also require further strengthening of transboundary water arrangements (A. Dubrie et al, 2021).

4. SIDS International Conference: The Fourth UN International Conference on SIDS will be held in Antigua and Barbuda in May 2024, to adopt a new Programme of Action for SIDS, 2024-2034 (4th International Conference on SIDS, 2023). This conference should address strategies for resilient water resources management in keeping with the SIDS priorities for sustainable development. ■

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WATER PRICING – EVOLVING COST DYNAMICS:

If full cost, or marginal cost pricing is the underlying premise for setting water prices, then any dynamic which impacts cost variables, would likely affect water utility pricing in the Caribbean. According to the OECD (2010), the main financial cost variables for management of the water supply include the daily running costs (electricity for pumping, labour, chemicals, and repairs) for the abstraction, treatment and distribution of water; the high capital investments for the establishment and renewal of infrastructure; and the debt servicing costs typically associated with public utilities.

There are however other economic costs which derive from the opportunity provided or denied to other sectors for the use of water in alternative applications[1], and the externality costs associated with modification of the physical environment (through for instance the construction of reservoirs). Taking these considerations into account, several important factors are expected to be important for the subregion's water supply in the future.

The first is climate change, which is projected to lead to an overall 20% reduction of precipitation in the subregion by the end of the century (CDB, 2020). Further, the seasonal distribution of precipitation is expected to result in a shorter wet season ending, between September and November. Climate change is also expected to increase the frequency of extreme events. All of these hold important cost implications for the future availability, abstraction, and treatment of water by utilities.

A second factor is growing water scarcity on account of increasing consumption globally. UN Water (2021) notes that over the last century, water consumption rates have increased at roughly twice that of the rate of population growth. This trend has become apparent in the Caribbean, with several countries[4] now showing extremely high levels of water stress (Rajballie, Tripathi, and Chinchamee, 2022). In economic terms, increasing scarcity suggests the need to increase tariff rates, which hold significant social and political implications for citizens in the subregion.

Related to the above is the issue of increasing intersectoral competition for water. For example, for most Caribbean countries, the largest share of water is used for municipal purposes, Ekuwe (2010) shows that, depending on the country, other sectors such as industry, and agriculture make significant demands on the water resource base. In Trinidad and Tobago, for instance, industry uses approximately 21% of water, while in Barbados this is estimated at 15%. More importantly, however, is that for some States, industry is de facto the tourism sector, which has been projected to increase its water use in the future (Gössling et al, 2011). These trends are also important especially for the setting of sector specific tariff rates going forward.

Energy transition is yet another important dynamic for further analysis in setting water prices since this is usually a significant share of operating cost for water utilities, especially since water production and distribution are energy demanding. Given the subregion's well-recognized energy insecurity and high dependence on fossil energy, several countries have set ambitious targets for increasing the share of renewable energy on the national grid. This development offers the prospect of significantly reducing operating costs if it can be successfully applied to Caribbean water utilities. To date, however, this has not proven to be the case in the subregion.

Finally, the emergence of desalination as a municipal water source offers prospects for changing water production and management costs in the Caribbean. The currently applied technologies of Reverse Osmosis and Multi-Stage Flash are energy intensive, which result in relatively high unit costs for freshwater production.

They also produce high concentrations of brine, which can also result in other externality costs. At the same time, desalination processes which are driven by renewable energy could significantly reduce energy costs, thus resulting in more feasible water management systems.

CONCLUSION:

Like other societies, the Caribbean faces a challenge in balancing the price of municipal water, with the costs of investments necessary to guarantee long-term sustainability and affordability of an adequate and safe supply. At the heart of the issue are questions of equity in guaranteeing access to water by all, as well as efficiency, where water access is not abused through wastage. Inefficient pricing also disincentivizes the

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[1] This is usually adjusted for by differential tariff rates set for various water use sectors.
[2] Dominica, St. Vincent and the Grenadines, Antigua and Barbuda, St. Kitts and Nevis, Barbados and Trinidad and Tobago.

application of strategies for water recycling, as well as other sustainable water harnessing practices such as rainwater harvesting, or more efficient irrigation practices.

Several emerging dynamics suggest that this issue will remain a key policy issue for the foreseeable future. As the subregion adjusts to these dynamics, strategies which incorporate wider policy variables are needed. Among these are questions about market structure, safety, reliability and equality of the water supply, and the future role of a broader public in the conservation, and distribution of water for the public good. ■

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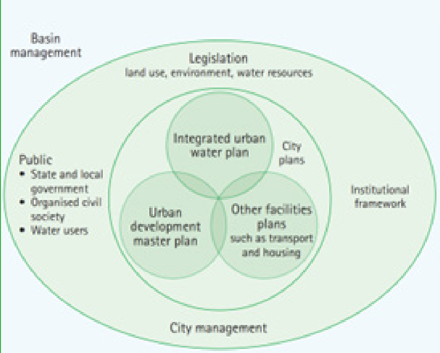
NATURE BASED SOLUTIONS: CAN THEY HELP US STAY ALIVE AT 1.5^{0}C? (CONTINUED)

Figure 3 – Drainage basin as a territorial planning unit for a model of Integrated Urban Water Management model



Source: GWP (2012).

Integrating different and often competing policy priorities, each with territorial implications, can be challenging from a policy and resource allocation perspective.

As complex evidence-based decision-making processes – such as those required by the IUWM approach - become more frequently needed by policy makers, producing quality, accurate, timely, and relevant geospatial data is crucial. One example of a model to support complex policy decisions using Geographic Information Systems (GIS) is the multi-criteria site suitability model employed by the Urban Development Corporation (UDC) of the Government of Jamaica to support the Jamaica's Next (Third) City project[6] (Lloyd, 2021). By employing horizon-scanning and foresighting analysis, the model sought to recommend the least vulnerable location in the country to natural hazards and sea level rise. Although this example is not only dedicated to water resources management, it shows that GIS tools and technologies are essential for developing methodologies that require inputs from numerous variables and datasets to provide insights on the spatial implications of infrastructure development in a territory. Such methodologies developed to support complex evidence-based decision-making can contribute to enhanced water security in the Caribbean.

Finally, ensuring a healthy land and water nexus in urban settings requires a change in how water is framed in the urban planning mindset. Drainage infrastructure is frequently planned to allow for the quickest rainwater run-off into the ocean and larger water bodies in order to avoid loss of life and damage to property and infrastructure. This approach has become more prevalent with the increasing intensities of tropical storms and flooding resulting from climate change. However, while extreme hydrological events become more intense, precipitation levels are also expected to decrease over time in the Caribbean, with dry spells becoming longer and more frequent. This change in rainfall patterns requires urban planners to approach rainwater not just as a potential hazard but as a valuable resource that needs to be carefully managed.

The concept of Sponge Cities provides key insights into how land use planning and green infrastructure in urban settings can mitigate flood risks while also tackling water scarcity. This approach advocates for distributing green roofs, rain gardens, permeable pavements, drainage swales, and storage tanks in urban areas. These elements can reduce runoff volume and speed, and store stormwater for later use or slower release into the traditional drainage network (Lancia et al., 2020). As land also becomes scarce, available space and financial resources for constructing sizeable green infrastructure in Caribbean SIDS - such as new public parks and storm ponds - may not be available.

Urban planners need to deploy planning and economic incentives to promote the adoption of smaller-scale solutions at the level of households and new developments, increasing cities' permeability, resilience, and water security. ■

CONCLUSION

Management of the potential positive and negative effects of urbanization on water security in the Caribbean, will require the careful integration and coordination of different policy perspectives and levels of government, particularly in light of the subregion's increasing vulnerability to climate change. Innovative solutions that integrate the priorities of IWRM and urban development using land use planning can significantly contribute to mitigating the effects of extreme weather events in the region while addressing the increasing water scarcity. Geospatial data can facilitate the integration of different policy priorities and their spatial implications, by providing evidence-based information to increasingly complex decision-making processes that constitute the pursuit of water security in the Caribbean.

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RECENT AND UPCOMING MEETINGS

2023

MAY
10 MAY 2023
Caribbean SIDS relevant climate change and disasters indicators for evidence-based policies: Final regional workshop of the project 2023

JUNE
1 JUNE 2023
Workshop "Contributions of international migration to sustainable development" - Jamaica

SEPTEMBER
18 SEPTEMBER 2023
Expert Group Meeting: Measuring the digital society to advance digital inclusion in the Caribbean

List of Recent ECLAC Documents and Publications

Listed by Symbol Number, Date and Title

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A study on challenges and opportunities in financing Sustainable Development Goals 4 and 9 in three Caribbean countries: an exploratory analysis

LC/CAR/TS.2023/4 March 2023
The importance of time-use surveys in guiding social policies: the gendered impact of COVID-19 on paid and unpaid work in the Caribbean

LC/CAR/TS.2023/3 February 2023
Policy considerations for sustainable transportation in three Caribbean small island developing States: options for improving land transportation efficiency. Barbados, the British Virgin Islands and Jamaica

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