PERSPECTIVES PAPER

Global Water Partnership Caribbean

Wastewater Management in the Caribbean: A Jamaican Case Study

This Perspectives Paper was prepared by Dr. Arpita Mandal and Stephanie Parker. It is intended to galvanise discussion within the GWP-C network and the larger water and development community.

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About Global Water Partnership-Caribbean

The Global Water Partnership-Caribbean (GWP-C) vision is for a water secure Caribbean.

Our mission is to support Caribbean countries in the sustainable management of their water resources at the community, national and regional level.

GWP-C is 1of 13 Regional Water Partnerships of the Global Water Partnership (GWP). It was established in 2004 to foster the application of Integrated Water Resources Management (IWRM) in the Caribbean region. IWRM is the coordinated development and management of water, land, and related resources, in order to maximise economic and social welfare without compromising the sustainability of ecosystems and the environment.

Any organisation with an interest in water sustainability in the region, can become a GWP-C Partner. GWP-C currently has over 100 partners in more than 20 Caribbean countries. These include water management agencies, water user associations, private water management agencies, government institutions, academic and research institutions, private sector companies, non-governmental organisations, community-based organisations, civil society organisations, youth organisations, regional agencies, consultancy firms, among others.

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Introduction

Water resources globally are under stress with increase in populations, impacts of climate change and inefficient management of water and sewage systems. The Small Island Developing States (SIDS) of the Caribbean are of no exception and are disproportionately more exposed to water stresses than continental countries owing to their unique physical, demographic and economic factors, limited natural internal water resources (Box 1), increasing water demand due to urbanisation, more rapid late-stage industrialization, and poor sewage treatment (Chase, 2012). In 2010, the United Nations adopted Resolution 64/292, which recognised "the right to safe and clean drinking water and sanitation as a human right that is essential for the full enjoyment of life and all human rights". Despite being a human right, many nations and communities in developing countries do not have the facilities to support this right. The effects of compounding factors poses challenges for Caribbean SIDS in meeting their Sustainable Development Goals (SDGs) Goal 6 (Clean Water and Sanitation). Comprehensive and sustained wastewater management in combination with sanitation and hygiene is central to improved human health, food security, economic development, decent work, and poverty reduction. The Caribbean has certainly achieved progress towards universal access to clean water with an average 97% of populations in 25 Caribbean countries having access to at least improved drinking water. However, access to basic sanitation services is only at 89% coverage on average for most countries but with up to 64% of the Haitian population having no access to basic sanitation services (World Bank, 2023). As the type of urbanization typical in the Caribbean accelerates, the spread of unplanned communities, increased abstraction of limited water resources outpaces the environmental replacement of water resources. Coupled with existing insufficient water and wastewater infrastructure, there has been increased stress not only on surface and underground water resources, but also on water utilities to provide the infrastructure for the delivery of water services. Six of 16 Caribbean countries for which data were available are water stressed according to the Falkenmark Indicator, each having less than 1,700 m^3/year/capita internal renewable water resources; and four of these have less than 1,000 m^3/year/capita and are thereby deemed water scarce (Falkenmark, 1989; World Bank, 2023).

Improper wastewater management poses threats to water resources, human and ecosystem health through pollution and proliferation of disease vectors and associated pathogens. It also has adverse impacts on agricultural and marine-based food systems by degradation of ecosystems. Efficient wastewater management can provide immediate, intermediate, and long-term co-benefits to health services, water and food security, industry, and ecosystems (Montoute & Peters, 2022). Therefore, seeing wastewater as a resource has cross-cutting multi-dimensional advantages across all sectors, including tourism, agriculture, and aquaculture – all of which are cornerstone economic activities within Caribbean societies. Notably, wastewater management has been considered an integral part of Integrated Water Resources Management (IWRM), specifically highlighted in Sustainable Development Goal Target 6.3 (SDG 6.3), which seeks to improve water quality and reduce untreated wastewater, by aiming to cut half of the proportion of untreated wastewater by 2030 (United Nations, 2018; Roopnarine et al., 2019).

This paper aims to review the challenges and opportunities associated with wastewater management, with a view to highlighting areas for improving implementation of sustainable wastewater management practices applicable in the Caribbean, with special reference to Jamaica. The paper looks at the existing wastewater management system in Jamaica along with an overview of the policies and governance frameworks that are in place to support efficient wastewater treatment and management.

Box 1. Special Characteristics of Small Island Developing States

- Small size – limited natural resource endowment; high import content.
- Limited institutional capacity and small manpower resource base.
- Limited scope for economies of scale
- Demographic factors: out-migration resulting in brain drain; rural-urban pull resulting in population concentrations in narrow coastal strips.
- Insularity and remoteness, leading to high transport costs.
- Proneness to natural disasters, which threaten the survival of some small islands; large damage per unit of area and costs per capita.
- Unique and fragile ecosystems with low level of resistance to outside influences.
- Entire island is a system of highly integrated ecosystems and sub-ecosystems.
- High vulnerability to the impact of global warming and rising sea level.
- Over-dependence on donor funding for capital projects.
- Access to funding is limited.

Box 1. Special characteristics of SIDS (Chase, V., 2012. *Integrated Water Resources Management Planning Approach for Small Island Developing States*. UNEP)

Key Features of Integrated Wastewater Management

Wastewater is any water whose quality has been affected by anthropogenic influence, which encompasses effluents from domestic, agricultural, industrial, or municipal processes including run-off, partially or untreated sewage, and leachates (Tchobanoglus, Burton, & Stensel, 2003). Wastewater management involves both effective mechanisms of collection as well as treatment, disposal, or reuse of wastewater from generating sources. The efficiency of processes involved in wastewater treatment and disposal/reuse operates according to policy guidance, infrastructural capacity, and regulatory action and intervention. The absence and deficiencies of these can have a significant impact on water security, the environment, and public health (Akpor & Muchie, 2011; Cashman, 2014). Three main facets are required to operate in tandem during wastewater management: (1) processing facilities, inclusive of collection, treatment, disposal and reuse infrastructure and services systems (2) regulatory bodies, which covers public and private sector organizations responsible for maintenance, policy enforcement, and implementation/oversight according to agreed national standards during processing, and (3) policy framework, which gives regulators and service providers the institutional arrangements and standards, and overall capacity and tools to manage processes and equipment during wastewater treatment, disposal and reuse.

Liquid and sewage effluents can be classified as greywater (typically from washing, bathing, and kitchen activities) or blackwater (typically from toilets or facilities designated for excreta). Generally, liquid waste is

deemed hazardous, such as those from some industrial processes, certain medical or biological waste, and are often governed by local regulations that control or restrict the quantity, composition and level of contaminants that may be discharged. Charges may be levied on industrial waste producers based on criteria such as toxic content, quantity, and quality.

Wastewater collection systems consist of buried pipelines connected to residential and commercial waste drain systems which convey liquid and sewage waste via pumps, rising mains, valves, screens, and associated infrastructure to treatment systems. For residential and commercial grey and blackwater, there are two main types of systems for handling wastewater treatment: decentralized systems and centralized systems. Decentralized systems, which are the more common type of system used in older urban communities, refer to onsite or near site wastewater collection and treatment that are managed at or close to the point of generation, while centralized systems refer to the use of extensive piping systems (sanitary sewers) that convey residential, commercial or industrial wastewater to central wastewater treatment plants (Crites & Tchobanoglous, 1998; Pasciucco, Pecorini, & Iannelli, 2022), after which, treated wastewater may converge with stormwater runoff in urban drainage systems (combined sewers).

Decentralized systems are typically inclusive of shared and improved sanitation facilities connected to septic tanks, pit latrines or composting toilets. These systems can promote proper treatment of wastewater and may be the most cost-effective way to ensure correct wastewater disposal into the environment, especially where there is limited availability of resources for connecting domestic effluent to centralized systems. However, decentralized systems are more susceptible to near source pollution and improper wastewater handling and disposal as responsibility and maintenance of these systems is normally at the private or municipal levels (United Nations, 2015). This promotes fragmented and inconsistent enforcement of safety regulations.

Centralized systems tend towards more uniformity in treatment standards as well as greater potential to ensure efficiency after wastewater processing. The use of centralized systems is more conducive to institutionalizing the utilization of wastewater as a resource. That said, if these systems are not properly maintained, they fail to safely treat wastewater resulting in the release of partially treated wastewater into runoff flows, coastal ecosystems, and underground drainage systems. This is an ongoing issue in the Caribbean as poorly maintained and insufficient pipe networks and infrastructure exacerbate issues related to surface and groundwater pollution. While there has been a shift from traditional systems to more centralized systems in urban and industrialized areas in developed countries, this has been slow in progress in developing countries, partially related to general SIDS issues (outlined in Box 1) as well as local constraints of which funding could be a significant one.

Wastewater Management Coverage in the Caribbean

The coverage of wastewater disposal and treatment facilities in the Caribbean has changed, mostly for the better, since the early 2000s with an overall increase in access to improved sanitation services. On average around 97% of populations within 15 Caribbean countries have access to improved waste disposal facilities (World Health Organization, 2022) wherein, 54% of households utilize septic tank facilities, 20% use improved latrines, and 25% utilize the facilities connected to sewer networks (Figure 1). The WHO/UNICEF Joint Monitoring Programme - JMP (2021) also indicated that there has been an average increase of 6.2% in the proportion of populations connected to sewer networks from 2016 to 2019 and a 3.9% decrease in the proportion connected to septic tanks. This could be, in part, the result of policies mandating sewer network connections within newer urban developments as Caribbean governments implement actions in support of SDG targets, and urban population growth.

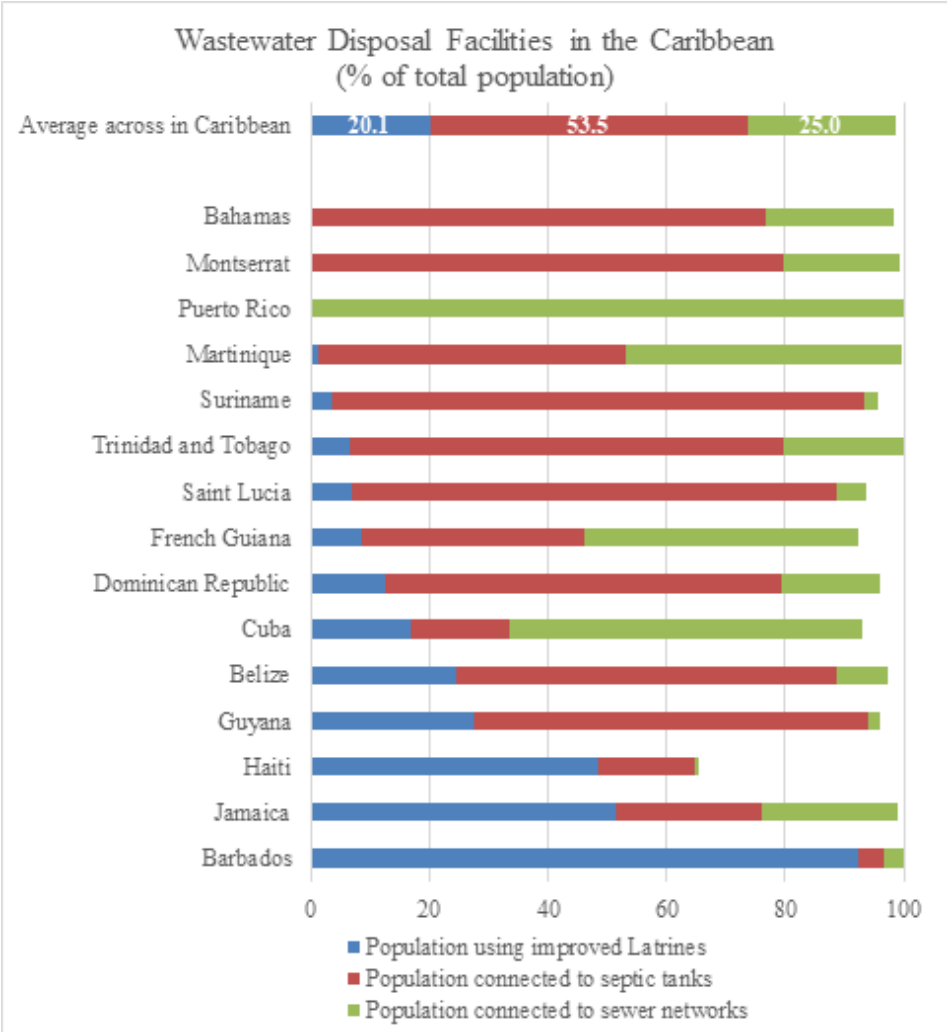

Figure 1. Proportion of population using certain waste disposal mechanisms in several Caribbean countries. Sourced from WHO/UNICEF Joint Monitoring Programme (JMP) 2021 (World Health Organization, 2022) and retrieved from UNICEF Data Warehouse

Apart from septic tanks, another metric of importance within the Caribbean setting, particularly for older urban and rural communities is the use of improved latrines connected to in-situ waste and wastewater disposal facilities which can be considered a form of decentralized systems. Data collected for Cuba, and Suriname (2 of 3 countries for which data were available) showed that 20% and 24% of their populations, respectively, utilized in-situ waste disposal facilities in 2019, while close to 1% used off-site waste treatment in Cuba and none utilized this method in Suriname (World Health Organization, 2022). Visualization and mapping of disposal and treatment usage can point out locations vulnerable to improper disposal and water contamination associated with poor upkeep of certain facilities. The main challenge comes from the lack of maintenance. Proper periodic cleaning (desludging) of the septic tanks, pit latrines, and pit privies needs to be carried out. Failure to de-sludge results in poor effluent quality. A further issue with on-site disposal is that septic tanks built on soils which are not very permeable results in poor adsorption of the contaminants by the soil resulting in soil contamination and if the groundwater levels are high, leading to groundwater contamination.

As noted earlier, having connections to sewer networks does not necessarily equate to safely treated wastewater. The Findings of the 2021 Joint Monitoring Programme (JMP) have further indicated that in four Caribbean countries, within the subset of populations with facilities connected to sewerage, there is only 14.3% of progress in minimum level of treatment of secondary wastewater treatment (WHO 2022). This is based on wastewater treatment plant design and categories defined in System of Environmental-Economic Accounting (SEEA) and the International Recommendations for Water Statistics (WHO, 2021). Primary level of treatment only requires that the effluent is screened (removal of larger material) and kept away from further human contact (WHO, 2021). This fails to remove harmful bacteria and contaminants in effluent. Additionally, the vast majority utilizing sewer connections practice long ocean outfalls method to the sea. The implications of only using primary level treatment in conjunction with ocean outfalls means that pollutants in the effluent are carried to marine ecosystems. This results in high coliform concentrations and low dissolved oxygen levels in coastal waters. Assessments conducted by GEF-CReW and UNEP that indicate 85% of wastewater entering the Caribbean Sea remains untreated. This has largely contributed to degradation and loss of over 80% of living coral in the past two decades (ECLAC & CDCC, 2015).

Targets for policy and management interventions tend to focus on resource protection and water supply, and several governments across the Caribbean have focussed on improving their water resource management policies, especially to maximize existing resource capture and storage. These are in the process of being refined even further to meet SDGs towards universal access to water and sanitation services. In the region, wastewater management is normally included under the umbrella of water management, and thereby, delegated to regulators and state-owned enterprises (SOEs) charged with providing utilities and sanitation services using an integrated water resource management (IWRM) system (Medina, Kullmann, & Felter, 2021). IWRM governance frameworks, through prioritization of more sustainable practices and oversight, should ensure that (1) adaptive strategies are implemented in regard to infrastructure, behaviour, management, and government, (2) there are iterative and targeted assessments of resources, assets and hazard probability for the as needed restructuring and capacity building, (3) there is development and implementation of data collection networks to improve evidence-base for policy design, and (4) there is mainstreaming of development planning (ECLAC & CDCC, 2015).

Apart from recognising the importance to human and environmental safety, the argument for wastewater reuse has received much attention with the implementation of development goals and there are numerous approaches proposed on how best to address these transitions in the Caribbean. The overarching principles critical to any approach however, remains the sustainability of periodic maintenance management, and the implementation of locally-appropriate strategies that respect the local environment, climate and resources (ECLAC & CDCC, 2015). A consistent feature noted in some approaches – such as, the circular economy (Montoute & Peters, 2022), nature-based approach (Corbi et al., 2021), and climate adaptation approach (Medina et al., 2021) – has been the potential of wastewater reuse to supplement strained water resources while meeting environmental considerations. A look at water withdrawals in the Caribbean provides an indication of which category of water withdrawal places the highest burden on internal water resources and hence potential contribution to wastewater discharge. It also suggests where there may be a need for targeted wastewater reuse strategies to reduce dependence on existing resources. On average as per data available for the 16 Caribbean countries in 2019, municipal activities account for the largest water withdrawals at 41.4%, followed by the agricultural sector at 41% and finally the industrial sector at 17.6% (FAO, 2019). These proportions vary vastly depending on the country with some of the larger or more agrarian economies like Guyana and Belize having disproportionately high agricultural withdrawals than more industrialized/tourist-centric economies like Trinidad and Tobago and St. Vincent and the Grenadines.

The potential for reuse would be of particular importance to the more water stressed countries like Antigua and Barbuda versus water abundant countries like Suriname.

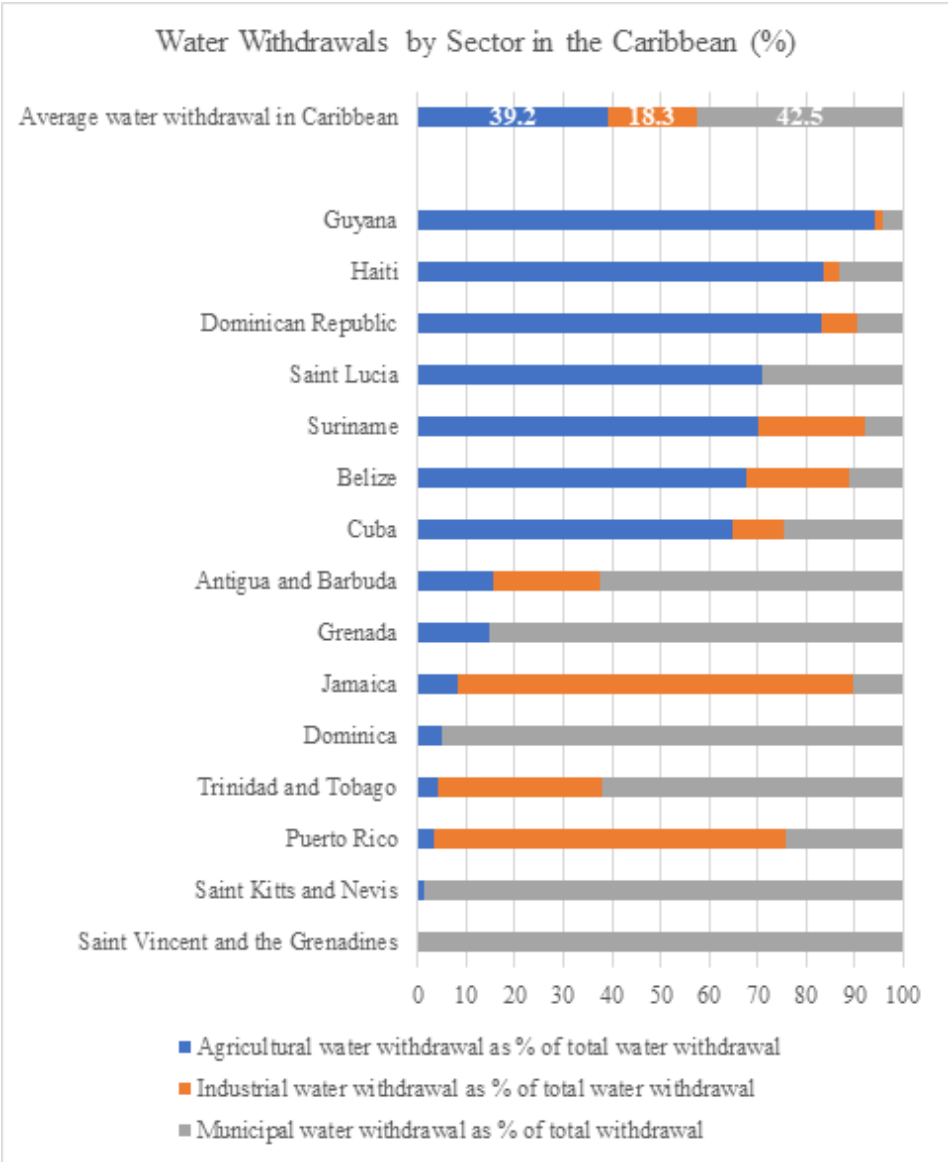

Figure 2. Sectoral water withdrawals as a proportion of total water withdrawals in several Caribbean countries in 2019. Sourced and retrieved from the Food and Agriculture Organization (FAO) database.

Issues in the Approaches to Wastewater Disposal and Reuse

Numerous “failures” in wastewater management stem from a lack of coordination in defining the desired output after wastewater treatment. There are now a broad range of methods, such as aerobic, anaerobic, and physicochemical processes, that can be used to treat effluents from the standard of simply removing gross solids to the standard of having potable water (United Nations, 2015). The challenges arising from this are that since there are many different standards applied to water treatment for different entities, communities, and administrative units, there is little uniformity in the end product after wastewater treatment – attaining primary, secondary or tertiary level of treatment. Not only does this confound control of quality of water

disposed but, also presents obstacles in reforming management approaches to adopt wastewater reuse systems.

It is important to note that not all wastewater generated from residential and commercial activities becomes conveyed to treatment systems. In fact, in the Caribbean, most assessments have shown that the majority of wastewater remains uncollected for treatment – a pre-emptive indicator of inefficient wastewater management in the contemporary sense, where environmental considerations and reuse potential are included in developmental goals. Pertaining to SDG 6.3.1 [Proportion of safely treated domestic water flows], data were only available for two Caribbean countries (Cuba and Suriname) and showed that around 76% of wastewater generated domestically remained unsafely treated or untreated in 2020. This represents a major shortfall in collection systems that are consequences of limited infrastructural networks, lack of forward planning for the built environment, and limited capacity of service providers. This lack of pertinent indicator data also serves to highlight gaps in data collection which hinder holistic assessments of wastewater management and failure to monitor progress towards water and sanitation SDG targets in the Caribbean.

In many cases the push has been to transfer water management strategies applied in the higher-income countries to the Caribbean. In an analysis of the three major governance paradigms associated with water resource management that was popularized in the last century, Belmar et al (2016) postulated that the paradigm most suitable for the governance structures in SIDS, like the Caribbean, would be the adaptive management paradigm. This concept acknowledges social-ecological systems perspectives, multi-scalar, governance partnerships and iterative planning, which are features vital in developing policies in the small-economies where civil service agencies do not have the luxury of being politically neutral and there is less chance of maladaptation (Belmar, McNamara, & Morrison, 2016). The Caribbean countries may need to examine the suitability of iterative management with room for re-evaluation over smaller timeframes. This is based on the consideration that much effort has been put into designing policy based on the integrated water management paradigm despite lacking the top-bottom governance rescaling needed for management at the watershed management level. For the Caribbean, the risk of maladaptation of wastewater management must be circumvented through adaptive evaluation and local awareness.

Wastewater Management Coverage and Approaches in Jamaica

In Jamaica, the public supply of drinking water and sewage treatment falls under the responsibility of the National Water Commission (NWC), while regulation, control and management of water resources are the duties of the Water Resources Authority (WRA). Figure 3 shows the existing wastewater treatment plants in the island operated by the NWC and Figure 4 shows the location of the 187 wastewater treatment plants that are monitored by the Environmental Health Unit under Ministry of Health. The NWC operates a fairly large number of plants in the island and accounts for 90% of the sewage handled and collected in major urban areas in the parishes of Kingston and St Andrew, St Catherine and St James. As per the GEF CREW 2015 report there are 306 sewage treatment plants in the island with 67 of them operated by the NWC.

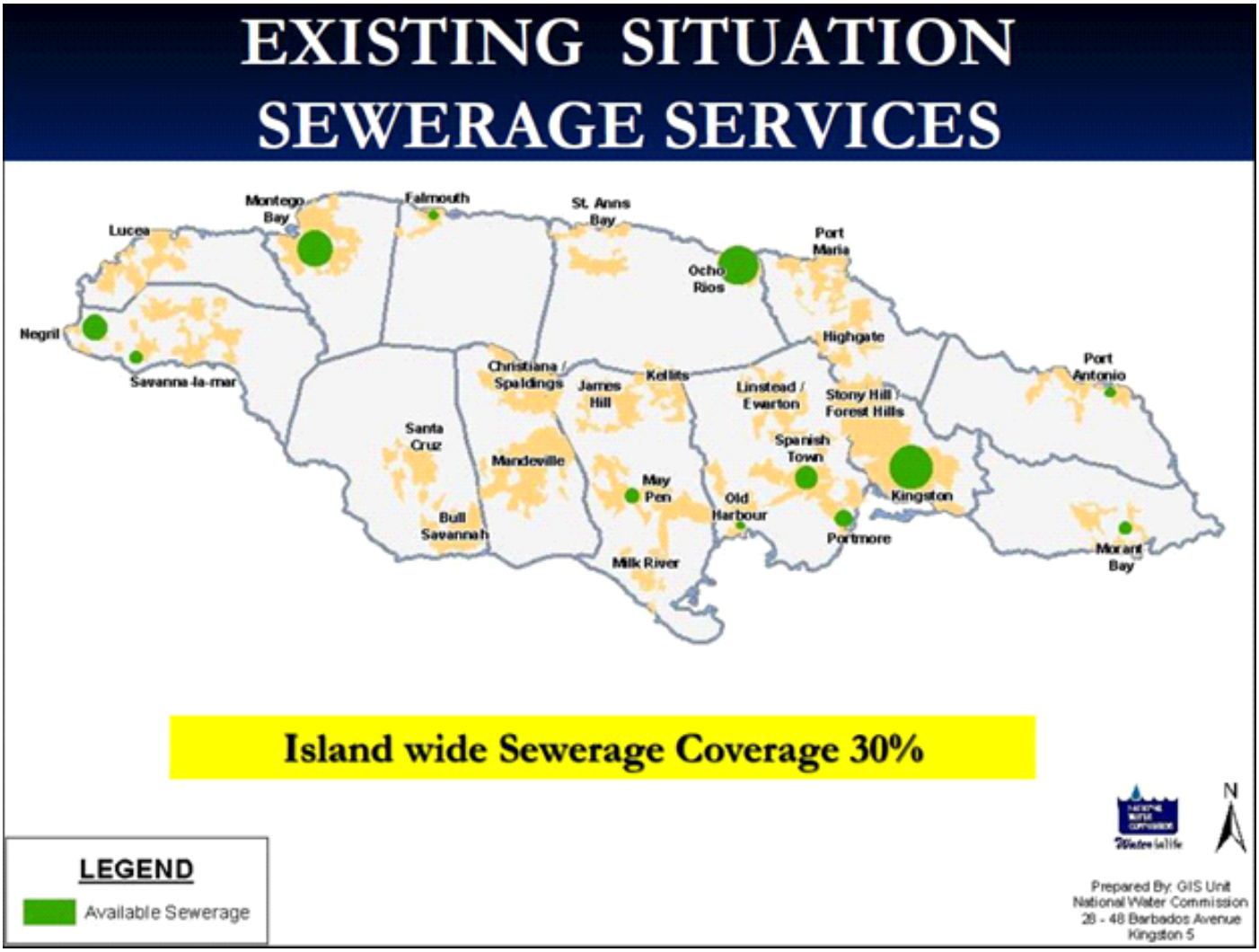

Figure 3. Islandwide Coverage of Sewerage system in Jamaica. GEF CREW Report 2015.

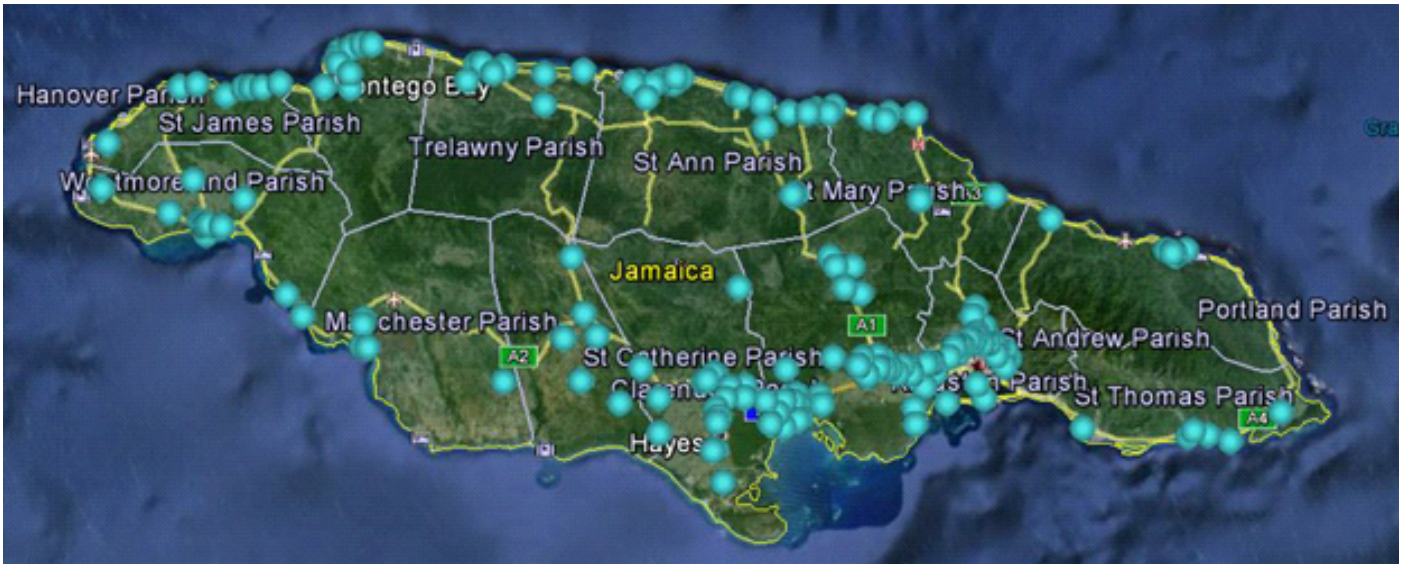

Figure 4. Location of 187 major Wastewater Treatment Plants in Jamaica (GEF CREW Report 2015).

Other satellite departments, agencies and SOEs are responsible for water supply to rural communities and agricultural irrigation, like the National Irrigation Commission and parish councils, however, NWC has the sole responsibility for wastewater treatment. The regulatory services of the WRA are supported by the National Environment Planning Agency (NEPA) and the Office of Utility Regulations (OUR). Policy and institutional initiatives, guided by SDGs, have been articulated through the revised National Water Sector Policy and Implementation Plan 2019, the Water Sector Plan, and Vision 2030 Jamaica – National Development Plan. Renewed focus has been made clear in revised strategic plans that have as their main outcomes, that all households will have access to improved sanitation, and technical solutions and institutional arrangement will be reformed to support universal access. In terms of goals of the National Water Sector Policy 2019 which relate to wastewater, only one of 13 objectives explicitly refer to effective wastewater management. Most objectives have implicit benefits that carry over to wastewater management. As explicated in Voluntary National Reviews (VNR), these objectives have guided advancements in sustainable development of mandate to provide clean water and sanitation. However, the assumption of implicit improved wastewater management may prevent outright prioritization of all components of wastewater management. The revised policies seek to target the most relevant challenges faced by Jamaica in water management, such as, high non-revenue water, high energy consumption, and poor storage and infrastructural capacity. The guidance principles around the latest iteration of the National Water Sector Policy are sustainability and intergenerational equity, efficiency, integrated water resource management (IWRM), universal access, gender and vulnerable groups responsiveness, and stakeholder participation (Government of Jamaica, 2019). From the legislative perspective, the *Town and Country Planning Act (1958), National Water Commission Act (1963), Watershed Protection Act (1963), Public Health Act (1985), Office of Utilities Regulation Act (1995, 2015), and Public Bodies Management and Accountability Act* (2001) provides the legal framework for wastewater management activities in the country. Together, these acts govern the provision of secure sanitation conditions through development orders, the operation of wastewater services, the provision of national standards for waste disposal, the enforcement of regulations around sewerage and related utilities, and the financial accountability by which delegated public entities are held (Government of Jamaica, 2019). No act is dedicated solely to wastewater management in Jamaica. While the previously mentioned acts contain laws for effluent treatment, disposal and management, this fragmentation exacerbates the control and delegation issues around the subject matter.

According to the 2021 JMP, 51.3% of households in Jamaica use improved latrines while 24.8% are connected to septic tanks and 22.8% are connected to sewer networks. Compared with the findings of the 2017 JMP, there has been a 6.5% increase in the use of improved latrines from 2015, a 3.4% increase in connections to septic tanks, and a 3.6% increase in sewer connections (SALISES, 2018). One of the major issues to water security that overlap with wastewater management is water pollution. Around 10% of surface and groundwater quality in Jamaica has been affected by inadequate disposal and treatment from domestic, commercial, and industrial activities (Government of Jamaica, 2019). Extensive use of absorption pits and poorly maintained septic tanks have led to nutrient and faecal pollution of many aquifers and watersheds, while leachates from unsealed limestone pits for bauxite/alumina discharge and dunder from rum distilleries have contributed to sever degradation of 4 of 26 watershed management units in Jamaica (Government of Jamaica, 2019). Most recent inventories of wastewater treatment plants in Jamaica have shown that around 97 plants are in operation by the NWC (Medina et al., 2021) up from 71 in 2015 (Silva, 2015), though there may be vast differences in capacity and efficiency of said operations from plant to plant. The largest treatment plants in the island are the Soapberry, Greater Portmore, Negril, Montego Bay, and Ocho Rios plants which handle 60% of sewage collected (Silva, 2015). A benchmarking study assessed the performance of SOEs with primary water supply and sanitation functions in the Caribbean (Medina et al., 2021). The study found that focus on the provision of utilities (water supply services), along with limited financial capacity and poor maintenance has resulted in inadequate coverage of wastewater handling responsibilities (Medina et al., 2021). The NWC, as the sole SOE responsible for both water and sewage services in Jamaica, meets the criteria for risk of underperformance based on inadequate cost recovery and inadequate focus on maintenance (Government of Jamaica, 2019). It is noteworthy however, that the Soapberry Treatment Plant remains the only plant in the Caribbean that treats wastewater to a tertiary level (Silva, 2015). The success of this plant has been the result of a public-private partnership between the NWC and the Central Wastewater Treatment Company which sees to operations with a 75,000 m^3/day capacity. Current efforts are underway to further increase the capacity and recycling capabilities of the Soapberry Treatment Plant while reducing energy consumption with outfitting of renewable technologies through a US$85 million project with the Development Bank of Jamaica. This proves that similar PPP procurement models are effective within the wastewater landscape of Jamaica; an opportunity which has been highlighted by the government with emphasis on economic programs to boost investor confidence within the sector (Government of Jamaica, 2019).

Apart from public or semi-private agencies, wastewater treatment and reuse has been undertaken by private companies in Jamaica, either independently or guided by government campaigns encouraging wastewater reuse (Government of Jamaica, 2022). The operations undertaken at the wastewater treatment facility of the Jamaica Broilers Ethanol Dehydration Plant provide one such example of private sector treatment which has led to overall reductions in water usage across production facilities in the company (Jamaica Broilers Group, 2006, 2016). The bauxite industry is one of the largest and most water intensive industries in the country. Campaigns and reuse initiatives have also focused on encouraging and institutionalizing wastewater recycling in bauxite companies (Government of Jamaica, 2022; Silva, 2015). Through these efforts, there has already been a reduction in water withdrawals by the industry (Government of Jamaica, 2022).

The tourism sector drives a significant portion of the nation's economy bringing in approximately US$3.3 billion in 2022 (Government of Jamaica, 2023), yet poses significant threats and challenges to the environment and accounts for high amounts of water withdrawals each year (Silva, 2015). In 2022, there were 3.3 million visitor arrivals to Jamaica, and current trends suggests that this will continue to increase (Government of Jamaica, 2023). Initiatives have been aimed at promoting water recycling in the tourism sector especially focusing on the six main destination hubs that receive the higher numbers of tourists. In response to pressures on water demand owing to influx of visitors to the island, several resort areas have

used recycled water for outdoor recreational activities like for irrigating golf courses. Environmental tests conducted by the WRA have noted that coastal water near hotels that have wastewater treatment plants are of better quality than those without, where biochemical oxygen demand (BOD), total coliforms (TC), and faecal coliform (FC) content are significantly lower than other hotel adjacent beaches (Silva, 2015).

From the domestic and municipal perspective, which account for around 10% of the total water withdrawal in Jamaica (FAO, 2019), several housing developments have wastewater treatment plants and utilize recycled wastewater for outdoor maintenance tasks (Silva, 2015). Efforts to improve coverage in rural areas and smaller communities have been undertaken through projects by the Rural Water Supply Limited. Externally funded projects such as the GEF CReW and GEF CReW+ focus on implementing small scale solutions in the Caribbean based on an Integrated Water and Wastewater Management approach that targets the institutional level planning, sustainable financing, nature-based design, and data sharing and knowledge management. Of note, this has been articulated through manuals entitled, 'Training Manual on Water Use Efficiency (WUE) in Agriculture' and 'Training Manual on Aquaculture for Caribbean Small Island Developing States (SIDS)' that articulates strategies inclusive of water budgeting and production waste management in water-based food production systems which was noted to have particular relevance to Jamaica (Creary, 2020). Furthermore, the CReW project, in partnership with NWC, commenced the design and implementation of three wastewater conveyance systems to replace decommissioned wastewater treatment plants in Acadia, Bay Farm Villas and Hughenden, and divert effluent to the Soapberry Treatment Plant (SALISES, 2018).

Evidence suggests that while more progress needs to be made in improving wastewater management, especially to improve treatment beyond primary and secondary levels according to national and international standards, there have been key advances in connectivity of sewerage for urbanized areas in Jamaica. With a broadening of the scope of wastewater management, there may be a need to consider appointing a separate entity with wastewater treatment responsibilities, or at least revamping the capacity of the NWC and WRA to boost efficiency and coverage of their operations, especially in non-urbanized areas. While the institutional arrangements and policy framework exist to guide the path to water and sanitation developmental targets, the nation struggles with limited capacity of existing infrastructure, inadequate oversight and poor maintenance and equipment upgrading (Government of Jamaica, 2019) which are steadily lagging in the face of urban population growth. That said, the privately-run operations and funded projects have eased the pressure off overburdened SOEs. The use of locally appropriate systems, such as community level treatment plants and properly maintained absorption pits where, and the Bio-digester technologies developed by the Scientific Research Council has benefitted Jamaica and provided more access to sanitation services. These are more apt in the Jamaican context than systems directly mimicking systems from larger more developed counterparts, as can be seen from the establishment of package plants in rural areas where the construction of centralized systems would be too costly and disruptive. Legislation mandates connections to sewer networks in residential developments within 90 meters of NWC sewerage systems (NWC, 2023), and WRA has restricted new building permits for premises planning to utilize absorption pits in the Corporate Area (Foster, 2010). These policies will facilitate the transition to systems conducive to the public regularization of wastewater recycling, and plans for increasing the number and capacity of treatment plants steer the country towards much needed reductions in discharge of unsafe wastewater. The concern, however, is that Jamaica is subject and highly susceptible to stressors like the global energy crises and economic recessions, which are compounded by the uncertainties associated with shifts away from climate precedents resulting in longer droughts, more intense extreme weather, as well as threats of potential geophysical disasters like earthquakes. The pace of building resilience in all sectors, including and especially water and sanitation, needs to be accelerated to withstand, and ensure timely recoveries from, internal and external shocks.

Takeaways for Jamaica Wastewater Management

1. The legal and institutional framework exists to support sustainable wastewater management in Jamaica. However, fragmented legislation with caveats for location- and condition-specific delegation in the maintenance of wastewater and sanitation services/regulations confound the enforcement of acts and policies surrounding treatment quality, system siting, and coastal and watershed pollution. The result is a complex chain of command that is slow to engage and limited in investigative capacity owing to inadequate cost recoveries. Focus must be placed on consolidating wastewater legislation to make clear the responsibilities from the community level upwards. This must be paired with informative and wide-reaching public campaigns to increase awareness of public and private consequences and reporting structures. Limited enforcement of acts has severely impacted human and environmental health. Urgent focus has to be given to increasing the scope, frequency and parameters of water quality tests and environmental assessments to ensure timely regulation and attract heavy corrective fees for flagrant offenders.

2. The coverage of waste disposal facilities in Jamaica has increased over the past 10 years. While commendable, the pace must be accelerated to meet 2030 targets. Forward planning must involve siting of disposal facilities based on hydrogeological, socioeconomic, and environmental factors such as distance from rivers, dominant economic activity and income level of communities, and underground aquifers and flows, to ensure the use of locally appropriate facilities within community context. Climatic shocks have been identified as events to which we are vulnerable; planning must account for the resilience of structures and renewed focus must be given to maintaining infrastructure and technical knowledge of all associated ministries, departments, and agencies (MDAs) and SOEs. Current coverage of sewerage facilities by the NWC stands at around 30% of the population with the majority of wastewater pipelines concentrated within the corporate areas of KMA and Montego Bay. NWC has plans to increase connectivity and conveyance to treatment plants, however, these must also be accelerated to across corporate areas as well as communities above shallow aquifers or with other characteristics that heighten vulnerability to pollution.

3. The contribution of private sector and PPPs in improving wastewater management has been particularly visible for several industries like tourism and bauxite, and the most successful and wide-reaching example of remains the Soapberry Plant. Given the limitations of MDAs and SOEs from the maintenance and capacity standpoint, continued exploration and expansion of similar collaborative projects can be beneficial, especially if guided by principles in the 2019 National Water Sector Policy and Vision 2030.

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