Managing Water Resources in Jamaica, the Land of Wood and Water

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Abstract

As a result of continued global warming, it is expected that Jamaica will experience increasing droughts and stronger storms, affecting land use patterns and water supply systems. Jamaica has a total land area of 10830.0 sq. km. Approximately 40% is used for agriculture, and approximately 10% is permanent crop land. Slightly more than 30% comprises forestry reserves. However, these reserves, as well as agricultural lands are under threat, as Jamaica continues to experience extreme climate-related events in storms and droughts. Historically, Jamaica has a tropical maritime climate. Temperatures range from a low of 26° C in February to a high of 30° C in August. It is mountainous and the average temperature changes by 2° C with every 300m change in altitude. Long-term mean annual rainfall is 1,981 mm. The hurricane season from July to November usually causes flooding. Since more than 80% of Jamaica's water is from groundwater sources, this poses great threat to the quality and the quantity of future freshwater resources. This article explores the management of Jamaica's freshwater resources and the roles of the Water Resources Authority, the National Water Commission, and the National Irrigation Commission in preserving this valuable resource.

Keywords: Jamaica, freshwater resources, climate change

1. Introduction

As a result of continued global warming, it is expected that Jamaica will experience increasing droughts and stronger storms, affecting land use patterns and water supply systems (See Table 1). Jamaica has a total land area of 10830.0 sq. km. According to the World Bank's (2011) indicators, approximately 40% is used for agriculture, and approximately 10% is permanent crop land. Slightly more than 30% comprises forestry reserves. However, these reserves, as well as agricultural lands are under threat, as Jamaica continues to experience extreme climate related events in storms and droughts. Historically, Jamaica has a tropical maritime climate. According to data from the Water Resources Authority (WRA) (2014), temperatures range from a low of 26° C in February to a high of 30° C in August. It is mountainous and the averagetemperature changes by 2° C with every 300m change in altitude. Long-termmean annualrainfall is 1,981 mm. The Blue Mountains receive over 5,080 mmannually whereas the city of Kingston receives less than 762 mm as it, and most ofthe Southern Coast, falls in the rain shadow of the Blue Mountains. There is abi-modal pattern of rainfall with the primary maximum in October and secondary inMay. The hurricane season from July to November usually causes flooding. Sincemore than 80% of Jamaica's water is from groundwater sources, this poses greatthreat to the quality and the quantity of future freshwater resources (Water Resources Authority, WRA, 2014).

Various reports indicate that Jamaica has experienced an increasing number of storms, as well as droughts, over the last decade. These have severely impacted economic growth and development. Prior to the category 5 hurricane, Gilbert, in 1988, most Jamaicans could only recall Hurricane Charlie that affected the island in 1951. However, current reports reveal an

increase in storm activity, as well as increased intensity of the storms, resulting in major damage to infrastructure, economic and social activities, and also loss of life (Government of Jamaica, GoJ, 2013; 2015; Observer, 2012). The Climate Change Policy Framework and Action Plan (GoJ, 2013) prepared by the Ministry of Water, Land, Environment, and Climate Change (MWLECC), highlighted the following:

> Between 2001 and 2012 Jamaica experienced 11 storm events (including 5 major hurricanes) and several flood events. These events combined resulted in loss and damage amounting to approximately J$128.54 billion (State of the Jamaican Climate 2012 Report), in one case (Hurricane Ivan, 2004) the loss was equivalent to 8.0 % of GDP. Hurricane Sandy (2012) accounted for J$9.7 billion or 0.8% of 2011 GDP in direct and indirect damage (J$9.4 billion in damage and J$0.3 billion in losses, including expenditure for vector control) as well as increased expenditure by private and Government entities. The health, housing and education sectors experienced the greatest impact accounting for 48% of the total costs in damages. One death and 291 injuries resulted from Hurricane Sandy (Government of Jamaica: GoJ, 2013, p. 7).

Additionally, with the changes in temperature and the fluctuations in the water cycle, doctors have seen an increase in the number of children with asthma in the Kingston Metropolitan Area. There have also been an increase in the number of vector-borne diseases being experienced by the island. Dengue cases have been diagnosed and quickly treated, curtailing the spread across the island. However, the country was severely affected by the Chikungunya virus transmitted by the Aedes Aegypti mosquito in 2014. A conservative estimate by the Ministry of Health, predicted that approximately 60% of Jamaicans would be affected by chikungunya. In real terms, “that is one million six hundred thousand Jamaicans, and with a downtime of five to 10

days, we are estimating a loss to the Jamaican economy of at least $30 million using a daily wage of $2,000.00 per day" (Gammon, 2014). This year, 2016, Jamaica officially confirmed its first case of the Zika virus on January 17, 2016 (Observer, 2016; Stanglin, 2016). Prompt responses from the government to fog the surrounding communities, as well as extensive public education campaigns have raised awareness among the populace. However, this new vector-borne disease once again confirms the importance of protecting and providing freshwater resources in the country.

2. Agencies with Primary Responsibility

Jamaica's national water demand can be divided into 4 categories (Table 2). Agriculture has been, and is expected to remain, the largest consumer of water; consuming from 75% to 80% of the total demand over the last 3 decades. Non-agricultural demand consists of domestic urban and rural demand which consumes approximately 17% to 15% of total demand. Industrial consumption follows, ranging from 5% to 7% of total demand. The tourism sector is the last major consumer of the national demand, accounting for 1% of the total demand. The primary agencies responsible for meeting this demand are the WRA, the National Water Commission (NWC), and the National Irrigation Commission (NIC). They also partner with other agencies in fulfilling their mandates. The following section explores the roles of these 3 primary agencies and the strategies they have proposed and adopted in the management of Jamaica's freshwater resources.

2.1 The Water Resources Authority

The WRA, by the Water Resources Act of 1995, is responsible for "the orderlydevelopment and equitable allocation of water resources, including the analysis ofalternative methods of developing and supplying water…" According to the Jamaica Water Sector Policy (Ministry of Water and Housing, 2004), the WRA has "formulated the Water ResourcesDevelopment Master Plan" (p. 13). This plan identifies the 10 main hydrologic basins in Jamaica, and accounts for the supply and demand of water resources at that level. Secondly, they have "prepared the National IrrigationDevelopment Master Plan with theNational Irrigation Commission" (p. 13). This plan accounts for the high consumption of the agricultural sector by defining the irrigable areas and thedemand of the sector. Thirdly, the WRA "worked with the National Water Commission (NWC) to prepare 'parish plans' setting out time-frames fordevelopment of resources" (p. 13).

Besides agricultural concerns for water, approximately 82% of Jamaica'spopulation lives along the coast line, or within 5km of the coast (Climate Change Policy Framework, p. 16). Thismeans thatmost of the population is vulnerable to saltwater intrusion if freshwater resources are notprotected.

2.2 The National Water Commission

The WRA works closely with the NWC, ParishCouncils and the NICto develop innovativetechnologies to ensure adequate water supply, especially for agriculture anddomestic sanitation."The National Water Commission is responsible forthe urban water supply throughout the island. It isalso the largest provider of sewerage services" (Ministry of Water and Housing, 2004, p. 14).Some sewerage services are provided in partnership with the Urban Development

Corporation (UDC), and housing developers. Table 3 summarizes the NWC's water supply to the public and the type of access available to urban and rural dwellers, from piped water and standpipes, to surface water and wells. "The great majority of urban residents have accessto safe, piped, potable water" (p. 14). Approximately 98% of the KMAhouseholds have piped water; and 86% in other towns. Where there is no piped water the predominant type of access is through a community standpipe. The NWC boasts that "about half thestandpipe users in urban areas travel 46 metres orless to fetch water" (p. 14). However, the extensive coverage is often affected by inconsistent and erratic supply as a result of low precipitation or equipment in need of repairs.

In the rural areas, the Parish Councils work closely with the NWC in supplying potablewater. This is done through "usingsprings, rainwater catchments and wayside tanks" (p. 35). Additionally, private suppliersof water also assist in meeting the demand. For example, the Four Rivers Development,the bauxite companies, Rio Bueno Water Company,
some private estates and Runaway Bay Water Company, a publicly-owned, private company" (p. 35).

One of the expectations of the future is water stress. For example, the most severe drought in five years that affected Jamaica, and the wider Caribbean, in summer 2015 (Observer, 2015), that resulted in long periods of water restrictions all across the island. Water stress is where there is a severe shortage of water relative to the demand for water.

> In global-scale assessments, basins are defined as being water stressed if they have either a per capita water availability below 1,000 m3 per year (based on long-term average runoff) or a ratio of withdrawals to long-term average annual runoff above 0.4. A water volume of 1,000 m3 per capita per year is typically more than is required for domestic,

> industrial and agricultural water uses. Such water-stressed basins are located in northern Africa, the Mediterranean region, the Middle East, the Near East, southern Asia, northern China, Australia, the USA, Mexico, north-eastern Brazil and the west coast of South America … (Bates, Kundzewicz, Wu & Palutikof, 2008, p. 8).

This means that approximately 1.4 billion to 2.1 billion people are affected by water stress (Bates, Kundzewicz, Wu & Palutikof, 2008). For Jamaica, the implications for water stress are clear, particularly in light of the severity of the drought experienced during July and August 2015. As the majority of Jamaica's water supply is met through groundwater sources, the concern increases when there is a decrease in precipitation patterns and a reduction in streamflows and run-offs to recharge groundwater resources. "In most countries, except for a few industrialised nations, wateruse has increased over recent decades, due to population andeconomic growth, changes in lifestyle, and expanded watersupply systems, with irrigation water use being by far the mostimportant cause" (Bates, Kundzewicz, Wu & Palutikof, 2008, p. 9). As with Jamaica, agriculture is globally the largest consumer of freshwater resources. Reports indicate that "Irrigation accounts for about 70% of total waterwithdrawals worldwide and for more than 90% of consumptivewater use (i.e., the water volume that is not available for reuse downstream) (Bates, Kundzewicz, Wu & Palutikof, 2008, p. 9). Global population rates are on the decline, so "Global water use is probably increasing dueto economic growth in developing countries" (Bates, Kundzewicz, Wu & Palutikof, 2008, p. 9). As economic growth is driven by agricultural and industrial activities, the unintended consequence has been an increase in the level of contamination of surface water and groundwater sources. In Jamaica, one of the major challenges facing the Kingston and Metropolitan Area is the contamination of the wells and aquifers as a result of industrial activities. "To counterthis problem, many countries (e.g., in

the European Union andCanada) have established or enforced effluent water standards and have rehabilitated wastewater treatment facilities" (Bates, Kundzewicz, Wu & Palutikof, 2008, p. 9).

In light of the global concerns regarding water stress, Jamaica is becoming more proactive in the approach to water management. In 2004, reports revealed an unmet demand of approximately "220 million litres per day. It isprojected that by the year 2010, the un-metdemandfor potable water will be 320 million litres per day,if no additional capacity is put in place" (Ministry of Water and Housing, 2004, p. 37). In order to meet this shortfall, the GoJ had outlined a number of strategies which included, "household taps, catchment tanks and the trucking ofwater" (Ministry of Water and Housing, 2004, p. 37).

The un-met demand of water has increased significantly in light of the severe drought that affected the island in 2015 from July to November. In an emergency press release to the nation, the Minister of Water, Land, Environment and Climate Change, the Hon. Robert Pickersgill, it was clear that extreme events can challenge any action plan. For example, "since January only 74 per cent of normal rainfall has occurred, with the least amount in May, which is the secondary rainy period" (Observer, 2015). This meant that as early as July 2, 2015, "critical water sources, including dams, reservoirs and rivers, are being depleted, or have all but dried up" (Observer, 2015). Reports on storage levels at that nation's major reservoirs in the KMA were critical. The NWC, reported that levels "at the Mona Reservoir was at 32.8 per cent, or 264.4 million gallons, out of a capacity of 808.5 million" (Observer, 2015). At the "Hermitage Dam are down from 393.5 million gallons to 173.8 million gallons, or 44.2 per cent of capacity. 'At the best of times, the inflow would be 22 million gallons per day,' Minister Pickersgill said" (Observer, 2015). Also evident was the severe drop in production at many of the facilities, to about half their normal capacity. The Hope Treatment Plant produced "3.7 million gallons per

day, a little over half of its normal capacity"; the Mona Treatment Plant dropped from 16 million gallons per day to 7.1 million gallons; and, the Constant Spring Treatment Plant produced only 5.4 million gallons per day, down from 20 million gallons (Observer, 2015).

The situation was more severe in some parishes than others, for example in Clarendon which received only 8% of its normal rainfall, and St. Thomas, which received 16 per cent of its normal rainfall for the month of May. "Manchester saw only 40 per cent, while St Mary recorded 30 per cent, and Portland 34 per cent. These parishes are all said to be experiencing 'severe drought' " (Observer, 2015).Consequently, a mixed modality approach had to be taken to mitigate the effect of the drought on the island, particularly on health and agriculture. Prohibition notices prevented citizens from wasting water on washing vehicles, filling swimming pools, watering lawns and more. While water was trucked to the most severely affected communities. The NWC began exploring the feasibility of rehabilitating wells in the Corporate Area. Additionally, in an attempt to protect the agricultural sector, farmers in the southern region received assistance from the NIC's Rapid Response Unit (Observer, 2015).

These strategies have been implemented over the years, and continue to be the main strategies used to meet the shortfall in supply. However, a more sustainable programme of water supply through upgrading the NWC's facilities is also underway. The NWC, over the last several years, has been investing $100 billion dollars to upgrade theirsystems. This includes refurbishing/upgrading of water production sources, networkrefurbishing to reduce technical losses and improve service level and wellrehabilitation. Additionally, they do coastal clean-ups to prevent saltwater intrusion and also to maintain the integrity of the current systems (Mitchell, 2014).

2.3 The National Irrigation Commission

The NIC works to supply the agricultural sector with water in Jamaica. As the largest consumer of freshwater resources, the agricultural sector is particularly vulnerable to changes in the water supply. Droughts and floods can result in significant damage to the economic and social conditions of the country. This was once again illustrated during the most severe drought to hit the Caribbean region in five years. Reports estimate that "the farm sector has lost more than US$1 million in crops as well as tens of thousands of dollars in livestock, said Norman Gibson, scientific officer at the Trinidad-based Caribbean Agricultural Research and Development Institute" (Observer, 2015). Threats to the water supply to agriculture go beyond rainfall patterns. They also include greater levels of sedimentation in reservoirs and loss of agricultural lands (Climate Change Policy Framework, 2013; 2015; IPCC, 2014).

According to the Ministry of Water and Housing (2004), "The total potential irrigable area of Jamaicais approximately 188,000 hectares.Approximately 25,000 hectares, or 10% ofcultivated lands in Jamaica, are currently irrigated" (p. 44).Half are reportedly managed by the NIC, while the other half exist on commercial farms. Irrigation systems are implemented in areas where conditions are dry and rainfall is less than "1000mm/yr, which is inadequate for economic agricultural production. Of the areas irrigated by the NIC, 80% are served by surface systems, compared with the 70% served by private schemes" (Ministry of Water and Housing, 2004, p. 44).

The primary crop for irrigation is sugar cane, ranging from 70% to 80% of the NIC's systems. However, other crops such as mangoes, bananas, papayas and vegetables are also irrigated. Some of the commercial farms use more advanced technologies such as drip irrigation

and sprinkler in order to conserve water. Others may have implemented a waste water recycling system to maximize the benefits of all water used on the properties.

The NIC developed the National Irrigation Development Plan (NIDP) in 1998. The plan,

- assessed the state of the irrigated agricultural sector;
- identified and prioritised projects for implementation;
- proposed the establishment of Water Users' Associations (WUA's) to increase farmer participation; and
- proposed strategies for making NIC self-sustainable(Ministry of Water and Housing, 2004, p. 45).

The NIC conducts work in collaboration with other partner agencies. One of their chief partners in managing on-farm irrigation systems, is the Rural Agricultural Development Agency (RADA). Together they work "to promoteefficient use of water" (Ministry of Water and Housing, 2004, p. 45). Some of the measures that they have already implemented to improve the efficiency of water management in the agricultural sector includes, "conveyance systems, such as canal lining,installation of pipe systems, and watermeasurement" (Ministry of Water and Housing, 2004, p. 45). In time, the NIC will work with farmers and other stakeholders to replace earthen channels with pipes, introduce more canal-lining or piped systems, construct new reservoirs, rehabilitate existing micro-dams, and more. However, programme development and implementation are costly and so public-private partnerships are being encouraged to develop the water resources in the agricultural sector.

1. Jamaica's Responseto Managing Freshwater Resources

The MWLECC anticipates that Jamaica will experience a permanent rise in temperature by 2050, and an even greater rise by 2080. This is expected to produce more severe weather systems such as the storms and droughts that have been experienced over the last decade (GoJ, 2015). Consequently, a comprehensive and systematic approach to managing Jamaica's freshwater resources is imperative. According to the GoJ, "Human resettlement will cause increasing degradation and destruction of watersheds, and scarcity during periods of prolonged droughts" (Climate Change Policy Framework, 2013, p. 17). Therefore, any adaptation and mitigation strategies must account for population growth and settlement, as well as preserve Jamaica's "Bread Basket." The GoJ's main strategy to climate change has been adaptation planning, requiring that all policies and plans reflect the importance of climate change and increase Jamaica's resilience to combat the effects. Mitigation strategies to limit the impact of climate change on the country are also considered, particularly in relation to the energy sector (GoJ, 2015).

The GoJ, specifically the Climate Change Department (CCD) in the MWLECC,has been engaged in publicawareness activities for several years. This included a 2012 Report on Climate Change and theClimate Change Adaptation & Disaster Risk Reduction Project 2012-2013.However, poverty is still a challenge for the most vulnerable sectors of society.Jamaicans have been encouraged to conserve and to store water. They have alsobeen advised to empty containers that contain standing water to decrease the riskof vector-borne diseases. In 2008, a draft National Water Sector AdaptationStrategy was prepared under the Mainstreaming Adaptation to Climate ChangeProject being led by the Caribbean Community Climate Change Centre (CCCCC).This assessed the vulnerability of the water sector and outlined the duties of thegovernment and other key stakeholders.

Since then, Jamaica has prepared the Climate Change Policy Framework and Action Plan (GoJ, 2013), and held public consultations with a range of stakeholders from the public and private sectors, as well as civil society. In September 2015, the Climate Change Policy Framework for Jamaica (GoJ, 2015) was approved by the Parliament, and accepted as Jamaica's response to climate change in all sectors. The ultimate aim of the Framework is, "to create a sustainable institutional mechanism to facilitate the development, coordination and implementation of policies, sectoral plans, programmes, strategies, policies and legislation to address the impacts of climate change" (p. 10). In general, the CCD, in the MWLECC, will be the centre of all the activity related to climate change in Jamaica, acting as a clearing house for information and institutional support, as well as directing policy development and national plans regarding adaptation and mitigation strategies to climate change.

Additionally, new policies were formulated in 2015 related to managing Jamaica's freshwater resources, for example on rainwater harvesting.

> The 2015 Policy Guideline on Rainwater Harvesting which will guide members of the public, developers and the planning authorities by providing information, standards and criteria/requirements for mandatory rainwater harvesting and use. Additionally, it aims to encourage citizens to partner with government to mitigate this negative effect of climate change (GoJ, 2015, p. 18).

Among the flagship programmes identified by the GoJ, is a special initiative for water resources management. This programme acknowledges the importance of water as a critical input for every sector including health, energy, agriculture, industry, tourism, natural resource management, urban planning and so much more (GoJ, 2013; 2015). Consequently, any changes to the water supply system or the quality of water available to the populace will be of grave

concern for the GoJ. "MWLECC and the Water Resources Authority will play the lead role in this Special Initiative to develop programmes that address water resources management including watershed protection and the scaling up of conservation programmes (e.g. rain-water harvesting)" (GoJ, 2013, p. 35; 2015, p. 25).

However, Jamaica is rare among the countries of the world to have more than 80% of its water resources supplied from groundwater resources. Additionally, 50% of what is harvested and stored is lost through evaporation. So, programmes, policies, and strategies proposed and implemented by the GoJ must account for these facets of our environment (Mitchell, 2014). Other measures that can be implemented include low-pressure technology in the water supply systems, as well as dry toilets in an effort to conserve on our most valuable resource.One measure that has been implemented at the height of the drought in 2015 is the "Artificial Groundwater Recharge Project" in Innswood, St. Catherine. The facility uses a systems of wells, sinkholes and other components to treat water. It produces more than five million gallons per day for residents of St. Catherine and the Kingston Metropolitan Area (National Water Commission, 2015). In December 2015, the NWC also announced a public-private partnership between itself and the University of Technology, Jamaica (UTech), to install a sewerage system that would connect the UTech to the main Mona Road sewer system. In this phase of the project, "some 1.5 kilometres of PVC trunk sewers and sewer manholes from UTech's south-western boundary, to the existing manhole at the intersection with Mona Road will be constructed" (Observer, 2015). Most recently, the MWLECC (2016) released a Draft National Water Sector Policy and Implementation Plan which is intended to provide a more comprehensive strategy for freshwater management in Jamaica.

Water resource management cannot be separated from land use planning. The Climate Change Policy Framework of Jamaica (GoJ, 2013; 2015) includes a special initiative for land use planning. According to the Framework, "The MWLECC will play the lead role in this Special Initiative to rationalize land use planning and development processes including preparing a National Spatial Strategy and enacting regulations for Environmental Impact Assessments of proposed developments" (GoJ, 2013, p. 35; 2015, p. 26). Although no details of the initiatives are provided in the Framework, climate change adaptation strategies can be easily integrated into land use planning at minimal cost. For example, climate proofing in an urban centre such as Kingston.Through climate proofing, to increase the resilience of biodiversity and increase resilience to climate change, simple actions, likeclearing solid waste fromurban waterways to prevent localized flooding due to clogged drains, can have a far-reaching effect. Additionally, green infrastructureinvestments, such as pervious pavement, can generate economic advantages while alleviating theurban heat island effect and reducing the risk of flooding (World Bank, 2012). Hence, land use plans need to protect as much of the natural environment as possible, as well as make provisions to create carbon sinks to absorb the additional carbon that will be emitted in the atmosphere as a result of the proposed development (Mitchell, 2014, pp. 3-5).

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Appendix

Table 1: World Bank Indicators - Jamaica - Land Use

	Previous	Last
Agricultural land (sq. km) in Jamaica	4640.0	4490.0
Agricultural land (% of land area) in Jamaica	42.8	41.5
Arable land (hectares) in Jamaica	125000.0	120000.0
Arable land (hectares per person) in Jamaica	0.1	0.0
Arable land (% of land area) in Jamaica	11.5	11.1
Permanent cropland (% of land area) in Jamaica	10.2	9.2
Forest area (sq. km) in Jamaica	3382.0	
Forest area (% of land area) in Jamaica	31.2	
Average precipitation in depth (mm per year) in Jamaica	2051.0	2051.0
Land area (sq. km) in Jamaica	10830.0	10830.0

World Bank, 2011

Table 2: Water Resources Authority (WRA) Summary of National Water Demand

Demand Sector	**Present**		**2000**		**2015**	
	MCM/yr	**Percent**	**MCM/yr**	**Percent**	**MCM/yr**	**Percent**
Agricultural	682	75	1,149	80	1,338	79
Non-Agricultural	231	25	288	20	346	21
Domestic Rural	21	2	46	3	62	4
Domestic Urban	138	15	161	11	181	11
Tourism	10	1	15	1	23	1
Industrial	62	7	66	5	80	5
Total	913	100	1,437	100	1,684	100

Water Resources Authority, 2014

Table 3: Water Supply of the NWC by Type of Access in Urban and Rural Areas

Type of Access	***Present***
Urban	
Piped water	97% (Kingston)
	79% (other towns)
House connections	85% (KMA)
Stand pipes	8% (KMA)
Other water sources	6% (KMA)
No public services	1% (KMA)
Rural	
Piped water (inside)	20%
Piped water (outside, private tap)	18%
Standpipes	26%
Rainwater harvesting	23%
Wells	1%
Surface water	8%
Other sources	4%

Ministry of Water and Housing, 2004, p. 35

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