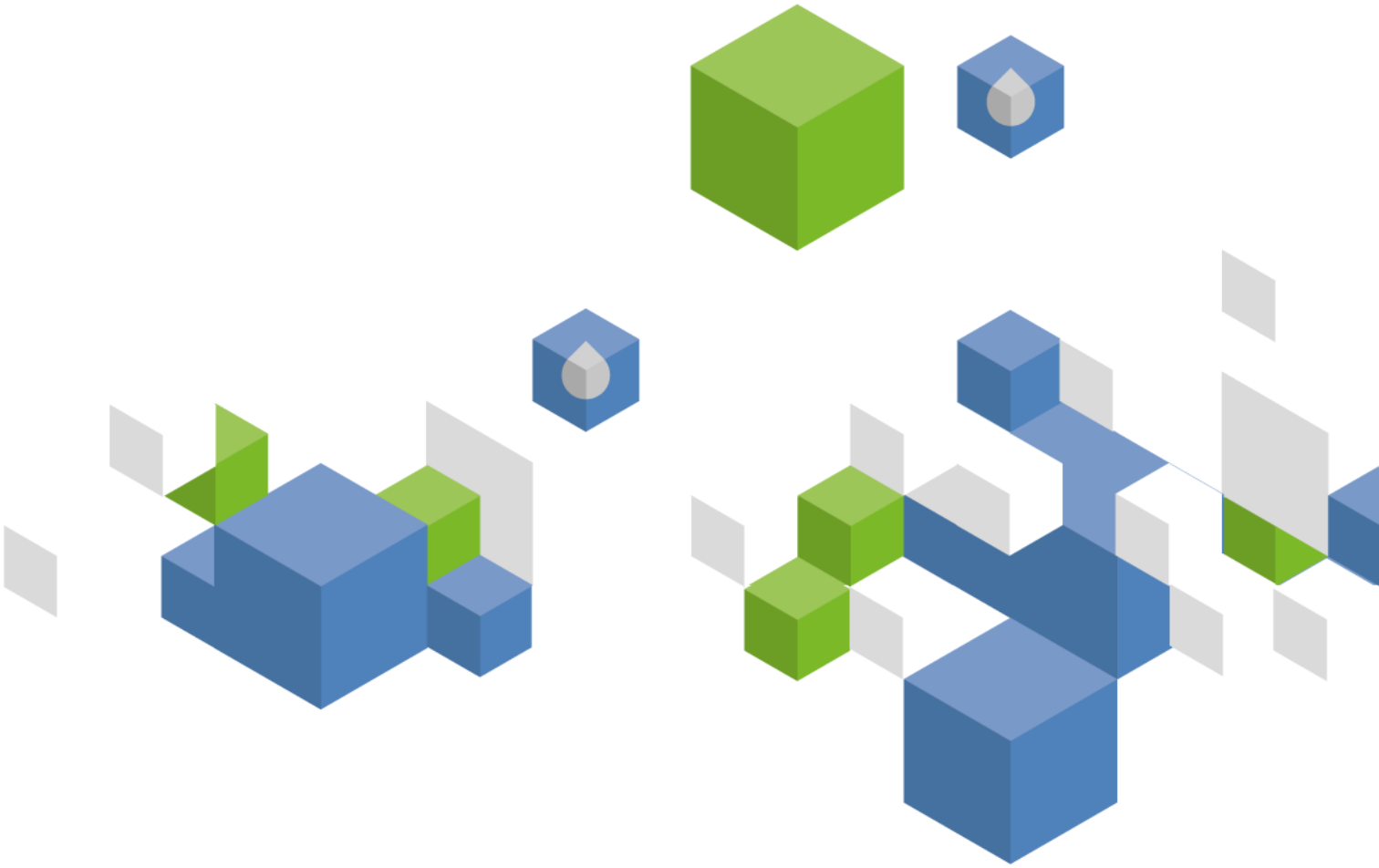
Food and Agriculture Organization of the United Nations

FAO AQUASTAT Reports

Country profile – Barbados

Version 2015



Recommended citation: FAO. 2015. AQUASTAT Country Profile – Barbados. Food and Agriculture Organization of the United Nations (FAO). Rome, Italy

Barbados

GEOGRAPHY, CLIMATE AND POPULATION

Geography

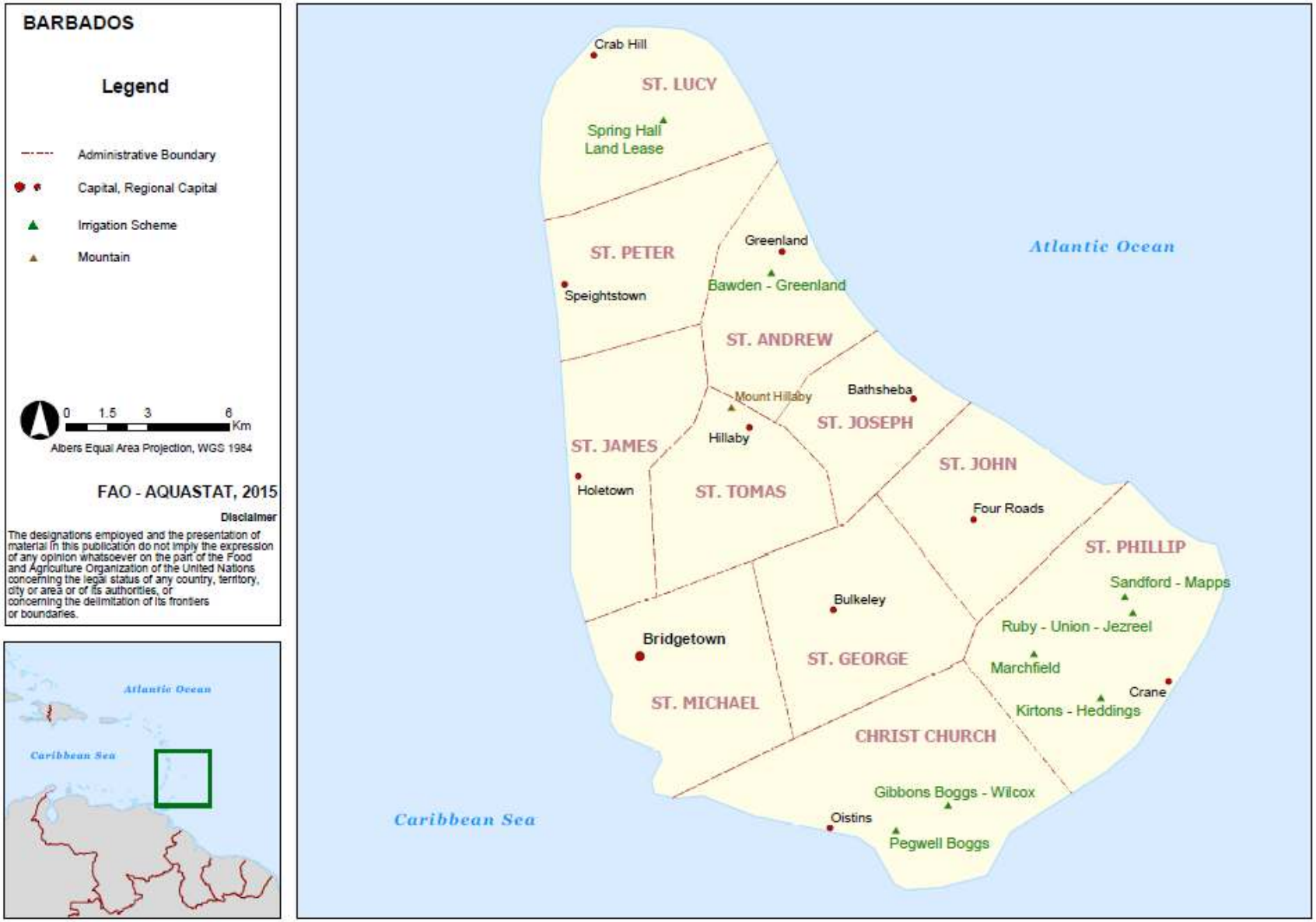
Barbados is an independent island nation located at 13º10'N latitude and 59º30'W longitude. The country has a total land area of 430 km^2 and a length of 34 km from north to south and 23 km from east to west. It is the most easterly of the Eastern Caribbean islands, located about 150 km east of Saint Vincent and the Grenadines. The country is administratively divided into 11 parishes (Christ Church, Saint Andrew, Saint George, Saint James, Saint John, Saint Joseph, Saint Lucy, Saint Michael, Saint Peter, Saint Philip, Saint Thomas) and 1 city Bridgetown, which is the capital of the country.

In 2012, the total physical cultivated area was estimated at 12 000 ha, of which 92 percent (11 000 ha) consisted of temporary crops and 8 percent (1 000 ha) of permanent crops. Permanent meadows and pasture cover 2 000 ha, which brings to total agricultural area to 14 000 ha (Table 1).

TABLE 1
Basic statistics and population

Physical areas:			
Area of the country	2012	43 000	ha
Agricultural land (permanent meadows and pasture + cultivated land)	2012	14 000	ha
• As % of the total area of the country	2012	33	%
• Permanent meadows and pasture	2012	2 000	ha
• Cultivated area (arable land + area under permanent crops)	2012	12 000	ha
- As % of the total area of the country	2012	28	%
- Arable land (temp. crops + temp. fallow + temp. meadows)	2012	11 000	ha
- Area under permanent crops	2012	1 000	ha
Population:			
Total population	2013	285 000	inhabitants
- Of which rural	2013	55	%
Population density	2013	663	inhabitants/km^2
Population economically active	2013	172 000	inhabitants
• As % of total population	2013	60	%
• Female	2013	47	%
• Male	2013	53	%
Population economically active in agriculture	2013	4 000	inhabitants
• As % of total economically active population	2013	2	%
• Female	2013	50	%
• Male	2013	50	%
Economy and development:			
Gross Domestic Product (GDP) (current US$)	2012	4 225	million US$/year
• Value added in agriculture (% of GDP)	2012	1	%
• GDP per capita	2012	14 929	US$/year
Human Development Index (highest = 1)	2013	0.776	-
Gender Inequality Index (equality = 0, inequality = 1)	2013	0.35	-
Access to improved drinking water sources:			
Total population	2012	100	%
Urban population	2012	100	%
Rural population	2012	100	%

FIGURE 1
Map of Barbados



The island is divided into two distinct geological regions: about 85 percent of the island is coralline in nature, with the remaining 15 percent being shale, sand and clay known as the Scotland district in the east of the island. The Scotland district, though quite rugged, is known for its land slips and erosion problems. The coralline area is characterized by a number of terraces rising towards the interior of the island, and deep gullies from the higher elevations (bordering the Scotland District) radiating to the coast. The island is relatively flat, with the highest point being Mount Hillaby at 340 m, near the centre of the island.

Climate

Barbados has a tropical oceanic climate with a cooling influence from the northeast trade winds. Average daytime temperature is about 29ºC, ranging from 20ºC to 32ºC.

Average annual rainfall is 1 422 mm with the wet (hurricane) season from June to December. In the dry season, from January to May, rainfall may be less than 25 mm/month. Rainfall distribution varies with the season such that during the dry season rainfall is highest at the centre of the island, while during the wet season the western side of the island receives more rainfall. Rainfall varies considerably with elevation, ranging from an average of 1 875 mm per year in the higher central area to 1 275 mm in the coastal zone.

Population

In 2013, the total population was about 285 000 inhabitants, of which around 55 percent was rural (Table 1). Population density is 663 inhabitants/km^2, which is amongst the highest in the world. The average annual population growth rate in the 2003-2013 period has been estimated at 0. 5 percent. The population is mainly concentrated in the urban corridor along the west coast, south coast and in Bridgetown, the capital (located in the southwest).

In 2012, 100 percent of the total population had access to improved water sources. In 2006, 92 percent of the total population had access to improved sanitation (both urban and rural).

ECONOMY, AGRICULTURE AND FOOD SECURITY

In 2012, the gross domestic product (GDP) was US$ 4 225 million and agriculture accounted for 1 percent of GDP, while in 1992 it accounted for 4 percent. In 2013, total population economically active in agriculture is estimated at 4 000 inhabitants, which is only 2 percent of the economically active population, and half of it is female.

Since its independence in 1966, Barbados has changed from an agricultural economy in the early 1970s and 1980s to an economy based on manufacturing and tourism services in the 1980s and 1990s. Since the beginning of the 21st Century, the importance of the manufacturing industry has declined substantially and tourism has become the main economic sector (GoB, 2008).

The major crops grown are sugarcane, cotton, root crops and vegetables. The sugar industry has declined in overall importance but it still has a role to play in the economy as it has sought to rebrand itself as a niche market commodity. The government's policy in agriculture has reduced the dependence on sugar and has encouraged diversification, especially in vegetables, poultry, livestock and fishing by providing support and incentives for small farmers (GoB, 2008).

WATER RESOURCES

Surface water and groundwater resources

Annual internal renewable water resources (IRWR) are estimated at about 80 million m^3 (Table 2). Surface water amounts to about 8 million m^3, groundwater derived from infiltrated rainfall to about

74 million m^3, while the overlaps between the two (springs and base flow) is estimated at about 2 million m^3. Groundwater accounts for by far the largest proportion of the island's water resources due to the fact that the limestone cap, which covers 86 per cent of the island, is highly permeable, allowing for a well-developed aquifer system (MPDE, 2001).

TABLE 2
Renewable water resources

Renewable freshwater resources:			
Precipitation (long-term average)	-	1 422	mm/year
	-	612	million m^3/year
Internal renewable water resources (long-term average)	-	80	million m^3/year
Total renewable water resources	-	80	million m^3/year
Dependency ratio	-	0	%
Total renewable water resources per inhabitant	2013	281	m^3/year
Total dam capacity	-	-	million m^3

Most of the rivers in Barbados are dry due to the permeable nature of the coralline karstic limestone. Water finds its way into the aquifers via gullies and sinkholes. As a result there are no perennial rivers which may be used for water supply. In the Scotland district much of the rainfall is lost through runoff to the sea due to the relatively impermeable oceanic rocks. However, at times of intense rainfall the gullies do become flooded, often causing localized flooding downstream (GoB, 2008).

Produced wastewater in 1996 is estimated at 11 million m^3 (MPDE, 2001). Barbados is now serviced by two municipal wastewater treatment plants, the Bridgetown Sewage Treatment System (BSTS) and the South Coast Sewage Treatment System (SCSTS), and several package treatment plants. The Bridgetown Sewerage System was commissioned in 1982 and has an average design flow capacity of 9 000 m^3 a day (3.29 million m^3/year) and services about one eighth of the town of Bridgetown. The South Coast Sewerage System, commissioned in 2003, is an advanced preliminary treatment plant. Planning is at an advanced stage for the construction of a third wastewater treatment facility along the West Coast (GoB, 2008 and BWA, 2014).

Due to high demand of water resources and the low per capita renewable water resources a desalination plant was built in 2000 at Spring Garden, Saint Michael, primarily to augment the public water supply in the event of a prolonged drought as well as to meet additional demand arising from increased economic activity. It consists in a brackish water reverse osmosis desalination plant with a total capacity of 30 000 m^3/day (11 million m^3/year). The water produced is mixed with and serves to complement the general supply of the Barbados Water Authority (BWA) (BWA, 2014 and GoB, 2008).

There are no important dams in Barbados.

WATER USE

In 2005 total water withdrawal was estimated at 81 million m^3 of which 54.8 million m^3 (68 percent) for agriculture, 20 million m^3 (20 percent) for municipalities and 6.2 million m^3 (26 percent) for industries (Table 3, Figure 2 and Figure 3).

TABLE 3
Water use

Water withdrawal:			
Total water withdrawal	2005	81.0	million m^3/year
- Agriculture (Irrigation + Livestock + Aquaculture)	2005	54.8	million m^3/year
- Municipalities	2005	20.0	million m^3/year
- Industry	2005	6.2	million m^3/year
• Per inhabitant	2005	296	m^3/year
Surface water and groundwater withdrawal (primary and secondary)	2005	70	million m^3/year
• As % of total renewable water resources	2005	88	%
Non-conventional sources of water:			
Produced municipal wastewater	1996	11	million m^3/year
Treated municipal wastewater	2003	3.3	million m^3/year
Direct use of treated municipal wastewater	-	-	million m^3/year
Direct use of agricultural drainage water	-	-	million m^3/year
Desalinated water produced	2005	11	million m^3/year

FIGURE 2
Water withdrawal by sector
Total 81 million m^3 in 2005

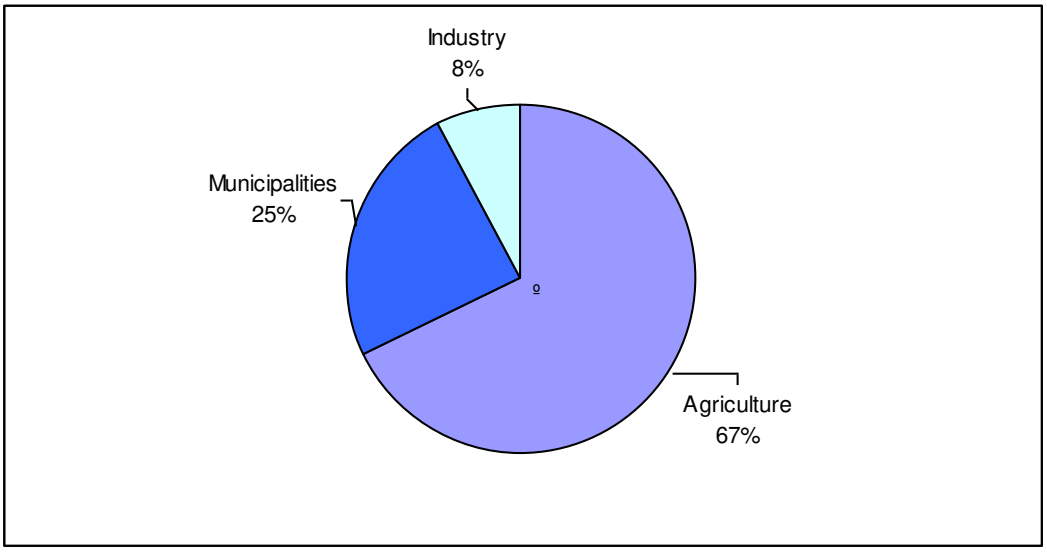
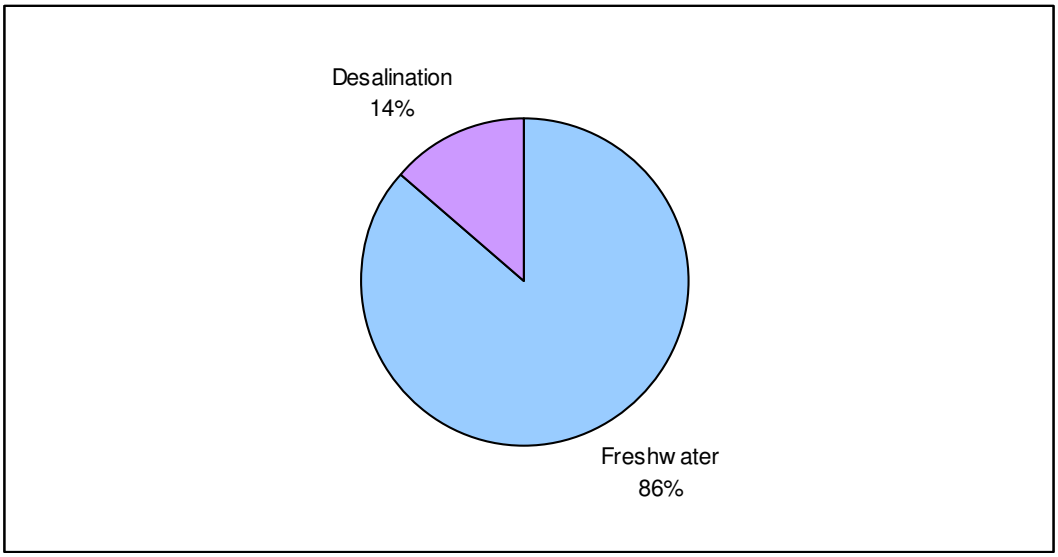


FIGURE 3
Water withdrawal by source
Total 81 million m^3 in 2005



BWA currently supplies approximately 58 million m^3 of water per year. Its water supply network comprises 2 spring sources, 22 wells, 8 boreholes, 27 reservoirs and 14 re-pumping stations scattered across the island (BWA, 2014). There are also some 120 privately-owned wells, most of which abstract water for irrigation purposes.

In 2000, groundwater accounted for 98.6 percent of the public water supply (MPDE, 2001).

IRRIGATION AND DRAINAGE

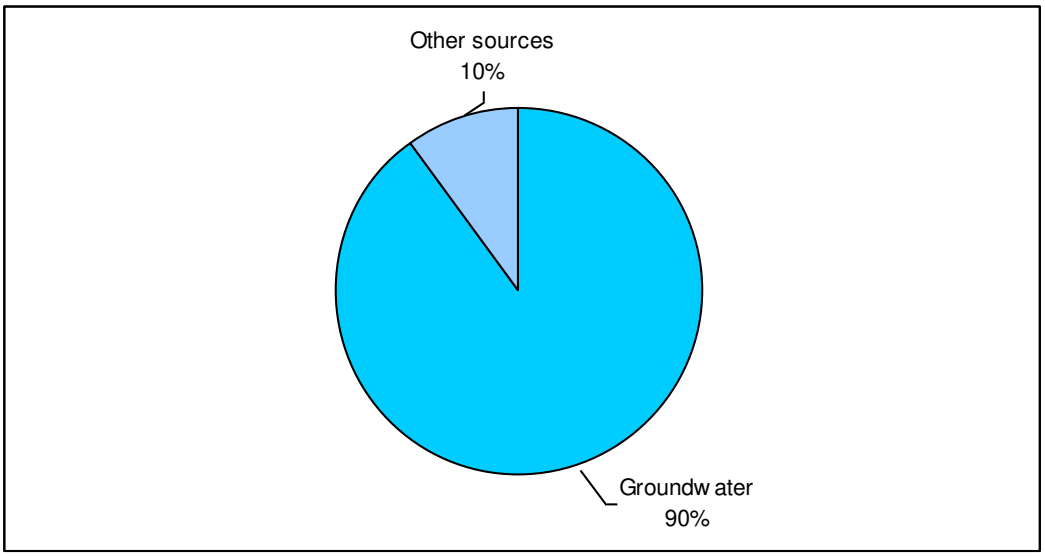
Evolution of irrigation development

The 1989 agricultural census indicated an irrigated area of 5 435 ha (Table 4). It is considered that this is still the same in 2005. The island's drinking water supply is used extensively by small farmers as their irrigation water supply. Even though strictly speaking this water would fall under municipal water withdrawal, for clarity purposes we have added all water used for irrigation under agricultural water withdrawal. There are also about 120 private hand-dug wells which are mainly used for irrigation. In the past many of the shallower wells were equipped with windmills but today the electric submersible pump is the norm. There is some relatively limited use of dams, springs, streams, roof catchments and road-catchments.

There is extensive use of conventional sprinkler systems and drip irrigation systems for vegetables, fruit and horticultural crops. Drip irrigation has been widely used both by farmers and for landscaping. There is no surface irrigation (basin, furrow, flood recession) in the conventional sense, but the term is used to include the use of garden-hose flooding and hand-watering. The government offers rebate incentives for the use of sprinkler and drip irrigation systems.

In 1989, around 90 percent of the area equipped for irrigation was irrigated by groundwater (Figure 4).

FIGURE 4
Source of irrigation water on area equipped for irrigation
Total 5 435 ha in 1989



There is relatively little direct use of wastewater for irrigation. A few hotels treat their wastewater and directly use it for irrigating lawns and gardens. Also, a number of private homes run part of their wastewater to fruit trees or small banana patches in the backyard.

TABLE 4
Irrigation and drainage

Irrigation potential		-	-	ha
Irrigation:				
1. Full control irrigation: equipped area		2005	5 435	ha
- Surface irrigation		-	-	ha
- Sprinkler irrigation		-	-	ha
- Localized irrigation		-	-	ha
• Area equipped for full control irrigation actually irrigated		2005	5 435	ha
- As % of area equipped for full control irrigation		2005	100	%
2. Equipped lowlands (wetland, ivb, flood plains, mangroves)		2005	0	ha
3. Spate irrigation		2005	0	ha
Total area equipped for irrigation (1+2+3)		**2005**	**5 435**	**ha**
• As % of cultivated area		2005	39	%
• % of area irrigated from surface water		-	-	%
• % of area irrigated from groundwater		1989	90	%
• % of area irrigated from mixed surface water and groundwater		-	-	%
• % of area irrigated from non-conventional sources of water		-	-	%
• Area equipped for irrigation actually irrigated		2005	5 435	ha
- As % of total area equipped for irrigation		2005	100	%
• Average increase per year		-	0	%
• Power irrigated area as % of total area equipped for irrigation		-	-	%
4. Non-equipped cultivated wetlands and inland valley bottoms		-	0	ha
5. Non-equipped flood recession cropping area		-	0	ha
Total agricultural water managed area (1+2+3+4+5)		**2005**	**5 435**	**ha**
• As % of cultivated area		2005	39	%
Size of full control irrigation schemes:	**Criteria**:			
Small schemes	< - ha	-	-	ha
Medium schemes	> - ha and < - ha	-	-	ha
large schemes	> - ha	-	-	ha
Total number of households in irrigation		-	-	
Irrigated crops in full control irrigation schemes:				
Total irrigated grain production		-	-	metric tons
• As % of total grain production		-	-	%
Harvested crops:		-	-	
Total harvested irrigated cropped area		-	-	ha
• Temporary crops: total		-	-	ha
-		-	-	ha
• Permanent crops: total		-	-	ha
-		-	-	ha
Irrigated cropping intensity (on full control area actually irrigated)		-	-	%
Drainage - Environment:				
Total cultivated area drained		-	-	ha
• Non-irrigated cultivated area drained		-	-	ha
• Area equipped for irrigation drained		-	-	ha
- As % of total area equipped for irrigation		-	-	%
Area salinized by irrigation		-	-	ha
Area waterlogged by irrigation		-	-	ha

There are two government-financed and operated irrigation schemes providing a piped, on-demand, pressurized water supply. In Saint Lucy in the north of the island, there is the Spring Hall Land Lease Project (land settlement project) with 22 farmer/family leased plots of land averaging about 10 ha each. The second scheme is the Rural Development Programme in the south, made up of individual irrigation systems servicing over 250 farmer-owned plots averaging less than one hectare each. The systems are now quite dependable and small farmers rely upon them heavily during the dry season.

The Irrigation Engineering Unit of the Ministry of Agriculture serves government-financed irrigation systems in twelve irrigation districts, of which ten in the south (four in Saint Philip, four in Christ

Church and two in Saint Michael parishes), and two in the north (one in Saint Lucy and one in Saint Andrew parishes). Water is sourced from 21 wells, 17 of which are leased from private owners (MoA, 2015).

Role of irrigation in agricultural production, economy and society

Regularly produced crops include tomatoes, cucumbers, hot peppers, sweet peppers, onion, carrot and beet. Other irrigated crops include citrus, bananas, plantains and cut-flowers. Irrigated vegetable farmers can get three crops in a season.

Women and irrigation

The majority of labour involved in land preparation, weeding, crop protection and irrigation is undertaken by women. The equipment used by women in the farms are mainly hand tools (such as fork, hoe, rake and shovel), irrigation equipment (hoses, overhead sprinkler systems and drip or trickle irrigation systems) and sprayers for application of crop protection chemicals. Forty-three percent of the female family members use the irrigation equipment, compared to only three percent of the male family members (Harvey, 1996).

Status and evolution of drainage systems

There is little drainage work carried out by private farmers. In some areas, beds are raised in the wet season to facilitate better drainage in the root zone. Generally, none of the drainage work is traditionally linked to surface irrigation or a high water table. The Soil Conservation Unit of the Ministry of Agriculture has carried out substantial land stabilization works in Scotland district. The drainage of surface and subsurface flows is essential for this land stabilization. The flows are channeled safely via gabion structures to storage reservoirs or to stream courses which flow into the sea. Little of this water is used for irrigation, and little quantification is made of the stream flow and irrigation potential in the area. Plans are being put in place to utilize some of this water for irrigation.

WATER MANAGEMENT, POLICIES AND LEGISLATION RELATED TO WATER USE IN AGRICULTURE

Institutions

The major institutions related to water resources are:

- *Barbados Water Authority (BWA):* was created in 1981 and is a Statutory Body charged with supplying the island with potable water as well as the provision of wastewater treatment and disposal services to the areas of Bridgetown and the South Coast. The Authority is also responsible for the monitoring, assessment, control and protection of the water resources in the public's interest (BWA, 2014).
- *National Commission on Sustainable Development (NCSD):* has the mandate to advise the government on measures required to integrate environmental and economic considerations in decision-making processes and on global issues of sustainable development (UN, 2004).
- *Environmental Protection Department:* belongs to the Ministry of Environment, Water Resources and Drainage and is responsible of water quality monitoring, public health protection and control of effluent disposal.
- *Drainage Unit:* belongs to the Ministry of Transport Works and International Transport is responsible of digging and maintenance of drainage wells, construction of dams and permits for drainage works.
- *Soil Conservation Unit:* was established in 1957, in the Ministry of Agriculture (MoA), and addresses the many special land conservation and stability problems occurring in Scotland district.
- *Land and Water Use Unit:* belongs to the Ministry of Agriculture and is responsible for the hydrology and agrometeorological data and irrigation extension and agronomy (GoB, 2008).

- *Barbados Agricultural Development and Marketing Corporation (BADMC):* belongs to MoA and is responsible of the provision of water for irrigation, water quality monitoring and well development.
- *Irrigation Engineering Unit (IEU):* is a department of BADMC of MoA, developed from the Integrated Rural Development Project (IRDP), which commenced in 1981. Its vision statement is to satisfy the irrigation water requirements of the farming districts serviced by government-financed irrigation systems and to continue the expansion of such systems into new farming communities (MoA, 2015).

Water management

Barbados belongs to the top 20 of the world's most water scarce countries, where the competing demands for freshwater resources are increasing as it seeks to develop and grow its economy. Water management and pollution of groundwater and surface water are issues that must be addressed as these resources strengthen sustained economic growth and development. The 2005 National Development Plan has recognized the importance of good water management and the government committed itself to preparing an Integrated Water Resources Management (IWRM) Plan for the country. BWA and the Coastal Zone Management Unit have taken the initiative to develop a "roadmap", policy and plan for IWRM at national level (GoB, 2008).

Finances

Water rates are subsided at US$0.44 per m^3 in the Integrated Rural Development Project (IRDP) systems and US$0.33 per m^3 at the Spring Hall Land Lease Project (SHLLP). It has not changed during the past 15 years. By comparison, other commercial rates are US$2.97 per m^3 (MoA, 2015).

Policies and legislation

The process of policy formulation is generally conducted through the work of a committee of experts and stakeholders (UN, 2004).

Relevant water resources legislation and policies include (GoB, 2008):

- *Barbados Water Authority Act (1980):* establishes the Barbados Water Authority.
- *Underground Water Control Act (1953):* provides for the control and use of the underground sources of water supply in the island. It establishes a Water Board for the purpose of this Act. Licenses from the Board are required for the sinking of wells and for the obstruction of underground water.
- *Heath Services Act (1969):* allows the Minister to divide Barbados into health and sanitation districts. The Minister has the power to construct sewers. This Act also prohibits taking water from public taps without permission.
- *Irrigation Act (1967):* allows the Chief Agriculture to order to carry out surveys, investigation or research for irrigation purposes, to distribute water and to control or operate waterworks.

- *Prevention of Floods Act (1951):* makes provision for measures for the prevention of floods.
- *National Strategic Plan 2005-2025 (2007):* has within its goals to promote and facilitate the environmentally sustainable use of natural resources and to maintain a safe and reliable water supply.
- *National Water Conservation Plan:* comprises two parts: long-term ongoing measures such as leakage reduction and universal metering and short-term measures such as temporary shutdown of parts of the system on a rotational basis or temporary licence restrictions on private abstractions (UN, 2004).
- *Groundwater Zoning Policy:* implemented through the Town and Country Planning Office in collaboration with the BWA, it controls development in areas of groundwater abstraction as a way of protecting groundwater resources (GoB, 2008).

ENVIRONMENT AND HEALTH

Water resources quality in Barbados can be affected by the contamination from agricultural activity, the petrochemical industry, industrial facilities and hazardous wastes, urban development and domestic waste disposal, and solid and liquid waste disposal.

In 1963, the Government instituted a policy (revised in 1973) which created a system of five Groundwater Protection Zones implemented across the island to guard against bacteriological contamination of the public water supply wells. The most stringent regulations are enforced in the Zone I area which is located immediately around all existing and potential public water supply sites. Zones 2 to 5 provide progressively less stringent controls. The policy, however, does not address chemical contamination and still needs specific legislative authority.

The zoning system, along with an effective disinfection system, has been partially effective in ensuring a biologically-safe water supply. Diseases such as cholera, dysentery, giardiasis or hepatitis have not occurred in Barbados on any significant scale (MPDE, 2001).

The impacts of climate change on freshwater in Barbados are estimated to be an increase severity of droughts and a sea level rise which increase salt water intrusion within freshwater aquifers (UN, 2004).

PROSPECTS FOR AGRICULTURAL WATER MANAGEMENT

Barbados will have to deal in the near future with an increase in competing demands for freshwater and pollution of groundwater and surface water. These issues must be addressed as these resources strengthen sustained economic growth and development. An integrated management of the water resources will facilitate to face these constraints.

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