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Guyana

GEOGRAPHY, CLIMATE AND POPULATION

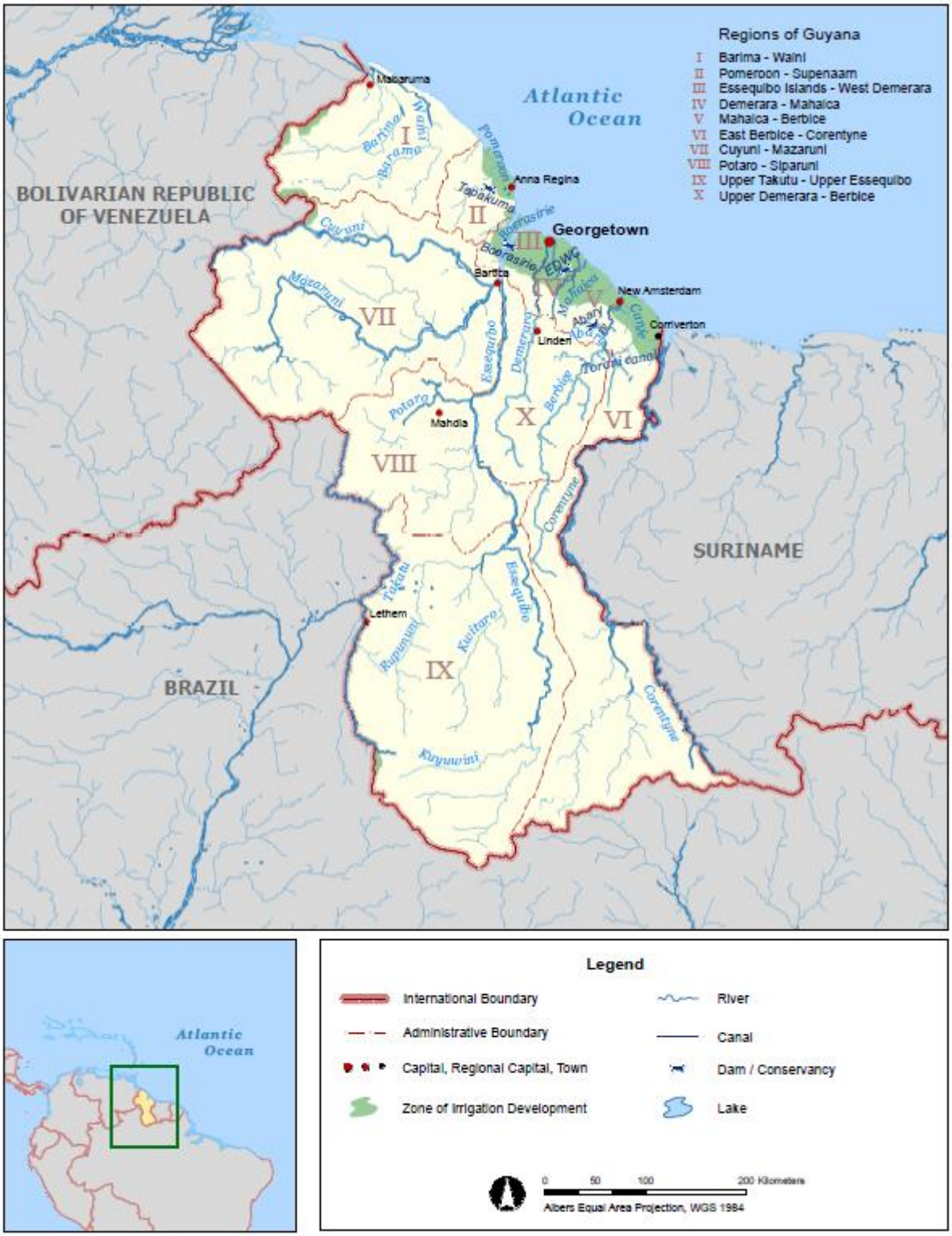
Geography

Guyana is located in the northern part of South America, with a 430 km Atlantic coastline and a total area of 214 970 km^2 (Table 1). It's bounded by the Atlantic Ocean in the north, Suriname in the east, Brazil in the south and southwest, and the Bolivarian Republic of Venezuela in the northwest. For administrative purposes, the country is divided into ten regions. Regions I-VI are located in the north along the coast while the others are more inland to the south.

TABLE 1
Basic statistics and population

Physical areas:			
Area of the country	2012	21 497 000	ha
Agricultural land (permanent meadows and pasture + cultivated land)	2012	1 678 000	ha
• As % of the total area of the country	2012	8	%
• Permanent meadows and pasture	2012	1 230 000	ha
• Cultivated area (arable land + area under permanent crops)	2012	448 000	ha
- As % of the total area of the country	2012	2	%
- Arable land (temp. crops + temp. fallow + temp. meadows)	2012	420 000	ha
- Area under permanent crops	2012	28 000	ha
Population:			
Total population	2013	800 000	inhabitants
- Of which rural	2013	72	%
Population density	2013	4	inhabitants/km^2
Population economically active	2013	373 000	inhabitants
• As % of total population	2013	47	%
• Female	2013	37	%
• Male	2013	63	%
Population economically active in agriculture	2013	51 000	inhabitants
• As % of total economically active population	2013	14	%
• Female	2013	92	%
• Male	2013	8	%
Economy and development:			
Gross Domestic Product (GDP) (current US$)	2012	2 851	million US$/year
• Value added in agriculture (% of GDP)	2011	21	%
• GDP per capita	2012	3 586	US$/year
Human Development Index (highest = 1)	2013	0.638	-
Gender Inequality Index (equality = 0, inequality = 1)	2013	0.524	-
Access to improved drinking water sources:			
Total population	2012	98	%
Urban population	2012	97	%
Rural population	2012	98	%

FIGURE 1
Map of Guyana



GUYANA **FAO - AQUASTAT, 2015**

Guyana is a sparsely populated country endowed with ample natural resources for agriculture. It is also one of the few countries in the world where population pressure on natural resources is virtually non-existent: 16.5 million ha of the country's territory are made up of mostly inaccessible forests and woodlands, about 1.2 million ha are under permanent pasture and less than 0.5 million ha are cultivated land.

In 2012, the cultivated area was estimated at 448 000 ha. Of this total, 420 000 ha were under annual crops and the remaining 28 000 ha were under permanent crops.

The land comprises three main geographical zones:

- The coastal plain, which occupies about 5 percent of the country's area. The plain ranges 5 to 6 km wide along the coast.
- The white sand belt, which lies south of the coastal zone. This area is 150 to 250 km wide and consists of low sandy hills interspersed with rocky outcroppings with hardwood forest and most of Guyana's mineral deposits. These sands cannot support crops and, if the trees are removed, erosion is rapid and severe.
- The interior highlands, which is the largest and southernmost of the three geographical zones and consists of plateaus, flat-topped mountains and savannahs that extend from the white sand belt to the country's southern borders.

Climate

Guyana has a tropical climate with almost uniformly high temperatures and humidity, and much rainfall, modified slightly by trade winds along coast. Air temperature usually ranges between 16°C and 34°C with the lower temperature experienced in the highland regions. The temperature in Georgetown is quite constant, ranging from 24°C to 32°C. Humidity averages 70 percent year-round. The interior, away from the moderating influence of the ocean, experiences slightly wider variations in daily temperature. Humidity in the interior is also slightly lower, averaging around 60 percent. Guyana lies south of the path of Caribbean hurricanes and none is known to have hit the country.

Guyana has an annual average rainfall of 1 500 - 3 000 mm, with the higher amounts being experienced in the southern highland and forested regions and the lower amounts in the southeast and interior. Annual averages are near 2 500 mm on the coast near the Venezuelan border and 1 500 mm in southern Guyana's Rupununi Savannah. Although rain falls throughout the year, there is a rainy season that extends from May to the end of July along the coast and from April through September further inland. Coastal areas have a second rainy season from December through February. There are two dry seasons from March to April and from September to November. This is influenced by the movement of the Inter Tropical Convergence Zone (ITCZ) across the equator and the Southern Oscillation Index (SOI): high positive values cause reduced rainfall in the secondary rainy season while high negative values result in prolonged and extensive rainfall, leading to flooding in low-lying areas with poor drainage. Rain generally falls in heavy afternoon showers or thunderstorms.

Population

The total population was estimated at 800 000 inhabitants in 2013, of which 72 percent were rural. During the period 2003-2013 the annual population growth rate was estimated at 0.6 percent. There is a low population density of about 4 inhabitants/km^2 but with 90 percent of the population residing in the coastal regions.

In 2012, 98 percent of the population had access to improved water sources (97 and 98 percent in urban and rural areas respectively). Sanitation coverage accounted for 84 percent (88 and 82 percent in urban and rural areas respectively).

ECONOMY, AGRICULTURE AND FOOD SECURITY

In 2012, Guyana's gross domestic product (GDP) was $US2 851 million. The main productive sectors of the economy are: agriculture, forestry, fishing, mining and quarrying, manufacturing, and construction. The agriculture sector consists mainly of rice, sugar and livestock production. The sector's contribution to total GDP declined from 30 percent in 2001 to 21 percent in 2011 because of declining sugar productivity, due to the removal from the European Union preferences, management deficiencies and industrial unrest.

In 2013, the total economically active population is 373 000 inhabitants, or 47 percent of the total population. The economically active population in agriculture is estimated at 51 000 inhabitants (14 percent of total active population) of which 8 percent are female. Agriculture is concentrated along the coastal belt where most of the population resides.

Guyana's two main crops, rice and sugar, are the lead export oriented earners. They occupy most cultivated land and also most irrigated land. They are mostly produced in the declared drainage and irrigation areas (DDI). However a small amount is produced in the undeclared drainage and irrigation areas (UDI). Other crops - vegetables, staple crops, fruits and spices - are now being produced in larger quantities to satisfy local needs and to meet the export markets that are being developed in the Caricom Region and beyond. The non-traditional crops and vegetable sector is growing and contributing to the food production efforts by taking advantage of the support of the government and of the New Guyana Marketing Corporation (NGMC), which assists farmers to market their produce both locally and internationally.

Guyana relies significantly on trade. The country is one of the most open countries in the region. In 2009, exports accounted for some 75 percent of GDP. During the period 2005-2009 there has been a consistent growth in both exports and imports, but with a persistent trade deficit: in 2009 exports accounted for US$ 741 million while imports accounted for US$ 1 118 million. The main export products are sugar, rice, bauxite, gold, forest products, and fishing.

The government, through its development strategies, makes efforts to provide food security to its people, concentrating its resources to maximize production.

WATER RESOURCES

The internal renewable water resources (IRWR) are estimated at 241 km^3/year. Surface water resources are estimated at 241 km^3/year, groundwater resources at 103 km^3/year and the overlap between surface water and groundwater is estimated to be 100 percent (Table 2).

TABLE 2
Renewable water resources

Renewable freshwater resources:			
Precipitation (long-term average)	-	2 387	mm/year
	-	513 100	million m^3/year
Internal renewable water resources (long-term average)	-	241 000	million m^3/year
Total renewable water resources	-	271 000	million m^3/year
Dependency ratio	-	11	%
Total renewable water resources per inhabitant	2013	338 750	m^3/year
Total dam capacity	2011	809.15	million m^3

Surface water resources

Guyana is an Amerindian word meaning "Land of many waters". Numerous rivers flow into the Atlantic Ocean, generally in a northward direction. Of these, fourteen river basins were monitored during the period 1965-1974: Waini, Pomeroon, Essequibo, Potaro (tributary of Essequibo), Mazaruni, Cuyuni, Supenaam, Demerara, Berbice, Canje (tributary of Berbice), Boerasirie, Mahaica, Mahaicony and

Abary. Table 3 shows the monitoring of seven river basins, representing about three quarter of the total area of the country: Essequibo, Cuyuni, Potaro, Mazaruni, Demerara, Berbice and Canje. The Essequibo, the country's major river, runs from the Brazilian border in the south to a wide delta west of Georgetown. The rivers of eastern Guyana cut across the coastal zone, making east-west travel difficult, but they also provide limited water access to the interior. Waterfalls generally limit water transport to the lower reaches of each river.

TABLE 3
Maximum, minimum and average annual flow of selected rivers (Source: US Army Corps of Engineers, 1997)

River	Gauging station	Drainage area (km^2)	Maximum discharge (km^3/year)	Minimum discharge (km^3/year)	Mean discharge (km^3/year)	Period of record
Essequibo	Plantain Island	66 563	252.72	4.58	70.16	1950-1969
Cuyuni	Kamaria	53 354	170.12	0.31	33.54	1946-1968
Mazaruni	Hillfoot	20 720	130.70	1.79	36.13	1961-1968
Potaro	Tumatumari	6 203	70.15	1.38	16.46	1946-1954
Demerara	Saka	4 040	14.10	0.37	3.52	1950-1967
Berbice	Itabru	5 102	13.16	0.05	1.26	1960-1968
Canje	Reynolds Bridge	277	0.27	0.05	0.08	1969

The Corantyne river is the border river with Suriname, from its source till the sea. The total flow is estimated at 50 km^3/year. It is considered that the entire flow of this river is generated both in Guyana (50 percent) and in Suriname (50 percent) and therefore is part of the IRWR of each country and is not considered to be a border river. Incoming flow from Bolivarian Republic of Venezuela through the Cuyuni river basin is estimated at 30 km^3/year. This brings the total renewable water resources (TRWR) to 271 km^3/year. Possible exchanges with Brazil through the Takatu river basin are not known.

Groundwater resources

The groundwater system comprises three aquifers beneath Georgetown and the coastal plain. The "upper" sand is the shallowest of the three aquifers and its depth varies from 30 to 60 m, with thickness ranging from 15 to 120 m. It is not used as a source of water because of its high iron content (>5 mg/l) and salinity (up to 1 200 mg/l). Most potable water is obtained from the two deep aquifers. The "A" sand is typically encountered between 200 and 300 m below the surface with thickness ranging from 15 to 60 m. Water from the "A" aquifer requires treatment for the removal of iron. The "B" sand is found at about 300 to 400 m with thickness of between 350 and 800 m. Water from this aquifer has very little iron, a high temperature and a trace of hydrogen sulphide which can be treated with aeration.

Lakes and dams

A small amount of the surface water resources is trapped by a long low earth embankment to form large shallow dams locally known as "conservancies". The conservancies are located in the "backland" or upper stream catchment areas and comprise water-retaining embankments and structures. There are four large human-made conservancies:

- The Abary conservancy on the Abary river, also called Mahaica Mahaicony Abary (MMA), has a total capacity of 609 million m^3 and has been designed to provide irrigation to about 17 500 ha.
- The East Demerara Water conservancy (EDWC), which dams the Maduni river and Lama creek, has a capacity of 16 million m^3 and has been designed to provide irrigation to about 34 500 ha. It also supplies potable water to Georgetown, to augment the groundwater supply. Ten percent surface water is used for potable water supply against 90 percent groundwater.
- The Boerasirie conservancy collects the flow from the Boerasirie river, Warimia creek, Jumbi creek and finally the South Durabana creek. It has a total capacity of 166 million m^3 and has been designed to provide irrigation to about 36 000 ha.

- The Tapakuma conservancy dams the water from three inland lakes on the Essequibo coast and releases it as needed for irrigation. It has a total capacity of 18 million m^3 and has been designed to provide irrigation to about 12 000 ha.

All the conservancies store water at higher elevations than the surrounding fields, thus irrigation can take place by gravity flow to these areas. Abary, Demerara and Boerasirie conservancies are entirely covered by weeds. While in most years water supply is ensured throughout the year, if droughts occur during the secondary November-January wet season, these conservancies may have water shortages. Water shortages may also occur in the Tapakuma conservancy, which is partly supplied by pumping from the Pomeroon river, to release water or to take in water if needed to supplement irrigation needs in Region II.

The hydropower technical exploitable capability is 37 000 GWh in 2008. Despite the country's large potential, only 1 GWh/year is actually generated (World Energy Council, 2008).

International water issues

The Corentyne river is the border between Guyana and Surname over its entire length. It has its source deep in the south near the border with Brazil. It seems to be wholly claimed by Suriname, hence there is limited usage unless licenses are granted, especially for fishing. The Cuyuni river in the west has its origin somewhere on the border between the Bolivarian Republic of Venezuela and Brazil. It is not a continuous border river as it changes course as it flows northwards and turns eastwards into Guyana and flows into the Essequibo river near the coast. The Takatu river defines Guyana's southwestern border with Brazil and empties into the Rio Branco in Brazil. No major dams or other withdrawals are made by border countries and, except for navigation, these are free flowing rivers.

The Amazon Cooperation Treaty (TCA) was signed in 1978 by Bolivia, Brazil, Colombia, Ecuador, Guyana, Peru, Suriname and Venezuela and entered into force for Brazil in 1980. The basic scope of the TCA is to promote the harmonious development of the Amazon, in order to allow an equitable distribution of the benefits, to improve the quality of living of its peoples and to achieve the full incorporation of their Amazon territories to the respective domestic economies. In 1995, the countries members of the TCA created the Amazon Cooperation Treaty Organization (ACTO) to strengthen the implementation of the Treaty.

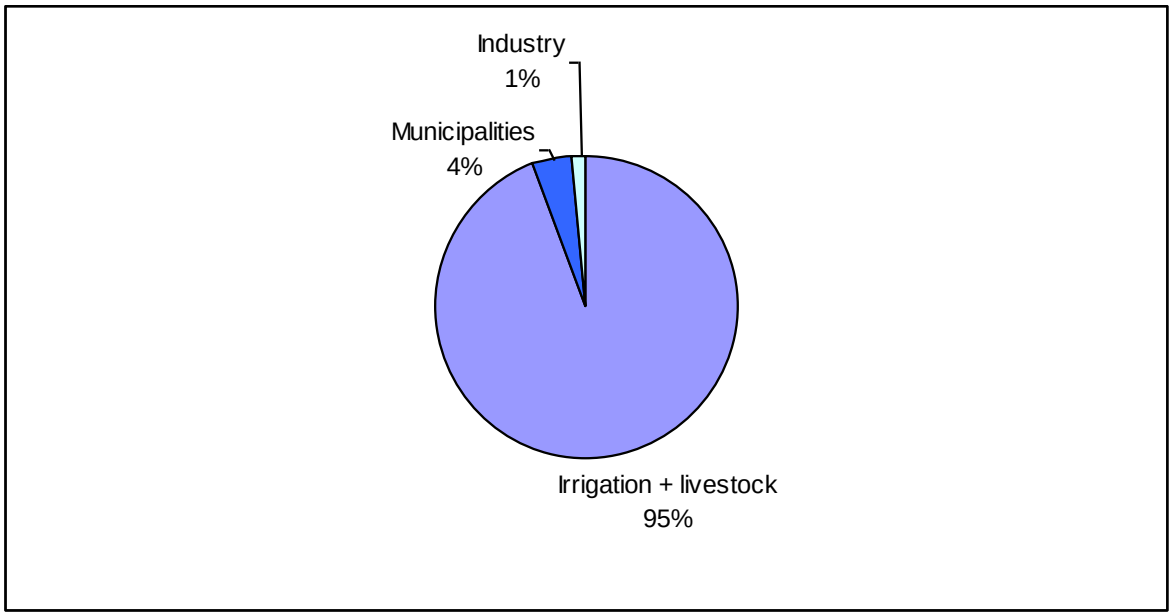
WATER USE

No official information has been found on water withdrawal, but estimated values give a total water withdrawal in 2010 of 1.445 km^3, of which 94.4 percent was for agricultural purposes, 4.2 percent for municipal and 1.4 percent for industrial purposes (Table 4 and Figure 2).

TABLE 4
Water use

Water withdrawal:			
Total water withdrawal	2010	1 444.7	million m^3/year
- Agriculture (Irrigation + Livestock + Aquaculture)	2010	1 363	million m^3/year
- Municipalities	2005	61.3	million m^3/year
- Industry	2005	20.4	million m^3/year
• Per inhabitant	2010	1 838	m^3/year
Surface water and groundwater withdrawal (primary and secondary)	2010	1 444.7	million m^3/year
• As % of total renewable water resources	2010	0.5	%
Non-conventional sources of water:			
Produced municipal wastewater	-	-	million m^3/year
Treated municipal wastewater	-	-	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	-	-	million m^3/year

FIGURE 2
Water withdrawal by sector
Total 1.4447 km^3 in 2010



Roughly 90 percent of the population is concentrated within the coastal area and thus all residents of the coastal area depend wholly on groundwater supply to meet their domestic needs. One exception is the Georgetown area, which utilizes about 10 percent of surface water from the EDWC conservancy. Intermediate savannahs and hinterland used a mixture of surface and groundwater. Nationwide, water supply facilities included about 178 groundwater wells and eight surface water sources in 2000.

In Guyana many businesses that use large quantities of water have their own wells to meet their needs. These include the bottling of beverages, water, other manufacturing and food processing industries.

There are three major water treatment facilities to produce drinking water: in Georgetown, New Amsterdam and Guymine.

IRRIGATION AND DRAINAGE

Evolution of irrigation development

The main irrigation and drainage works and schemes were executed in the early to mid-twentieth century, with a peak of construction and rehabilitation in the 1950s and 1960s. In the last decades, the area under irrigation has decreased due to the poor and deteriorating state of canals, drains, sluices, pumps and other necessary structures. At present, many irrigation areas are in need of rehabilitation. Total area equipped for irrigation in 2012 is estimated at 143 000 ha (Table 5).

The vast majority of agricultural activities takes place in the coastal plains. For more than 8 km inland the land is below sea level at high tide. Therefore, drainage and water control are major problems, and agricultural development has always been tied to the defence against water intrusion from the sea and from rainwater runoff.

Irrigated areas are concentrated between the mouth of the Pomeroon river and the Corentyne river. They are located in five out of the country's ten administrative divisions. All areas with fully developed drainage and irrigation facilities are classified as Declared Drainage and Irrigation Areas (DDIA). In addition, the sugar estates also have irrigation and drainage infrastructure.

TABLE 5
Irrigation and drainage

Irrigation potential	-	-	ha
Irrigation:			
1. Full control irrigation: equipped area	2012	143 000	ha
- Surface irrigation	2012	143 000	ha
- Sprinkler irrigation	2012	0	ha
- Localized irrigation	2012	0	ha
• Area equipped for full control irrigation actually irrigated	2010	127 500	ha
- As % of area equipped for full control irrigation	-	89	%
2. Equipped lowlands (wetland, ivb, flood plains, mangroves)	-	-	ha
3. Spate irrigation	-	-	ha
Total area equipped for irrigation (1+2+3)	**2012**	**143 000**	**ha**
• As % of cultivated area	2012	32	%
• % of area irrigated from surface water	2012	100	%
• % of area irrigated from groundwater	2012	0	%
• % of area irrigated from mixed surface water and groundwater	-	-	%
• % of area irrigated from non-conventional sources of water	-	-	%
• Area equipped for irrigation actually irrigated	2010	127 500	ha
- As % of total area equipped for irrigation	-	89	%
• Average increase per year	1991-2012	minus 0.2	%
• Power irrigated area as % of total area equipped for irrigation	-	-	%
4. Non-equipped cultivated wetlands and inland valley bottoms	-	-	ha
5. Non-equipped flood recession cropping area	-	-	ha
Total agricultural water managed area (1+2+3+4+5)	**2012**	**143 000**	**ha**
• As % of cultivated area	2012	32	%
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	2010	179 000	ha
• Temporary crops: total	2010	177 000	ha
- Rice	2010	131 400	ha
- Vegetables	2010	4 000	ha
- Sugarcane	2010	41 600	ha
• Permanent crops: total	2010	2 000	ha
- Citrus	2010	2 000	ha
Irrigated cropping intensity (on full control area actually irrigated)	2010	140	%
Drainage - Environment:			
Total cultivated area drained	1991	150 100	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

In the DDIA in Regions II, III, IV and V irrigation is done by surface flow, via gravity from high level storage in the conservancies. The areas in Region VI are supplied from pumps that extract from the Canje river basin, supplemented by the Berbice river basin, thus irrigation in this Region VI is mostly powered by pumping. Very few control structures exist along the main canals and distributor canals. Flows in the secondary canals are controlled by headgates, and farmers derive water from secondary canals normally by gravity. Minor drains are interspersed with secondary canals that drain directly to the sea through sluice gates (some are associated with pumping stations) or to a façade drain, which

drains to the sea at regular intervals. Sluice gates are open twice a day at low tides. Irrigation canals within sugar estates have no slope and are often used for cane transportation. Surface irrigation is the only technology used in the irrigation schemes.

Most irrigation infrastructure needs extensive rehabilitation, with the exception of some sugar estates and some infrastructure that is being maintained by large-scale farmers. The systems' state of disrepair contributes significantly to lowering Guyana's water use efficiency. Another important cause of poor water use efficiency is inadequate water management, a result of conflicting needs of farmers who have different crop calendars. While there are no recent studies measuring water use efficiency, efficiency levels are unlikely to exceed 40 percent.

At the end of the 1990s, the total length of the irrigation canals in Guyana was 485 km of main canals and 1 100 km of the secondary canals.

All the drainage and irrigation systems are open surface channels. However during dry spells, when the water supply level falls below the field intake, pumps are used to meet irrigation requirements. Channels are often used as refuse disposal sites in some areas especially adjacent to populated villages/towns, in addition to aquatic growth and siltation due to runoff over cleared and ploughed areas to facilitate cultivation. Hence, there is a need for regular maintenance of these drainage and irrigation systems.

In the east in Region VI, the irrigation requirements are met by extracting water from the Canje river, at six locations along a section of the river which then is directed northwards to the coast where irrigation is needed. Above the points of extraction is also a canal linking the Berbice river to the Canje river, called the Torani, which supplements the flow of the Canje river to facilitate extraction and limit the intrusion of salt/brackish water into the areas upstream where the pumps are located. The areas supplied by these systems are Declared Drainage and Irrigation Areas (DDIA) while those areas that are not served by these are designated Undeclared Drainage and Irrigation Areas (UDIA).

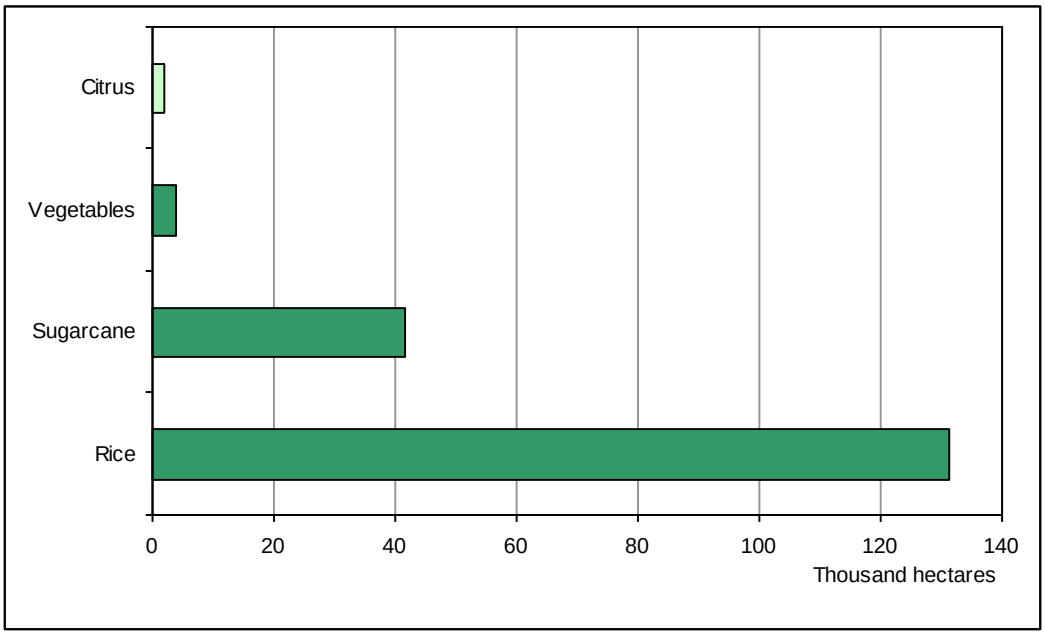
Role of irrigation in agricultural production, economy and society

Crop production (except sugarcane) and livestock production are characterized by the predominance of small farms. According to the farm household survey in the 1990s, farms of less than 6 ha accounted for about 75 percent of the country's 24 000 farms. It is estimated that about 70-80 percent of these small farms are geared to rice production. Many of these small farms combine their crop production with some milk production. There are, however, several larger agricultural operations that include private rice growers, some medium- and large-size forest and fishing operations, and large public-sector enterprises.

In the 1980s, sugar and rice were the primary agricultural products, as they had been since the nineteenth century. Sugar was produced primarily for export whereas most rice was consumed domestically. Other crops included bananas, coconuts, coffee, cocoa and citrus fruits. Small amounts of vegetables and tobacco were also produced. During the late 1980s, some farmers succeeded in diversifying into specialty products such as heart-of-palm and asparagus for export to Europe. The extent of Guyana's economic decline in the 1980s was clearly reflected in the performance of the sugar sector. Production levels were almost halved, from 324 000 tons in 1978 to 168 000 tons in 1988. Sugar production for 1994 was 252 615 tons and was the major export commodity, contributing 28 percent to total exports. The rice industry has been leading growth (1993-96) with production and export earnings rising steadily. In 1995, rice production reached 350 000 tons.

In 2010, total harvested irrigated cropped area was estimated at 179 000 ha, meaning an irrigated cropping intensity of 140 percent. Rice accounts for 131 000 ha or 73 percent of the harvested irrigated copped area. Irrigation allows double cropping of rice, which provides reasonable returns on investment, the average yield for rice being between 4-6 tons/ha. Sugarcane represents 41 600 ha (23 percent), vegetables 4 000 ha (2 percent) and citrus 2 000 ha (1 percent) (Table 5 and Figure 3).

FIGURE 3
Irrigated crops on area equipped for full control irrigation
Total harvested area 179 000 ha in 2010 (cropping intensity on actually irrigated area: 140%)



Irrigation development costs are US$3 647/ha composed as follows: construction of head work US$2 187/ha, conveyance system US$860/ha, field system US$600/ha. Maintenance costs are US$33/ha per year.

Women and irrigation

Women in Guyana have always been involved in agriculture at both formal and informal levels of production, processing and marketing. However, their involvement has been underestimated in statistics. Women in rural areas have less access than men to resources, particularly to productive assets such as land and water. Access to water and irrigation depends not only on the availability of water, but also on the legal and regulatory systems governing its distribution and use. In most cases, access to water is contingent on land tenure; as a result, women may find themselves disadvantaged. Rural women spend an average of 8.4 hours weekly fetching water for both domestic and farm use. Some problems that women face in agriculture are the lack of training, lack of farming equipment and poor drainage and irrigation (Rutherford and Odie-Ali, 1996 and IADB).

Status and evolution of drainage systems

Drainage throughout most of Guyana is poor and river flow sluggish because the average gradient of the main rivers is only 0.02 percent. Drainage by gravity is possible only when the tide is low, and this form of drainage is affected by the ever-changing levels of the foreshore outside the sea defences. Therefore, it has been necessary in many areas to resort to the expensive method of drainage by pumps. Land requires extensive drainage networks before it is suitable for agricultural use. In the 1990s, drainage canals occupy nearly one-eighth of the area of the average sugarcane field. Similarly, the main drainage infrastructure is about 500 km in length while the length of the secondary drainage system is 1 500 km. In 1991, the entire area equipped for irrigation, 150 100 ha, was drained.

The drainage systems were designed to facilitate the drainage of 37 mm of rainfall per day, through gravity at the low and falling tides. The recent record of rainfall events indicated that a higher drainage capacity is needed: approximately 50 mm/day is required for sugarcane (AGROTECH SpA/European Union, 2003).

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

Institutions

The main institutions dealing with irrigation and potable water management are:

- The National Drainage and Irrigation Authority (NDIA), created in 2004, which is in charge of the maintenance and delivery of irrigation water supply countrywide.
- The Guyana Water Incorporated (GWI), which is in charge of the drilling of wells and delivery of potable water countrywide. The GWI was created following the Water and Sewerage Act of 2002. This Act dissolved the Guyana Water Authority (GuyWA) and the Georgetown Sewerage and Water Commissioners (GSWC).

Since the settlements and the agricultural lands use the same drainage systems in large part, there is shared responsibility in operation and maintenance.

The NDIA works with the conservancies' boards, water users associations (WUAs), farmers groups and local government bodies to maintain irrigation and drainage systems in an operational and efficient manner.

The Mahaica Mahaicony Abary/Agricultural Development Authority (MMA/ADA) supports nearly half of the national rice production, about 30-35 percent of all livestock (most cattle) production and 10-15 percent of national sugar production. The MMA/ADA water control project was conceived for facilitating the complete agricultural development of an area of about 180 000 ha of land lying between the Mahaicony and Berbice rivers. The plans were first outlined in 1952. The idea was to provide water control for the coastal lands up to a distance of some 50 km inland, by impounding the flood waters in surface reservoirs (conservancies) located in the upper reaches of the rivers, and through the construction of appropriate civil engineering infrastructure, provide drainage and irrigation services to the areas nearer the coast.

The Guyana Rice Development Board (GRDB) and the Guyana Rice Producers Association (GRPA) are in charge of training farmers and the National Research and Extension Institute (NAREI) usually assists in the provision of extension services, for crops and fisheries, along with the Guyana Livestock Development Authority (GLDA) for livestock.

Water management

All irrigation schemes in Guyana have the same delivery arrangements. An irrigation schedule gives the date and duration of the opening of the head regulators on secondary canals. During the allotted period, the farmers can divert water on demand. There are no metered structures, and the entire system is operated through the concept of nearly constant water level. The volume released at any point throughout the systems is unknown.

The management of drainage and irrigation (D&I) systems has been slowly taken over by the farmers and other stakeholders. There were more than 30 WUAs, created since 1996, formed only by very poor farmers who were unable to sustain themselves because of lack of financial revenues. The creation of the NDIA in 2004 included among other things to provide a clear legal framework for the establishment of WUAs to transfer more participation rights to private concerns in the management of D&I systems. Since 2004 WUAs are under a new design, supported by the Inter-American Development Bank (IDB) and the Government of Guyana (GoG) through the Agricultural Support Services Programme (ASSP) project. Using experiences prior to 2004 and for the first half of 2005 indicated that large WUAs have the potential to be sustainable. Currently there are 11 functioning WUAs.

The sewerage and water services face operational, maintenance, financial and institutional challenges. During 2009-2010 there were different external funding sources towards the improvement of water and

sewerage services, with a special emphasis to reducing the high levels of non-revenue water and improving the performance of the Georgetown Sewerage system.

Finances

The NDIA prepares an annual budget for executing recurrent and capital works identified under feasibility studies and by the local authorities. Recurrent expenses are funded by the revenues generated by the state, through budgetary allocations to the Authority, or other management of the irrigation system, through its Region or Board. Donor agencies are usually approached for funds for capital works.

Drainage and irrigation fees collected by the WUAs meet the cost of the operation and maintenance of the secondary system.

Policies and legislation

The Water and Sewerage Act of 2002 gave the GWI authority for the supply of potable water. The NDIA was established under an Act Cap 6403, Drainage and Irrigation. These acts define the authority and guide the management, through the establishment of Boards and committees, to provide operational directions to potable water supply and D&I in the agriculture sector.

ENVIRONMENT AND HEALTH

Water quality from the main conservancies is generally deemed potable, as it is used for drinking and cooking by farmers and nearby residents. During low flows it generally gets degraded and loses its freshness. However, it still supports aquatic growth and fishes.

The use of pesticides and herbicides are controlled by the extension services and the Pesticides Toxic Chemical Control Board, which works closely with the agricultural departments. The areas in which extensive agriculture is practiced have not been known to carry chemical residues that affect the environment. Industrial and municipal users have not been found to be polluting the environment nor recycling wastewater, some of which is treated before discharge. However, in sugarcane cultivation areas, there is recirculation of water especially into navigation channels, which is also used for irrigation.

Guyana faces agricultural and domestic supply shortages whenever there is reduced rainfall during the rainy seasons. This occurs during strong positive El Nino Southern Oscillation (ENSO) episodes. The Civil Defense Commission (CDC) has developed a plan to mitigate the impacts of flooding.

There is a new drainage channel being built to ease flooding of riverain and coastal areas in Region IV due to excessive rainfall.

The data collected over the years indicate that an average of 80 persons per 1 000 of the population is affected by waterborne illnesses, which is below the global average.

PROSPECTS FOR AGRICULTURAL WATER MANAGEMENT

According to the Guyana Rice Development Board (GRDB) Strategic Plan 2012-2022, some of the projections for the rice industry are to improve 70 percent of the drainage and irrigation schemes in the rice sector and to increase yields of rice to 6 tons/ha. It also identifies the need for funding so that adequate irrigation requirement for expansion of cultivation are achieved, indicating that the agricultural sector is projected to grow.

The long-term plan for the development of the agriculture sector is evident in the construction of the largest Sugar Factory in the Caribbean Region, Skeldon, with assistance from the World Bank.

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