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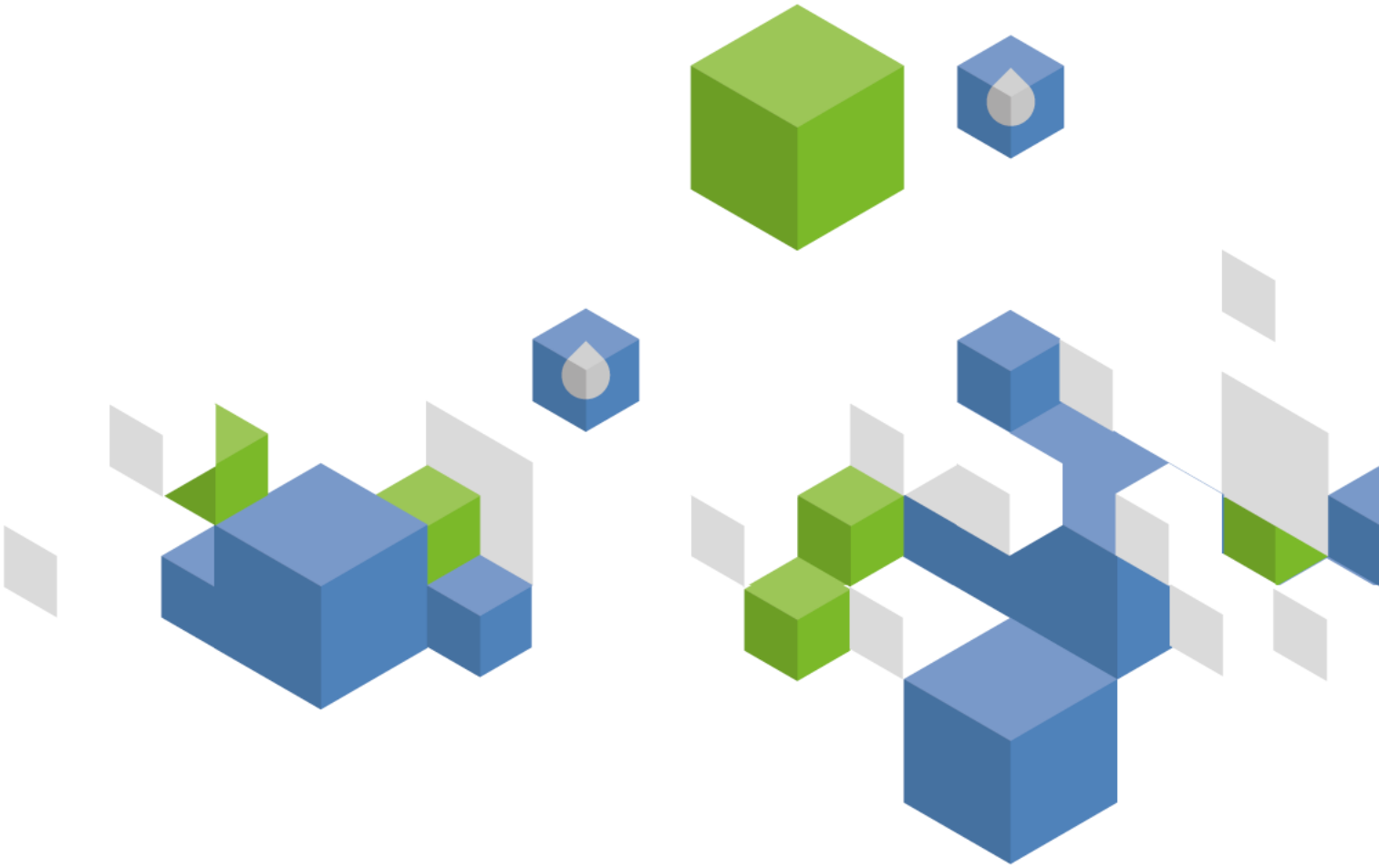

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Belize

GEOGRAPHY, CLIMATE AND POPULATION

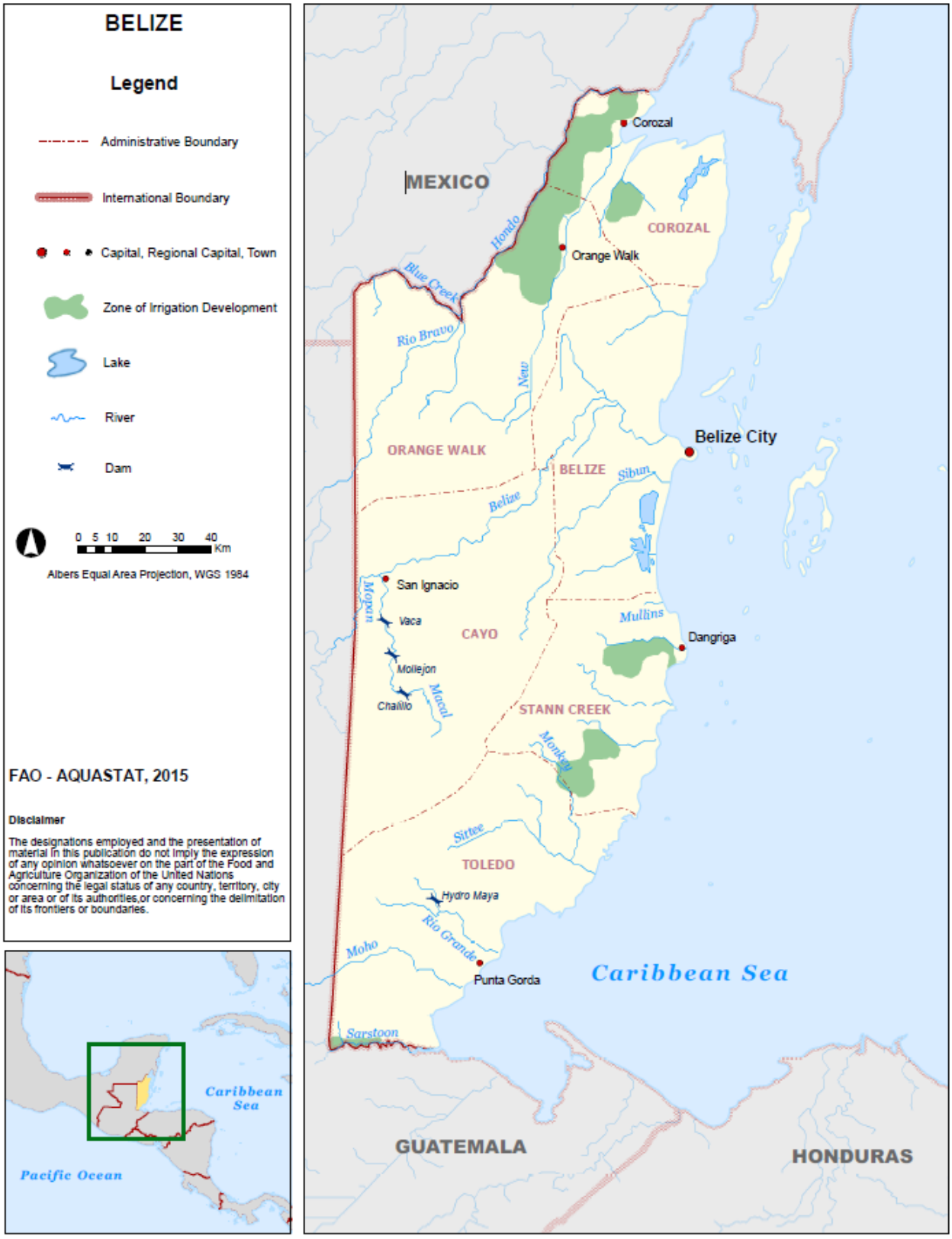
Geography

Belize is located in Central America, bordering the Caribbean Sea, between Guatemala and Mexico. It is 274 km long north to south and 109 km wide east to west. The country is divided into six administrative districts: Belize, Cayo, Corozal, Orange Walk, Stann Creek and Toledo. Its total area is 22 970 km^2, that includes 1 540 km^2 of lagoons and 690 km^2 of approximately 450 small islands (known as "cayes"). In 2012, the cultivated area was estimated at 110 000 ha (78 000 ha temporary crops and 32 000 ha permanent crops) (Table 1).

TABLE 1
Basic statistics and population

Physical areas:			
Area of the country	2012	2 297 000	ha
Agricultural land (permanent meadows and pasture + cultivated land)	2012	160 000	ha
• As % of the total area of the country	2012	7	%
• Permanent meadows and pasture	2012	50 000	ha
• Cultivated area (arable land + area under permanent crops)	2012	110 000	ha
- As % of the total area of the country	2012	5	%
- Arable land (temp. crops + temp. fallow + temp. meadows)	2012	78 000	ha
- Area under permanent crops	2012	32 000	ha
Population:			
Total population	2013	332 000	inhabitants
- Of which rural	2013	56	%
Population density	2013	14	inhabitants/km^2
Population economically active	2013	143 000	inhabitants
• As % of total population	2013	43	%
• Female	2013	38	%
• Male	2013	62	%
Population economically active in agriculture	2013	33 000	inhabitants
• As % of total economically active population	2013	23	%
• Female	2013	3	%
• Male	2013	97	%
Economy and development:			
Gross Domestic Product (GDP) (current US$)	2011	1 448	million US$/year
• Value added in agriculture (% of GDP)	2008	12	%
• GDP per capita	2011	4 468	US$/year
Human Development Index (highest = 1)	2013	0.732	-
Gender Inequality Index (equality = 0, inequality = 1)	2013	0.435	-
Access to improved drinking water sources:			
Total population	2012	99	%
Urban population	2012	98	%
Rural population	2012	100	%

FIGURE 1
Map of Belize



The coastal areas are lowland plains, with much of the coastline covered with mangrove swamps. The Maya Mountains (300 to 1 000 m in altitude) occupy the south-centre and dominate much of the remainder of the country.

They rise steeply to a maximum of 1 120 m at Victoria Peak in the Cockscomb Range, and slope down to the Vaca Plateau in the west. Belize has the second longest coral barrier reef in the world at 220 km running almost the entire length of the coastline.
Belize is a unique case of a very small country with a rich endowment of natural resources of global importance: its large and still relatively intact tropical forests and its almost pristine coral reef. Some 63 percent of the country is classified as forest, with 35.5 percent held by the government under forest reserves and protected areas status with a rich biodiversity.

Climate

The climate is subtropical with temperatures ranging from 22ºC to 31ºC in the coast and from 16ºC to 18ºC in the mountains, the coldest months being November and January. Annual precipitation varies from 1 500 mm in the North to 4 000 mm in the South. A dry season extends from February to May, followed by a rainy season from June to November that peaks in July. December to February is a transitional period. In November and December agricultural activities are commonly restricted due to high water saturation levels in the soil. Winds from the east and southeast prevail from February to September, while winds from the north and northeast dominate in winter. Annual evaporation in Belize district is 1 750 mm. Belize is within the area of the Caribbean commonly affected by hurricanes, which on average occur once every five years.

Population

The total population was estimated at 332 000 inhabitants in 2013 (56 percent rural). During the period 2003-2013 the annual population growth rate was estimated at 2.6 percent. The population density is about 14 inhabitants/km^2 which is one of the lowest population densities in Latin America. Belize has a diverse population: Mestizo, Creole, Garífuna, Caribbean, Maya Kekchi, Maya Mopán, Mennonite, Yucatec, etc.

In 2012, 99 percent of the population had access to improved water sources (98 and 100 percent in urban and rural areas respectively). Sanitation coverage accounted for 91 percent (94 and 88 percent in urban and rural areas respectively).

ECONOMY, AGRICULTURE AND FOOD SECURITY

In 2011, the Gross Domestic Product (GDP) was $US1 448 million of which the agriculture sector accounted for 12 percent.

In 2013, the total economically active population is 143 000 inhabitants, or 43 percent of the total population. The economically active population in agriculture is estimated at 33 000 (23 percent of total active population), of which 3 percent is female.

The economy is dependent on agricultural production, forestry and fisheries. The agriculture sector is primarily dependent on traditional export crops such as sugar, citrus and banana. Citrus exports are the principal source of income followed by sugar and banana. Rice, maize and beans are the main domestic food crops.

The country has two major agro-climatic zones: the northern and the southern. The northern zone is relatively flat, with considerable areas of swampland on the coastal plain. Its average annual precipitation is about 1 300 mm, and its calcareous soils are suitable for cultivation of a wide variety of crops. These soils may, however, change abruptly to acidic soils in certain areas. The southern zone encompasses the central mountains and a flat to undulating coastal belt. The siliceous soils of the

mountains are not suited for agriculture. The high level of soil acidity and poor drainage conditions constitute important constraints to crop production. In total, only 16 percent of the land is suitable for sustained agricultural production without skilled management.

Two main farming systems can be distinguished: Milpa farming and commercial farming. Milpa farming is based on slash-and-burn practices and is usually carried out on hillsides. It is the basic system used to produce food for domestic consumption: maize, grown during the wet season, and a variety of other crops (including beans, vegetables, root crops and plantains) grown in the subsequent dry season. Commercial farming includes export crops such as sugarcane, oranges, grapefruit, banana and cocoa.

WATER RESOURCES

Surface water and groundwater resources

Belize is very rich in surface water and groundwater resources. Surface water resources appear to be abundant all over the country except on the Vaca Plateau, where streams disappear in the porous limestone. The northern rivers show meandering streams while the southern have smaller basins and flow more rapidly into the sea. There are a total of 18 major river basins with another 16 sub-basins, which drain the Maya Mountains and discharge into the Caribbean Sea. The river basins are grouped into six main regions, based on general characteristics of topography, geology, soils, rainfall and land use: Northern, Northeastern, Central, Southeastern, Southwestern and Southern Watershed Region. The Hondo river originates in Guatemala, then enters Mexico and then becomes the northern boundary of the country with Mexico. In the South, the Sarstoon river originates in Guatemala and then becomes the boundary with Guatemala.

Generally, groundwater is available throughout the less mountainous areas of Belize and favourable yield characteristics can be attributed to geology and climatic conditions. The northern region consists of calcareous sediments that have shown high permeability. In the south where limestones are found similar groundwater yield conditions are indicated, while the shales and slates are naturally poorly permeable and therefore have low capacity for groundwater extraction.

Internal renewable surface water resources have been estimated at 15.258 km^3/year and internal renewable groundwater resources at 7.51 km^3/year (IGRAC, 2012). The overlap between surface water and groundwater being estimated to be 100 percent, total internal renewable water resources are thus 15.258 km^3/year (Ballesteros, Reyes and Astorga, 2007). The flow of the border river Hondo with Mexico is estimated at 0.864 km^3/year, of which 50 percent or 0.432 km^3/year is counted for Belize. The flow from Mopán and Sarstún rivers from Guatemala is estimated at 6.042 km^3/year. This brings the total renewable water resources to 21.732 km^3/year (Table 2).

TABLE 2
Renewable water resources

Renewable freshwater resources:			
Precipitation (long-term average)	-	1 705	mm/year
	-	39 160	million m^3/year
Internal renewable water resources (long-term average)	-	15 258	million m^3/year
Total renewable water resources	-	21 732	million m^3/year
Dependency ratio	-	30	%
Total renewable water resources per inhabitant	2013	65 458	m^3/year
Total dam capacity	2013	122	million m^3

Lakes and dams

Numerous freshwater and brackish water lakes or lagoons are scattered in the central and northern coastal and inland low-lying areas (BEST & CCCCC, 2009).

The country is well endowed with potential sites for the development of large and small hydroelectric projects.

Total large dam capacity is estimated at 122 million m^3 in 2013. There are three major hydroelectric projects on the Macal river: the Mollejon dam (1.7 million m^3) completed in 1995 at the confluence of the On river and the Macal river, the Chalillo dam (120 million m^3) completed in 2005, and the Vaca dam completed in 2010 in the area of the Vaca falls. These three dams have also flood control purposes. The Macal river was chosen because it has good elevation which means more pressure, but the construction of the dams has reduced considerably the flow and the quality on the river.

The Chalillo dam is located a few miles upstream from the Mollejon dam and was built to store water to be used at the Mollejon and Vaca stations during the dry season or when the water is low. With these three hydropower plants Belize is able to produce its own energy and does not really need to depend on Mexico. The Chalillo facility generates 7.3 MW of power and the Mollejon plant generates 25.2 MW.

There is another hydroelectric plant in San Miguel river, the Hydro Maya plant, which supplies 0.50 MW. There is also a small scale power plant at Blue Creek on the Hondo river, which provides 15KW of power.

International water issues

Belize is a party to several regional and international treaties and conventions that have water resources management obligations. The country is also working with neighbouring countries with the purpose of improving the management of shared river basins.

In 1998, Belize and Mexico signed a bilateral agreement for the hydro-meteorological monitoring of the Hondo transboundary river basin. This agreement was for the establishment of hydro-climatological monitoring sites on both sides of the boundary.

In 2003, Belize and Mexico signed an agreement through the International Commission of Boundaries and Water between Mexico and Belize for the diagnostic study for the sustainable management of the Mexico-Belize Hondo transboundary river basin. In 2007, the National Water Commission of Mexico (CONAGUA) and members of the defunct National Pro-Tempore Water Commission (NPTWC) presented the Diagnostic Study of the Hondo river basin that identifies problems areas and threats in this river basin and enhances cooperative ventures in addressing these threats (BAS, 2008).

In 2008, a bi-national Workshop on National Water Laws took place between Belize and Mexico that recognized the fundamental, universal principles upon which the integrated water resources management (IWRM) is based: social equity, legal certainty, efficiency, and sustainability (BAS, 2008).

WATER USE

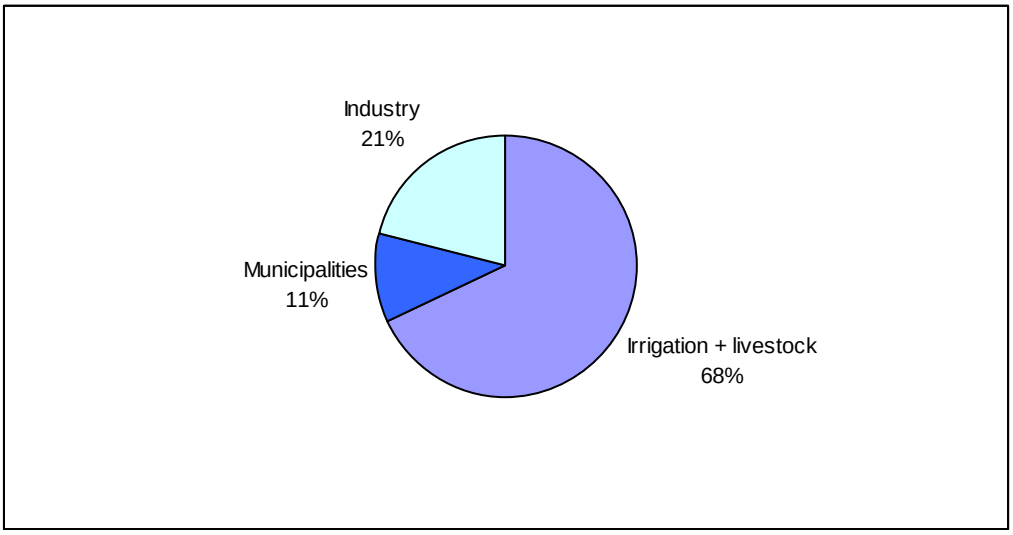
In 2000, total water withdrawal was estimated at 101 million m^3, of which 68.4 million m^3 or 68 percent for agricultural purposes, 21.2 million m^3 or 21 percent for industrial purposes and 11.4 million m^3 or 11 percent for municipal purposes (Table 3 and Figure 2).

The Macal river, which flows into the Belize river, supplies the major municipalities in the largest district, Cayo, specifically San Ignacio, Santa Elena, Belmopan and Belize City, Ladyville, and all the villages in between and is also the primary source of water for agriculture and industry of the major agricultural-producing area known as the Belize river valley. Other main towns withdraw their water from either other rivers or from wells, with the exception of San Pedro town where potable water is accessed using reverse osmosis. The majority of rural residents are supplied by rudimentary water systems. A bottled water industry has also developed to serve the country's rapidly increasing demand (BEST & CCCCC, 2009).

TABLE 3
Water use

Water withdrawal:			
Total water withdrawal	2000	101.0	million m^3/year
- Agriculture (Irrigation + Livestock + Aquaculture)	2000	68.4	million m^3/year
- Municipalities	2000	11.4	million m^3/year
- Industry	2000	21.2	million m^3/year
• Per inhabitant	2000	423	m^3/year
Surface water and groundwater withdrawal (primary and secondary)	2000	101.0	million m^3/year
• As % of total renewable water resources	2000	0.5	%
Non-conventional sources of water:			
Produced municipal wastewater	1994	2	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 101 million m^3 in 2000



IRRIGATION AND DRAINAGE

Evolution of irrigation development

Irrigation in Belize has been marginal because of its climatic and social conditions. Public irrigation and drainage systems are non-existent and only a few private irrigation systems were developed in the 1990s.

Considering water resources for irrigation, the country can be subdivided into three main areas (Ballesteros, Reyes and Astorga, 2007):

- A southern high rainfall area (Stann Creek and Toledo), which has abundant good-quality surface water resources for use in the dry season and supports irrigation systems with lower water use efficiencies, such as flood irrigation;
- An intermediate rainfall area in the central foothills (Cayo and the southern area of Belize), home of many small farming communities. The area is most favourable to irrigation systems with higher water use efficiencies for the production of rice, vegetables and papaya. Water quality of surface water resources is good although availability is low during the dry season;
- A much drier northern plateau (Corozal and the northern area of Belize) characterized by lagoons, creeks, swamps, subsurface storage in limestone aquifers and slow and sluggish

flowing rivers. Availability of water for dry season is good, but access to surface water and groundwater resources poses problems in small farming communities.

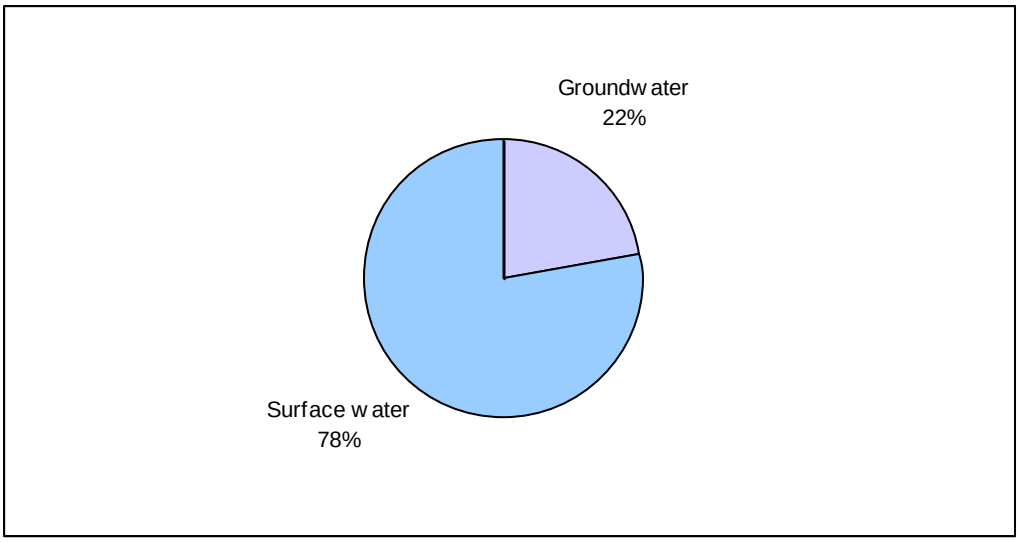
According to the Ministry of Agriculture, area equipped for irrigation was 3 548 ha in 2005 (Table 4). In 1997, it was estimated at 3 000 ha.

TABLE 4
Irrigation and drainage

Irrigation potential		-		ha
Irrigation:				
1. Full control irrigation: equipped area		2005	3 548	ha
- Surface irrigation		-	-	ha
- Sprinkler irrigation		-	-	ha
- Localized irrigation		-	-	ha
• Area equipped for full control irrigation actually irrigated		2005	3 548	ha
- As % of area equipped for full control irrigation		2005	100	%
2. Equipped lowlands (wetland, ivb, flood plains, mangroves)		-	-	ha
3. Spate irrigation		-	-	ha
Total area equipped for irrigation (1+2+3)		**2005**	**3 548**	**ha**
• As % of cultivated area		2005	3	%
• % of area irrigated from surface water		2005	78	%
• % of area irrigated from groundwater		2005	22	%
• % 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	3 548	ha
- As % of total area equipped for irrigation		2005	100	%
• Average increase per year		1997-2005	2.1	%
• 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)		**2005**	**3 548**	**ha**
• As % of cultivated area		2005	3	%
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		2005	3 548	ha
• Temporary crops: total		2005	1 612	ha
- Rice		2005	1 338	ha
- Winter vegetables		2005	74	ha
- Sugarcane		2005	200	ha
• Permanent crops: total		2005	1 936	ha
- Papaya		2005	721	ha
- Bananas		2005	1 215	ha
Irrigated cropping intensity (on full control area actually irrigated)		2005	100	%
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

Area actually irrigated was assumed to be similar to area equipped for irrigation. Area irrigated with groundwater was 792 ha in 2005, most of it located in the district Corozal, while the remaining area was irrigated by using surface water (Ballestero *et al*, 2007) (Figure 3).

FIGURE 3
Source of irrigation water on area equipped for irrigation
Total 3 548 ha in 2005

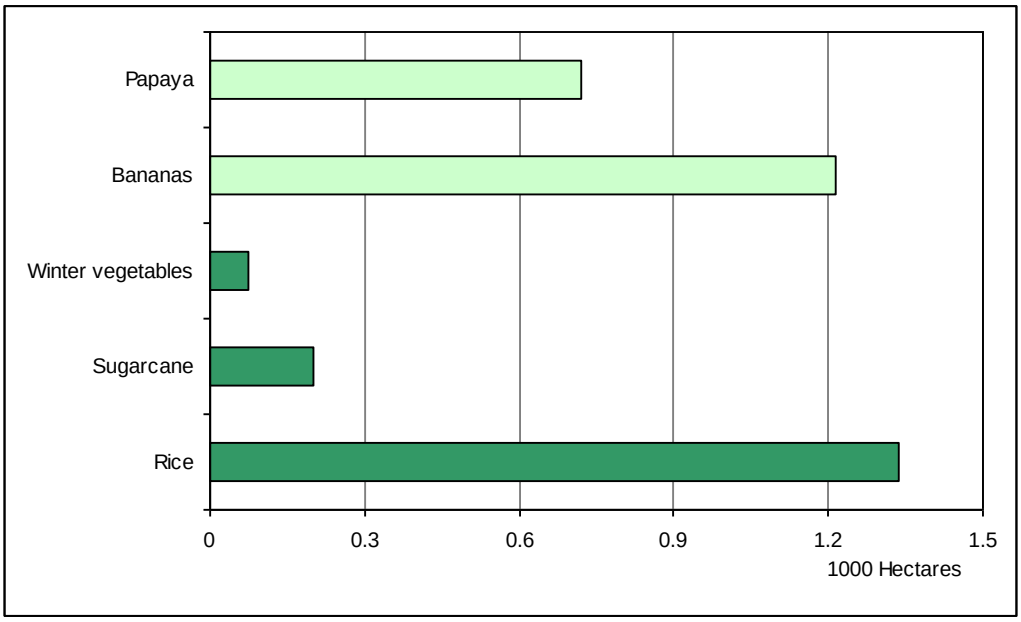


Surface and sprinkler irrigation are being used for sugarcane and banana production, surface irrigation for rice and localized irrigation for papaya production.

Role of irrigation in agricultural production, economy and society

Irrigation development has been successful in crops of high-intensity production such as bananas, papayas and rice. In 2005, total harvested irrigated cropped area was estimated at 3 548 ha. Rice and bananas are the main irrigated crops, followed by papaya and sugarcane (Table 4 and Figure 4). Rice is irrigated from April to August, during the rainy season. In the winter some vegetables are grown.

FIGURE 4
Irrigated crops on area equipped for full control irrigation
Total harvested area 3 548 ha in 2005 (cropping intensity on actually irrigated area: 100%)



Women and irrigation

Belize's poor rural people include rural women who are traditionally economically dependent on men and who are constrained both by traditional gender roles within households and by lack of access to financial resources and capacity-building. Women have in general the responsibility of resources management at the family level (IICA, 1995).
The government of Belize has promoted women's participation in income-generating activities and food and nutrition systems at the local level, focusing on creating opportunities for equal participation by women (FAO, 1996).

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

Institutions

Several government departments and agencies are legally responsible for the management of water resources within their respective sectors. This results in the uncoordinated and overlapping management of the nation's water resources (BEST & CCCCC, 2009). Joint efforts have been made to create a National Water Commission, but have not yet been successful.

The various agencies involved are:

- Belize Water Services Ltd. (BWS) is responsible for the provision of potable water to urban and some rural communities, and providing functional sewerage services to Belize City, Belmopan and San Pedro Town. It was formed in 2001, as part of a privatization initiative of the government and vested with the assets and liabilities of the former Water and Sewerage Authority (WASA). Some 83 percent of the shares of BWS were acquired by a joint British-Dutch company. In October 2005, the government repurchased the majority shares, thereby ensuring Belizean ownership (BWS, 2013).
- The Ministry of Natural Resources and Environment is the lead ministry with respect to water resources. It is responsible for water conservation, water pollution, watersheds, hydrology, climatology and climate change.
- The Ministry of Agriculture and Fisheries is responsible of ensuring food security and conserving natural resources, in order to make the economy grow, reduce poverty and empower the local population for sustainable development.
- The Ministry of Health, in partnership with Pan American Health Organization/World Health Organization (PAHO/WHO), has made great strides in containing the ravages of waterborne diseases.
- The Ministry of Works is responsible for the construction and maintenance of navigable waterways and bridges, engineering works, land reclamation and drainage and facilitating transportation along flooded roads.
- The Rural Water Unit of the Ministry of Rural Development is responsible for drilling wells for rural communities and the development of rudimentary water supply systems.
- The Belize Electric Company Ltd. (BECOL) is responsible for the hydroelectric plants of the country.
- The Belize National Emergency Management Organization (NEMO) is established to preserve life and property throughout the country in the event of an emergency, threatened or real, and to mitigate the impact on the country and its people. It is charged with flood management.

Some other important institutions related to water issues are Public Utilities Commission, local Bottled Water Companies, Public Health Bureau and various NGOs and national focal points of regional and international agencies such as UNEP, the Global Water Partnership (GWP-CATAC), UNDP and others.

No water quality monitoring programme exists in Belize. A number of agencies monitor water quality for their own purposes, such as the Department of the Environment, Public Health Bureau, Fisheries

Department, Coastal Zone Authority, Belize Water Services, environmental NGOs and consulting agencies (Frutos, 2003).

Irrigation and groundwater exploration and exploitation are not specifically delegated to any institution.

Water management

Belize, in general, has plenty of water resources of good quality. However, increases in demand due to expansion in the agricultural, industrial and tourism sectors along with a growing population and accompanying water pollution make a proper management and use of the water resources necessary.

In 2003, the government reactivated the National Pro Tempore Water Commission (NPTWC), with a mandate to prepare recommendations for an integrated water resources management policy which was enacted in 2008. It highlights the need to conduct a proper and comprehensive assessment of water resources and develop a baseline of water quality for the various uses of water (UNEP, 2011).

In 2011, the government enacted the National Integrated water Resources Act which provides for the management, controlled allocation and sustainable use and protection of the water resources of Belize. It also provides for the establishment of a National Integrated Water Resources Authority to coordinate and assist in regulating the water sector (UNEP, 2011).

With technical assistance from FAO, funded by UNDP, a national irrigation policy has been drafted as well as a 5 year plan for the development of irrigation and drainage in Belize.

Finances

All irrigation systems are private and were developed with private funds or loans from international cooperation organizations such as the European Union. The Ministry of Agriculture provides technical assistance for small producers and facilitates the financing requests of large producers. There is no tariff system, the costs of development and maintenance are paid by the producers (Ballesteros, Reyes and Astorga, 2007).

Policies and legislation

Several legislations related to legal management of water resources exist. These laws tend to cover, directly or indirectly, sub-sector or functional aspects of water resources management and provide for separate implementing institutions.

The policy and legislation related to water management consists of:

- Public Health Ordinance, 1943
- Water and Sewerage Act, 1971 (revised edition in 2000)
- Environmental Protection Act, 1992
- National Lands Act, 1992
- Water Industry Act, 1993 (revised edition in 2001)
- Public Utilities Commission Act, 1999
- Water Resources Management Act, 2006
- National Integrated Water Resources Management Policy, 2008
- National Integrated Water Resources Act, 2011

The Ministry of Agriculture and Fisheries in collaboration with FAO is currently working on the Belize Irrigation Policy and Strategy for Stakeholders (GoB, 2011).

ENVIRONMENT AND HEALTH

Although there is a limited evaluation and monitoring system, it is estimated that a large part of the surface water in urban areas is contaminated because of inadequate disposal of household, agricultural and industrial liquid and solid wastes (BAS, 2008). In rural areas, the water quality mainly in the districts of Toledo, Stann Creek and Cayo, is not satisfactory.

Sporadic occurrences of poor quality groundwater occur. High concentrations of chloride are found along the coast and along rivers that are subject to tidal effects. Chloride waters are evident in some inland wells in the northern half of the country, likely as a result of the dissolution of salts within the calcareous sediments. Large concentrations of hardness and sulphate are evident in some areas, particularly the Corozal district. Poor quality groundwater can be expected during the dry season when freshwater recharge from precipitation is negligible, particularly in the north where it extends for three to four months.

There is salt water intrusion into the coastal aquifers and it is estimated that it will continue at an accelerated rate (BAS, 2008).

The United Nations Framework Convention on Climate Change (UNFCCC) has identified that Belize is one of the most vulnerable countries to climate change due to: (i) its long, low-lying coastline; (ii) its over 1 060 small islands; (iii) its second-longest barrier reef in the world and 17 276 km^2 of forest cover; (iv) the fact that it is very prone to natural disasters, especially hurricanes (GOB, 2002).

The government has included the following environmental issues in the National Environmental Action Plan and the Belize Medium Term Development Strategy 2010-2013 (UNEP, 2011): sustainable management of environmental resources; strengthening of existing institutional management systems; need to address Belize's vulnerability to climate change; and need to invest in technology and irrigation and provide technical support to farmers while promoting the use of greener pesticides.

The Belize National Emergency Management Organization NEMO handles the procedures that are needed during flooding events.

PROSPECTS FOR AGRICULTURAL WATER MANAGEMENT

Climate change will affect rainfall, temperatures, and water availability for agriculture in vulnerable areas that will result in losses in agriculture production. There will be a need to develop weather-resistant crops (BAS, 2008).

It is also important to establish an integrated approach to water resources management with participation of all stakeholders, communities and decision-makers, and to formulate legislations for regulating the use of the country's freshwater.

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