

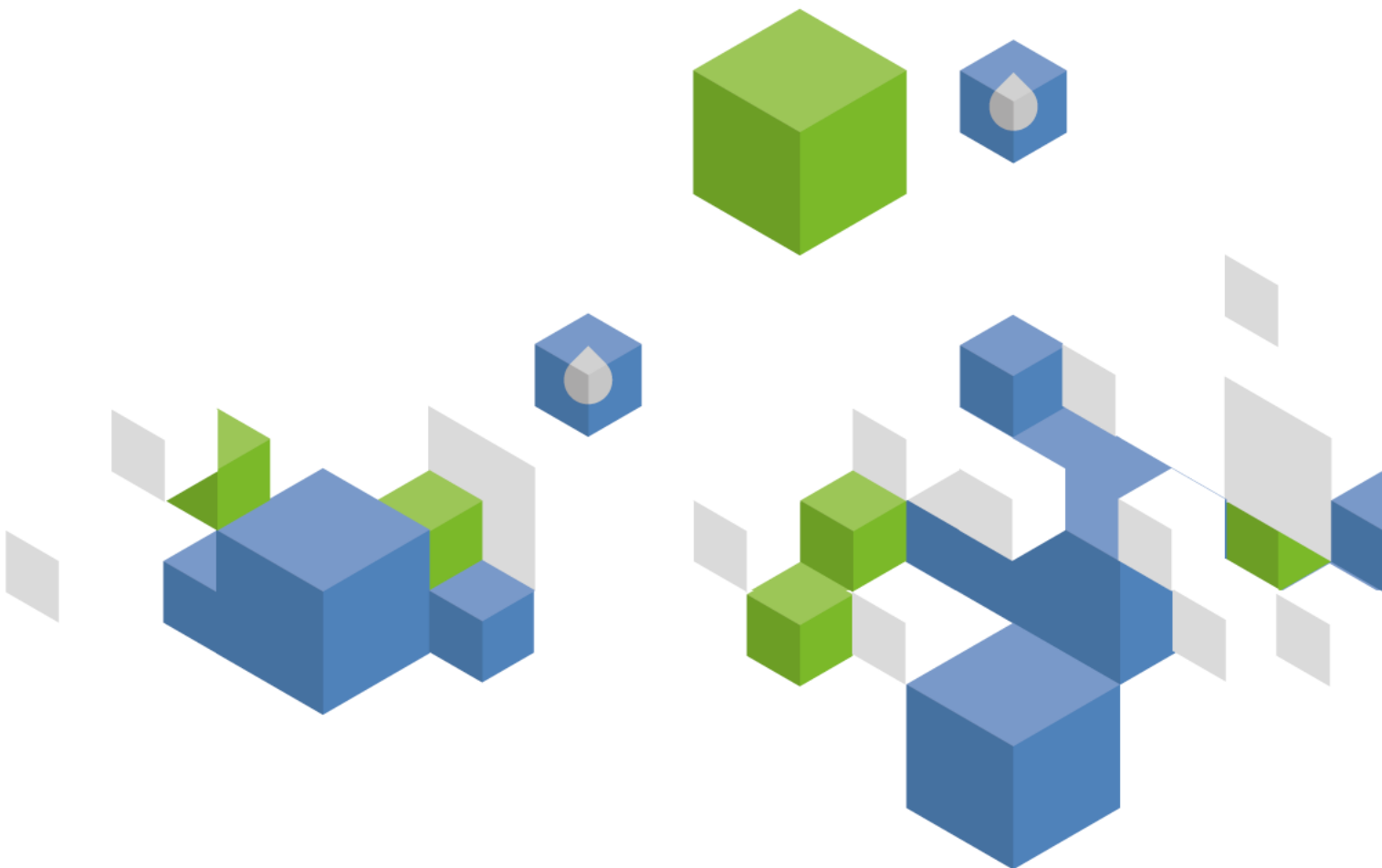


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Trinidad and Tobago

GEOGRAPHY, CLIMATE AND POPULATION

Geography

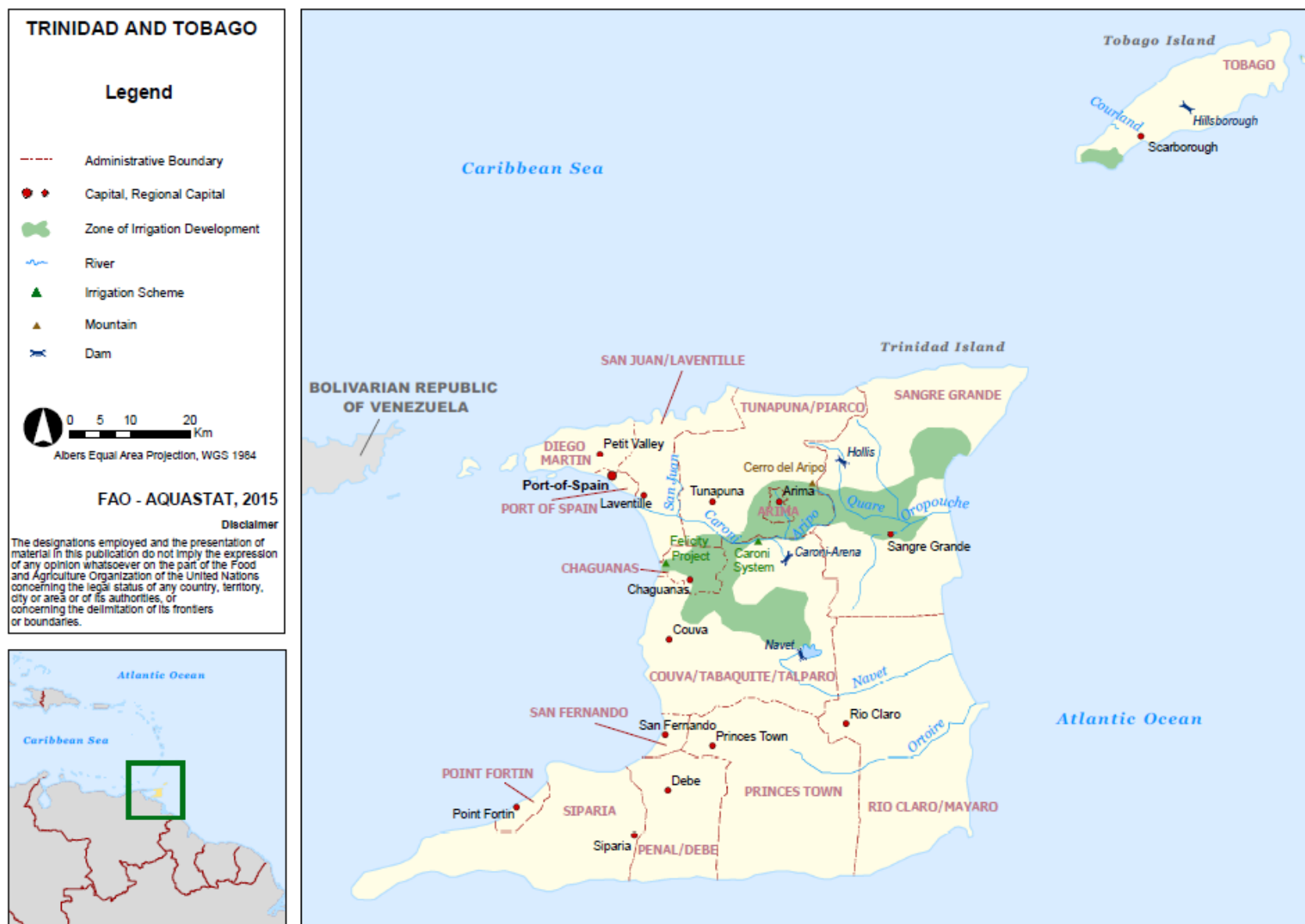
The twin-island republic of Trinidad and Tobago is the most southerly of the Caribbean Island chain, at 11 km from the Venezuelan Coast. It has a total area of 5 130 km². Trinidad is about 105 km long and 77 km broad with an area of 4 830 km². The island of Tobago lies northeast of Trinidad from which it is separated by a channel about 31 km wide. It is 51 km long and 18 km broad with an area of 300 km². The country is administratively divided in nine regions, three boroughs, two cities (Port of Spain and San Fernando in Trinidad), and one ward (Tobago). The capital is Port of Spain.

In 2012, the total physical cultivated area was estimated at 47 000 ha, of which 53 percent (25 000 ha) consisted of temporary crops and 47 percent (22 000 ha) of permanent crops. Permanent meadows and pasture cover 7 000 ha, which brings the total agricultural area to 54 000 ha (Table 1).

TABLE 1
Basic statistics and population

Physical areas:			
Area of the country	2012	513 000	ha
Agricultural land (permanent meadows and pasture + cultivated land)	2012	54 000	ha
• As % of the total area of the country	2012	11	%
• Permanent meadows and pasture	2012	7 000	ha
• Cultivated area (arable land + area under permanent crops)	2012	47 000	ha
- As % of the total area of the country	2012	9	%
- Arable land (temp. crops + temp. fallow + temp. meadows)	2012	25 000	ha
- Area under permanent crops	2012	22 000	ha
Population:			
Total population	2013	1 341 000	inhabitants
- Of which rural	2013	86	%
Population density	2013	261	inhabitants/km ²
Population economically active	2013	725 000	inhabitants
• As % of total population	2013	54	%
• Female	2013	44	%
• Male	2013	56	%
Population economically active in agriculture	2013	44 000	inhabitants
• As % of total economically active population	2013	6	%
• Female	2013	16	%
• Male	2013	84	%
Economy and development:			
Gross Domestic Product (GDP) (current US\$)	2013	24 641	million US\$/year
• Value added in agriculture (% of GDP)	2012	1	%
• GDP per capita	2013	18 375	US\$/year
Human Development Index (highest = 1)	2013	0.766	-
Gender Inequality Index (equality = 0, inequality = 1)	2013	0.321	-
Access to improved drinking water sources:			
Total population	2011	94	%
Urban population	2011	97	%
Rural population	2011	93	%

FIGURE 1
Map of Trinidad and Tobago



Trinidad is subdivided into five physiographic regions: (i) the *Northern Range*, a mountainous area running east-west, parallel to the north coast of Trinidad, with a maximum elevation of 940 m at Cerro del Aripo; (ii) the *Central Range*, which comprises rounded hills and ridges reaching a maximum elevation of 307 m at Tamana Hill just south of the Northern Basin; (iii) the *Southern Range*, which is a discontinuous range along the southern coast of Trinidad with a maximum elevation of 303 m in the Trinity Hills; (iv) the *Northern Basin* and (v) the *Southern Basin*, which lie between these ranges and consist of flat and undulating alluvial floodplains (*lowlands*); the *Southern Basin* includes the Nariva Swamp, the largest coastal wetland in this basin which is situated on the east coast. Tobago is subdivided into two physiographic regions: (i) the *Main Ridge*, comprised of metamorphic and volcanic rocks, occupies the northern third of the island, with the highest elevation of 550 m; (ii) the *Coastal Plain*, which is flat and coralline and occupies the southern two-thirds of the island.

Climate

The country has a tropical, warm and humid climate. Annual average precipitation in the country is 2 200 mm. The average annual rainfall of Trinidad is 2 000 mm. The evapotranspiration rate is very high accounting for up to 60 percent of the total rainfall received in some areas. In Tobago the average rainfall is 1 900 mm ranging from 3 800 mm in the Main Ridge to less than 1 250 mm in the south-western lowlands. There are two seasons, the dry season from January to May and the wet season from June to December, with a secondary dry season or *Petit Carême* occurring in September and October. Approximately 70-80 percent of annual rainfall occurs during the wet season.

Average temperature in the country is 27°C. The maximum temperature is 33°C, experienced in September, and the minimum temperature is 22°C in February. Temperatures in Tobago are somewhat lower than in Trinidad with a marked decline of about 4°C in the *Main Ridge* area.

Population

In 2013, the total population was about 1.3 million, of which around 86 percent was rural (Table 1). Population density is 261 inhabitants/km². The average annual population growth rate in the 2003-2013 period has been estimated at 0.4 percent. About 96 percent of the population lives on the island of Trinidad, mostly concentrated in urban areas along the west coastal areas and at the foothills of its northerly located mountain range. Tobago's population is concentrated in the southwest part of the island.

In 2011, 94 percent of the total population had access to improved water sources (97 and 93 percent in urban and rural areas respectively). In 2012, 92 percent of the total population had access to improved sanitation (both in urban and in rural areas).

ECONOMY, AGRICULTURE AND FOOD SECURITY

In 2013, the gross domestic product (GDP) was US\$ 24 641 million. In 2012 agriculture accounted for 1 percent of GDP, while in 1992 it accounted for 3 percent. In 2013, total population economically active in agriculture is estimated at 44 000 inhabitants (6 percent of economically active population), of which 16 percent is female and 84 percent is male.

The country is highly industrialized compared to other Caribbean islands, as a consequence of the country's oil and natural gas resources. The country also has a small but rapidly growing tourism industry concentrated mainly in Tobago (WRA, 2001).

Since the oil boom era of the 1970s agriculture has been declining steadily both in terms of national production and exports. Sugar, cocoa beans, coffee and citrus fruits are the main agricultural products.

WATER RESOURCES

Surface water and groundwater resources

The mean annual rainfall in the country is 2 200 mm (Table 2). Long-term annual renewable surface water resources are estimated at 3 740 million m³, of which 3 600 million m³ in Trinidad and 140 million m³ in Tobago. Long-term average annual renewable groundwater resources are estimated at 614 million m³, of which 545 million m³ in Trinidad and 69 million m³ in Tobago. Considering an overlap between surface water and groundwater resources of 514 million m³, the total Internal Renewable Water Resources (IRWR) are estimated at 3 840 million m³/year.

TABLE 2
Renewable water resources

Renewable freshwater resources:			
Precipitation (long-term average)	-	2 200	mm/year
	-	11 290	million m ³ /year
Internal renewable water resources (long-term average)	-	3 840	million m ³ /year
Total renewable water resources	-	3 840	million m ³ /year
Dependency ratio	-	0	%
Total renewable water resources per inhabitant	2013	2 864	m ³ /year
Total dam capacity	2015	71.47	million m ³

There are 55 catchment areas in Trinidad and 15 in Tobago. Large-scale development of surface water has been limited to four rivers in Trinidad and Tobago. These are the Caroni and Oropouche rivers in the *Northern Basin* and the Navet river in the *Central Range* in Trinidad and the Hillsborough river in Tobago, which is the principal source of supply for Scarborough and southwest Tobago.

Groundwater is found throughout most of Trinidad. The major groundwater areas include the Northern Valley aquifers in alluvial deposits at Chaguaramas, Tucker Valley, Diego Martin and Port of Spain; the alluvial fan deposits at El Socorro, Valsayn, Tacarigua and Arima; the artesian aquifers in the Sum Sum and Durham sands; the reef limestone's of the *Central Range*; and sands in the Erin, Morne L'Enfer, and Mayaro formations of Southern Trinidad.

Dams

There are four surface water reservoirs, three in Trinidad (Caroni-Arena, Navet and Hollis) and one in Tobago (Hillsborough), with a total capacity of 72 million m³. The largest of these reservoirs is the Caroni - Arena dam in the Caroni river, commissioned in 1981. It has a capacity of 46.6 million m³ and supplies water to areas of central Trinidad. The Navet reservoir, commissioned in 1962 and expanded in 1966 and 1976, has a total capacity of 19.1 million m³ and was designed to supply San Fernando and other outlying districts including Rio Claro, Princes Town, Moruga and Gasparillo. The Hollis reservoir on the Quare river, commissioned in 1936, has a total capacity of 4.75 million m³ and supplies Arima, Port of Spain and other areas of north Trinidad. The Hillsborough reservoir, commissioned in 1952, has a maximum storage capacity of 1.02 million m³. Water from the reservoir serves areas such as Mt. St. George, Concordia, Whim, Mary's Hill, Union and Les Coteaux (WASA, 2015).

Private water users have constructed and operate small reservoirs, mainly in south Trinidad, but no data about their capacity were available.

WATER USE

In 2011, total water withdrawal in the country was estimated at 383.2 million m³ of which 237.6 million m³ or 62 percent for municipal use, 128.9 million m³ or 34 percent for industrial use and 16.7 million m³ or 4 percent for agricultural use (Table 3 and Figure 2). Of the total withdrawal, 228.4 million m³ or 60 percent comes from surface water, 107.8 million m³ or 28 percent from groundwater and 47.0 million m³ or 12 percent from desalinated water (Figure 3). In Trinidad, surface water withdrawal was estimated at 218.4 million m³ of which 2.8 million m³ from rural intakes, 193.0 million m³ from reservoirs and

22.6 million m³ from other surface water sources. Groundwater withdrawal was approximately 100.2 million m³. Desalination water is purchased by WASA from the Desalination Company of Trinidad and Tobago, with an annual production of 47 million m³. In Tobago, surface water withdrawal in 2006 was estimated at 10.0 million m³ and groundwater withdrawal at 7.6 million m³ (WRA, 2012). WASA is the major abstractor of the natural water resources; other users include industrial and agricultural facilities.

TABLE 3
Water use

Water withdrawal:			
Total water withdrawal	2011	383.2	million m ³ /year
- Agriculture (Irrigation + Livestock + Aquaculture)	2011	16.7	million m ³ /year
- Municipalities	2011	237.6	million m ³ /year
- Industry	2011	128.9	million m ³ /year
• Per inhabitant	2011	287	m ³ /year
Surface water and groundwater withdrawal (primary and secondary)	2011	336.2	million m ³ /year
• As % of total renewable water resources	2011	8.8	%
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	2011	47	million m ³ /year

FIGURE 2
Water withdrawal by sector
Total 383 million m³ in 2011

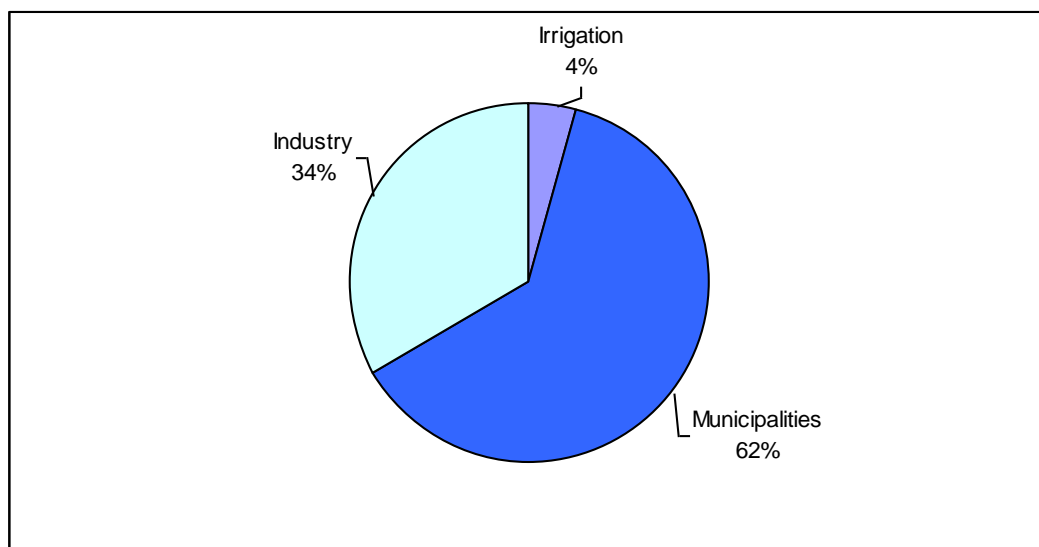
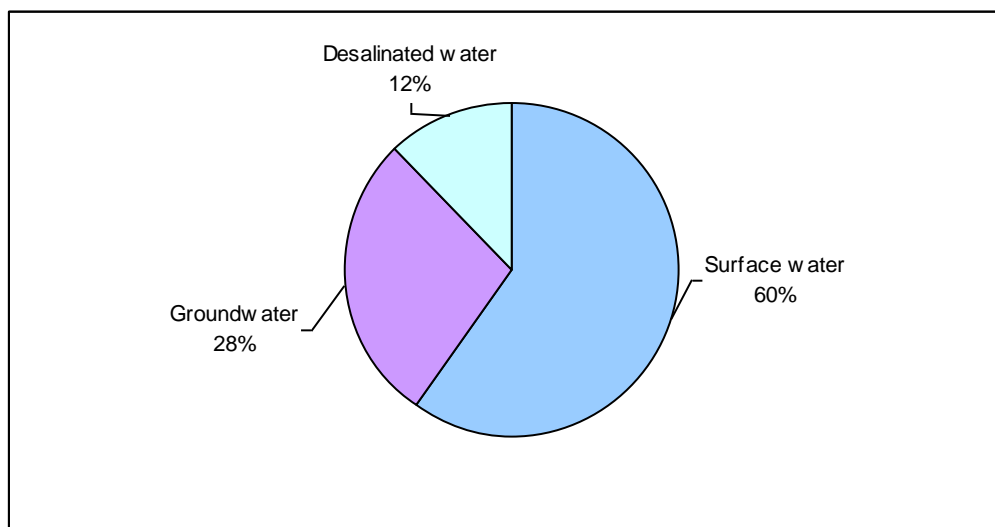


FIGURE 3
Water withdrawal by source
 Total 383 million m³ in 2011



IRRIGATION AND DRAINAGE

Evolution of irrigation development

The scarce rainfall during the dry season and the *Petit Carême* make irrigation necessary for crop production in some parts of the country. According to a land capability survey carried out in 1974, irrigation potential area considering soil suitability for irrigation (slope lower than 10 percent and alluvial and terrace lands) was estimated at approximately 102 000 ha. The Basic Agricultural Studies (1992) stated that irrigation is a key element in the agricultural development of the country, and a general target of increasing area under irrigation to 30 000 ha over a period of 20 years was suggested (Table 4). Even though this target is far from being reached in 2012, 20 years later, 30 000 ha is considered to be the irrigation potential taking into account both suitable land and water resources. Agriculture in the country is mainly rainfed. Access to water for agricultural purposes faces competition from the municipal and industrial sectors in certain areas, especially during the periods of drought. (European Union/HTSPE Limited, 2013).

In 1982, the total area under irrigation was 3 712 ha of which 3 634 ha in Trinidad and 78 ha in Tobago (1982 Agricultural Census). In Trinidad, surface irrigation systems (furrow, basin) were predominant accounting for 78 percent of the area under irrigation followed by sprinkler irrigation (19 percent) and localized irrigation (3 percent). In Tobago, sprinkler irrigation was prevalent, occurring on 75 percent of the area under irrigation, followed by furrow irrigation (22 percent) (Figure 4). No systematic information regarding irrigated areas for the country as a whole is available since the 1982 Agricultural Census. In 1997 area equipped for irrigation was estimated at 3 600 ha, of which 90 percent were irrigated by surface water and 10 percent by groundwater (Figure 5). Actual irrigated area in the 1998 dry season was estimated at 3 041 ha, distributed as follows: Caroni (1 739 ha), South Oropouche (720 ha) and Nariva (147 ha), with small-scale irrigation in South Trinidad (435 ha). However, it should be noted that as the 1997 wet season was relatively dry, these figures will most probably reflect the lower ranges of the extent of irrigated area. Cropped and irrigated areas differ largely from the wet to the dry season.

In 2004, the area equipped for irrigation is estimated at 7 000 ha, while the actually irrigated area is at present estimated at 5 000 ha. Agriculture in Trinidad and Tobago is practiced essentially under rainfed conditions.

TABLE 4
Irrigation and drainage

Irrigation potential			
	-	30 000	ha
Irrigation:			
1. Full control irrigation: equipped area	2004	7 000	ha
- Surface irrigation	1982	2 887	ha
- Sprinkler irrigation	1982	707	ha
- Localized irrigation	1982	118	ha
• Area equipped for full control irrigation actually irrigated	2012	5 000	ha
- As % of area equipped for full control irrigation	-	-	%
2. Equipped lowlands (wetland, ivb, flood plains, mangroves)	-	-	ha
3. Spate irrigation	-	-	ha
Total area equipped for irrigation (1+2+3)	2004	7 000	ha
• As % of cultivated area	2004	15	%
• % of area irrigated from surface water	1997	90	%
• % of area irrigated from groundwater	1997	10	%
• % of area irrigated from mixed surface water and groundwater	1997	0	%
• % of area irrigated from non-conventional sources of water	1997	0	%
• Area equipped for irrigation actually irrigated	2012	5 000	ha
- As % of total area equipped for irrigation	-	-	%
• Average increase per year	1997-2004	10	%
• 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)	2004	7 000	ha
• As % of cultivated area	2004	15	%
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
• Permanent crops: total	-	-	ha
Irrigated cropping intensity (on full control area actually irrigated)	-	-	%
Drainage - Environment:			
Total cultivated area drained	1998	776	ha
• Non-irrigated cultivated area drained	1998	0	ha
• Area equipped for irrigation drained	1998	776	ha
- As % of total area equipped for irrigation	1998	1.5	%
Area salinized by irrigation	-	-	ha
Area waterlogged by irrigation	-	-	ha

Irrigation in Trinidad involves small diversions from creeks and streams at works built by private individuals. Irrigation by gravity flow is also practiced in the floodplains. This type of irrigation takes place on a small scale in the Guanapo, Aripo and San Juan rivers, and on a large scale in the Caroni and South Oropouche rivers.

FIGURE 4
Irrigation techniques on area equipped for full control irrigation
Total 3 712 ha in 1982

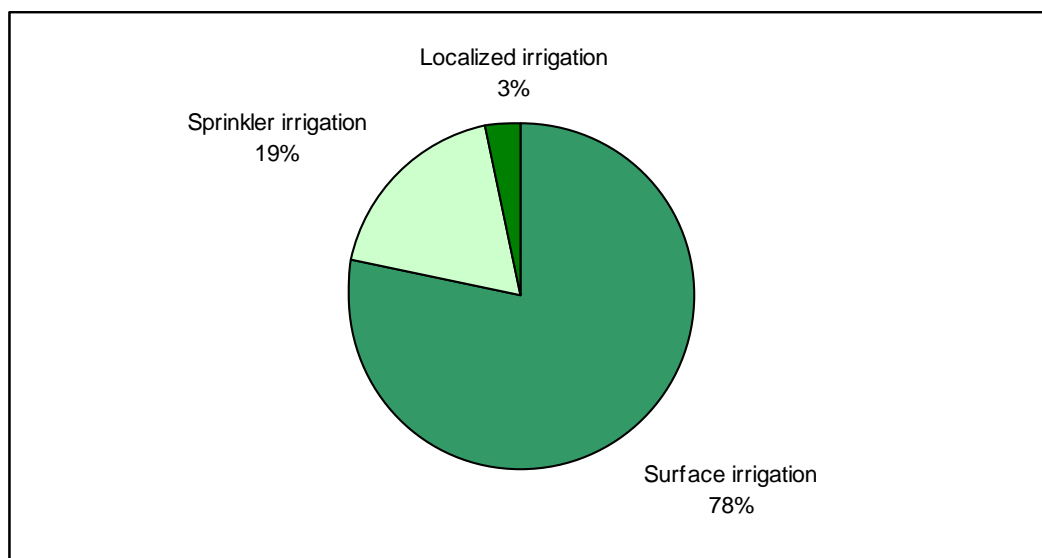
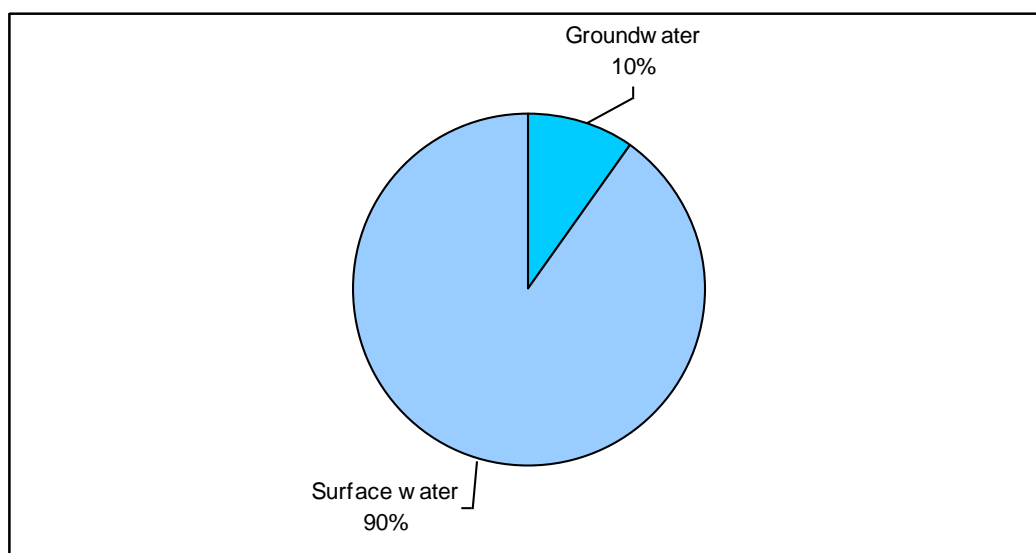


FIGURE 5
Source of irrigation water on area equipped for irrigation
Total 3 600 ha in 1997



The largest irrigation system is the Caroni system constructed to serve the surrounding rice fields. This system diverts water from the Caroni river and distributes the water over an area of about 1 200 ha. Other irrigation systems are small-scale and are located in St George, Nariva/Mayaro, St Andrew/St David, Victoria, and St Patrick.

Caroni (1975) Ltd., the former state owned sugar company for Trinidad and Tobago, played a major role in the economic and political life of the country. However, since the sugar industry in the country was not profitable and required substantial subsidies from the state, the government decided to close Caroni (1975) Ltd. in 2003. It then developed a National Sugar Adaptation Strategy (NSAS) that provided support to displaced workers and provided land for agricultural, residential and industrial development. Within the context of the NSAS the project “Water management and irrigation assessment and development on the Felicity Site, Central Trinidad” (also referred to as “Felicity Irrigation Project”), financed by the European Union, was carried out in 2013. The project has been implemented in conjunction with the Ministry of Food Production (MFP), and the Water Resources Agency (WRA) within the Water and Sewerage Authority (WASA). The project area consists of 530 ha in the former sugar lands of Caroni Ltd. The general objective of the project is to mitigate the adverse effects of

restructuring the sugar sector in the country. The global objective of the project is to identify options for irrigated agriculture for the Felicity agricultural site in Central Trinidad (European Union/HTSPE Limited, 2013).

Role of irrigation in agricultural production, economy and society

No systematic data are available on irrigated crops. However, paddy rice, root crops and vegetables (such as pumpkins, cucumber, tomatoes, hot and sweet peppers, cabbage, cauliflower, lettuce, beans, watermelon) are the major crops grown under irrigation.

Investments in water management infrastructure for irrigation and drainage tend to be expensive and these investments are only justifiable to produce high value crops.

Women and irrigation

The National Policy on Gender and Development supports initiatives aimed at removing the obstacles to women's and men's equal and active participation in, and enjoyment of the benefits from agriculture and natural resource development.

Poverty among women can be linked to their multiple responsibilities, to their roles in family care and to the undervaluing of jobs within the domestic sphere such as subsistence and unpaid agricultural production (MCDCGA, 2009).

In general women play a critical role in the provision and management of water (Schneiderman and Reddock, 2004).

Status and evolution of drainage systems

Drainage infrastructure and flood control structures are needed to allow cropping in the wet season in the lowlands. The drained area under irrigation was reported to be 776 ha in 1998 (Table 4).

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

Institutions

The Water and Sewerage Authority (WASA) was established by an Act of Parliament in 1965 to manage the water and sewerage sector of Trinidad and Tobago. WASA's mission is to:

- be a leading provider of water and wastewater services
- deliver customer service along the highest internationally recognized and accepted standards
- continuously develop best business practices utilizing advanced technology and a well-developed and motivated workforce
- leverage on industry expertise to offer global water and wastewater services
- sustain a commercialized business while remaining sensitive to the environment

The Water and Resources Agency (WRA) is a division within WASA since 1976. It evolved from an amalgamation of the Water Resources Survey, which was formed in 1966 and consisted of a team of Canadian experts engaged to boost surface water and groundwater research and development efforts in Trinidad and Tobago, and the Hydrology Section of the Drainage Division of the Ministry of Works. The functions of WRA are to manage water resources, using the integrated water resources management (IWRM) approach, and to promote development, conservation and protection of water resources. One of its objectives is to develop and maintain a national water resources database and information system. A project started in 2012 to implement HydroManager, a Geographic Information System (GIS) and a web-enabled National Water Resources Information Management System (NWRIMS). The NWRIMS will integrate existing database and applications of hydrological data, records, publications and GIS information.

Other institutions involved in water resources management include the Environmental Management Authority (EMA), The Ministry of the Environment and Water Resources (MEWR), the Ministry of Works and Transport Drainage Division, Ministry of Food Production, Land and Marine Resources, Ministry of Public Utilities, Office of Disaster Preparedness and Management (ODPM), and the Meteorological Services of Trinidad and Tobago (MET) (WASA, 2015; Parliament of the Republic of Trinidad and Tobago, 2012).

Water management

NWRIMS will provide a platform for integrated water resources management. Its implementation will ensure that there is cohesive management of the country's water resources toward the applied functions of WRA specifically, determining the effect of climate change on the water resources and pollution management of rivers and aquifers (WRA, 2012).

Licenses are required for the abstraction of raw water from any surface water or groundwater source for farming or commercial purposes. The WRA issues these licenses, that do not confer ownership of the water, nor do they guarantee the quality of the water or that the volume authorized for abstraction will always be available. It provides for re-allocation of water in circumstances of emergency, at times of scarcity and in cases of competing applications (WASA, 2015).

Finances

WASA, as the main provider of water and sewerage services, has tariffs for both services. The tariffs for water supply services recognize different rates for domestic and non-domestic customers, and for those who are metered and unmetered. The law states that citizens who live within quarter of a mile of a public standpipe must make WASA payments (Parliament of the Republic of Trinidad and Tobago, 2012).

Policies and legislation

Water resources issues are addressed either directly or incidentally in a substantial body of national legislation and international treaties, which the country has adopted.

The main legal instruments of direct relevance to the country water resources are (WRA, 2001; CSO, 2007):

- *Water and Sewerage Act (1980 revision)*: development and control of water supply, promotion of conservation and proper use of water resources, prevention of pollution of surface water and groundwater
- *Environmental Management Act (1995)*: framework legislation for environmental management: conservation, policy-making, public education, enforcement, data collection
- *Waterworks & Water Conservation Act (1980 revision)*: control and use of water; regulations for the control of the supply and use of water in water improvement areas
- *Public Health Act (1950)*: prevents dumping of offensive matter into streets, public places, river, drain and watercourses: prevents pollution of wells, tanks, ponds and water courses

It was realized that legislation governing the management of water resources in Trinidad and Tobago was fragmented and that a policy was necessary for the efficient management of these resources. A policy which emanated from recommendations proposed by the Integrated Water Resources Management Strategy was approved by Cabinet in 2005. This policy is presently being reviewed (Parliament of the Republic of Trinidad and Tobago, 2012).

ENVIRONMENT AND HEALTH

Trinidad and Tobago has historically enjoyed good drinking water quality. Increasing pollution from sewage, industrial effluents and agriculture are threatening the quality of drinking water while increasing treatment costs. The potential agricultural and industrial threats lie in the non-point or diffuse sources from pesticides and agrochemicals, from oil production, refining and toxic chemicals, inclusive of heavy metals.

The quality of the surface water is deteriorating in many places, as evidenced by high levels of biological oxygen demand, bacterial content, turbidity and the presence of chemical pollutants in rivers. The main threats are uncontrolled point waste discharges, in particular from industries and domestic sources, as well as the high level of erosion in the upper catchment of the watercourses. Pollution of surface water not only affects the production of drinking water, but also the ability of the rivers to provide productive habitats for terrestrial and aquatic species.

Most aquifers, in the absence of thick overlying clay layers, are vulnerable to contamination. Although there has been no recent major incident of groundwater contamination, intermittent high levels of nitrates were detected in three sub-aquifers of the Northern Gravel System. Another survey has detected the presence of trihalomethanes, BTEX (Benzene, Toluene, Ethylbenzene, Xylene), lead, and MTBE (Methyl Tertiary Butyl Ether) in the groundwater along the East-West Corridor. Although the levels pose no immediate danger, this indicates that there is a trend towards increasing health risks, which should be monitored, halted or preferably reversed.

Another serious concern is saltwater intrusion due to over-abstraction in coastal aquifers.

Trinidad and Tobago, as other Caribbean islands, is highly vulnerable to climate change and natural disasters such as cyclones, earthquakes, volcanic eruptions, tsunamis and storm surges. The islands are also susceptible to floods, droughts and sea-level rise. The regional belt located between the Northern Range and the Central Range of Trinidad, often referred to as the Caroni Basin, is considered most vulnerable to the impacts of climate change and sea-level rise (WRMU, 2005; WRA, 2001).

PROSPECTS FOR AGRICULTURAL WATER MANAGEMENT

Based on the “Securing Water for All” project (2014), developed by UN-Water and the Global Water Partnership (GWP), which includes Trinidad and Tobago among the 26 countries chosen to host a national consultation on water, the five targets for post 2015 in the country are (GWP, 2015):

- Achieve universal access to safe drinking water, sanitation and hygiene
- Improve the sustainable use and development of water resources in countries
- Strengthen equitable, participatory and accountable water governance
- Reduce untreated wastewater, nutrient pollution and increase wastewater reuse
- Reduce mortality and economic loss from natural and human induced water related disasters

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