Sri Lanka

GEOGRAPHY, CLIMATE AND POPULATION

Geography

Sri Lanka is a tropical island lying close to the southeast tip of India. Its land area is 65 610 km^2 (Table 1). Three-quarters of the land consist of a broad first peneplain with an average elevation of 75 m above sea level. A second peneplain rises to 500 m, and towards the south, a third peneplain rises steeply to form a mountain massif that reaches an elevation of 2 500 m. For administrative purposes, the country is divided into nine provinces: Central, Eastern, North Central, Northern, North Western, Sabaragamuwa, Southern, Uva and Western. The capital is Colombo.

In 2009, the total cultivated area was approximately 2.17 million ha of which 1.20 million ha for annual crops such as rice, kurrakkan, maize, green gram, green chilies and cowpea and 0.97 million ha of permanent crops such as fruits, tea, rubber, sugarcane and coconut.

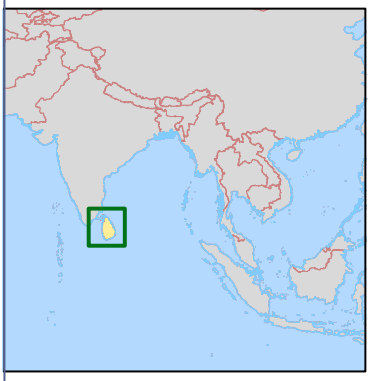
Climate

The island receives rain mainly during two monsoons. Rainfall intensity varies markedly across the island. Based on rainfall, several agroclimatic regions can be recognized, such as wet zone, intermediate zone, dry zone and arid zone. Depending on the rainfall pattern, climatologists divide Sri Lanka's climatic year into five seasons:

- The convectional-convergence period (March to mid-April) is when the island comes under the influence of the inter-tropical convergence zone.
- The pre-monsoon period (mid-April to late May) presents transitional weather patterns, with convectional weather gradually being suppressed by surges of the southwest monsoon.
- The southwest monsoon (late May to late September) brings the largest amount of rainfall to the southwest lowlands and windward slopes of the central hills. After the rains, dry desiccating monsoon winds blow across the north, north-central and southeast regions.
- The convectional cyclonic period (late September to late November) begins with the weakening of the southwest monsoon. This period can include cyclones and may result in heavy rainfall.
- The northeast monsoon (November to February), though weak compared to the southwest monsoon, brings agriculturally important rainfall to the northern and eastern parts of the island.

There is considerable variation around the national mean annual rainfall of 2 000 mm. The highest rainfall occurs in the central highlands and maximum values are on the western slopes with several stations recording values exceeding 5 000 mm (Maliboda, 5 330 mm; Weweltalawa estate, 5 258 mm; and Kenilworth estate, 5 085 mm). Mean annual rainfall values on the eastern slopes are less than 3 500 mm. Rainfall is lowest in the northwest and southwest lowlands with a minimum value of 935 mm recorded at the Ambalantota gauging station.

Mean annual temperature is about 27 ºC in the lowlands and 15 ºC in the central highlands. The temperature decreases with increasing altitude, approximately 2 ºC per 300 m of elevation.



Legend

- International Boundary
- Administrative Boundary
- Capital, Regional Capital, Town
- River
- Lake
- Dam
- Zone of Irrigation Development

0 500 1,000 2 000 3 000 km

Albers Equal Area Projection, WGS 1984

SRI LANKA

FAO - AQUASTAT, 2011

TABLE 1
Basic statistics and population

Physical areas			
Area of the country	2009	6 561 000	ha
Cultivated area (arable land and area under permanent crops)	2009	2 170 000	ha
• as % of the total area of the country	2009	33	%
• arable land (annual crops + temp fallow + temp meadows)	2009	1 200 000	ha
• area under permanent crops	2009	970 000	ha
Population			
Total population	2009	20 669 000	inhabitants
• of which rural	2009	86	%
Population density	2009	315	inhabitants/km^2
Economically active population	2009	9 372 000	inhabitants
• as % of total population	2009	45	%
• female	2009	38	%
• male	2009	62	%
Population economically active in agriculture	2009	4 012 000	inhabitants
• as % of total economically active population	2009	43	%
• female	2009	37	%
• male	2009	63	%
Economy and development			
Gross Domestic Product (GDP) (current US$)	2009	41 979	million US$/yr
• value added in agriculture (% of GDP)	2009	13	%
• GDP per capita	2009	2 031	US$/yr
Human Development Index (highest = 1)	2010	0.658	
Access to improved drinking water sources			
Total population	2008	90	%
Urban population	2008	98	%
Rural population	2008	88	%

Population

In 2009, the total population was just over 21 million, of which around 86 percent lived in rural areas (Table 1). The average population density is 315 inhabitants/km^2. The population is concentrated largely in the wet zone (southwest coastal regions and central regions). Much of the dry zone remains sparsely populated. During the period 1999-2009 the annual population growth rate was an estimated 1.1 percent.

In 2008, access to improved drinking water sources reached 90 percent (98 and 88 percent for the urban and rural population respectively).

ECONOMY, AGRICULTURE AND FOOD SECURITY

The total population economically active in agriculture in 2009 was around 4.0 million, amounting to 43 percent of the total economically active population. Around 37 percent of the population economically active in agriculture are women. In 2009, the gross domestic product (GDP) was US$41 979 million of which agriculture accounted for 13 percent (Table 1).

The total rice harvested area in 2008 was 1 032 859 ha of which the main Maha rice, normally harvested until March, accounted for 568 352 ha. The secondary Yala rice, which is planted

from April and normally represents one-third of total production, accounted for 464 507 ha. In 1988, the total rice harvested area was 815 560 ha, of which 498 554 ha was Maha rice and 317 006 ha Yala rice. Total rice production was an estimated 3 876 400 tonnes in 2008, giving an average yield of 4 184 kg/ha (Department of Census and Statistics, 2010).

WATER RESOURCES AND USE

Water resources

Sri Lanka's radial network of rivers begins in the central highlands. There are about 103 distinct river basins covering 90 percent of the island. The southwestern part of the island has seven major basins with catchment areas ranging from 620 to 2 700 km^2. They are, from north to south: Maha river (1 528 km^2), Attanagalu river (736 km^2), Kelani river (2 292 km^2), Kalu river (2 719 km^2), Bentota river (629 km^2), Gin river (932 km^2) and Nilwala river (971 km^2). An exception to the radial pattern is the largest basin, that of the 335 km long Mahaweli river, which has a catchment area of 10 448 km^2. After leaving the central highlands, it runs almost north for 90 km from Minipe to Manampitiya and then a further 70 km through several distributaries as far as Verugal and Mutur on the east coast. Most Sri Lankan river basins are small. Only 17 of the 103 basins exceed 1 000 km^2.

Besides the Mahaweli basin, four others exceed 2 500 km^2. Three of these (Deduru river, Kalu river and Malvathu river) have their entire catchment area in the dry zone, and only Kalu river is in the wet zone. The total runoff in Sri Lanka is an estimated 52 km^3/year (Table 2). Considering 75 and 50 percent dependability rainfall, annual runoff estimates are 42 and 49 km^3 respectively (Amarasinghe, 2009).

There are six types of aquifers: the shallow karstic aquifer of the Jaffna Peninsula, deep confined aquifers, coastal sand aquifers, alluvial aquifers, the shallow regolith aquifer of the Hard Rock

TABLE 2
Water: sources and use

Renewable freshwater resources			
Precipitation (long-term average)	-	1 712	mm/yr
	-	112 300	million m^3/yr
Internal renewable water resources (long-term average)	-	52 800	million m^3/yr
Total actual renewable water resources	-	52 800	million m^3/yr
Dependency ratio	-	0	%
Total actual renewable water resources per inhabitant	2009	2 555	m^3/yr
Total dam capacity	1996	5 942	million m^3
Water withdrawal			
Total water withdrawal	2005	12 950	million m^3/yr
- irrigation + livestock	2005	11 314	million m^3/yr
- municipalities	2005	805	million m^3/yr
- industry	2005	831	million m^3/yr
• per inhabitant	2005	653	m^3/yr
Surface water and groundwater withdrawal	2005	12 950	million m^3/yr
• as % of total actual renewable water resources	2005	24.5	%
Non-conventional sources of water			
Produced wastewater		-	million m^3/yr
Treated wastewater		-	million m^3/yr
Reused treated wastewater		-	million m^3/yr
Desalinated water produced		-	million m^3/yr
Reused agricultural drainage water		-	million m^3/yr

Region and the southwestern lateritic (cabook) aquifer (WRB, 2005). Sri Lanka's largest aquifer extends over 200 km in the northwestern and northern coastal areas. The internal renewable groundwater resources are an estimated 7.8 km^3, most (estimated as 7 km^3/year) returning to the river systems and being included in the estimate for surface water resources. Therefore the total renewable water resources are an estimated 52.8 km^3/year.

The Kalu, Kelani, Gin, Bentota, and Nilwala river basins cover only 13 percent of the land area, but are where 30 percent of the population live and where 38 percent of the total renewable water resources (TRWR) are located. The basin of the Mahaweli river, the longest river, covers 17 percent of the total area of the country, supports 17 percent of the population and carries 19 percent of TRWR. The basin of the eastward flowing Gal river, known for its irrigated rice production, covers 3 percent of the land area and has 2 percent of TRWR (Amarasinghe, 2009).

Most of the studies on water scarcity assessment rank Sri Lanka as a country with either little or no water scarcity or moderate water-scarcity conditions, but they do not consider the spatial and temporal variation of water availability. Sri Lanka experiences high seasonal and spatial variations in rainfall as a result of the bi-monsoonal climatic pattern (northeast monsoon from October to March and southwest monsoon from April to September). Large areas of the country are drought prone. Droughts occur to different degrees in both semi-arid and humid zones (Matin *et al.,* 2009). Dry-zone districts, comprising 75 percent of the country, contribute to only 49 percent and 29 percent of the *maha* and *yala* season runoff. Thus, storing water for irrigation in the *yala* season (April to September) is essential in many river basins (Amarasinghe, 2009).

In 1996, the total dam capacity was 5.94 km^3. Dams in Sri Lanka are classed according to the materials they use. They are mainly earthen, rockfill or concrete dams. Earthen dams are the most common type, the longest being the Parakrama Samudraya dam, which is 13.5 km long and has a storage capacity of 0.13 km^3. The highest, in this category, is the Senanayake Samudraya dam, built under the Gal river multipurpose scheme project, with a height of 34 m and a storage capacity of 0.95 km^3. The Victoria dam, built under the Mahaweli basin multipurpose project, is the highest concrete (double curvature) dam with a height of 106 m and a storage capacity of 0.73 km^3. Within this project, which begun in 1977, other multipurpose reservoirs were constructed such as the Kothmale, Randenigala, Rentembe, and Maduru Oya.

Between 1950 and 1975 the activities of the Irrigation Department focused on the construction and augmentation of major reservoirs such as Kantale, Hurulu Wewa, Padawiya, Kaudulla, Rajangana and Wahalkada (ID, 2010). The total capacity of dams built for irrigation is around 3.37 km^3.

The gross theoretical hydropower potential in Sri Lanka is an estimated 8 000 GWh/year. In 1997, 16 hydropower plants were in operation with an installed capacity of 1 103 MW. Hydropower accounted for 81 percent of electricity generation.

In 2009, the company Befesa Agua signed a contract for a major water treatment project for the greater Ratnapura area (Sabaragamuwa Province). Currently, the capacity of the existing system is inadequate to meet the area's future demand. The Ratnapura project is composed of raw water intakes located in the Kalu river, raw water transmission lines between the intakes and the treatment plant, the construction of one reservoir with a capacity of 2 500 m^3, the construction of a water treatment plant in Muwagama with a capacity of 13 000 m^3/day and transmission pipelines from the treatment plant to different reservoirs (Befesa Agua International News, 2009). This project, designed to meet the estimated water demand for the horizon year 2025, will ensure the provision of potable water to Ratnapura city and its environs, which will benefit a population of 100 000 inhabitants (Infoagua, 2010).

Water use

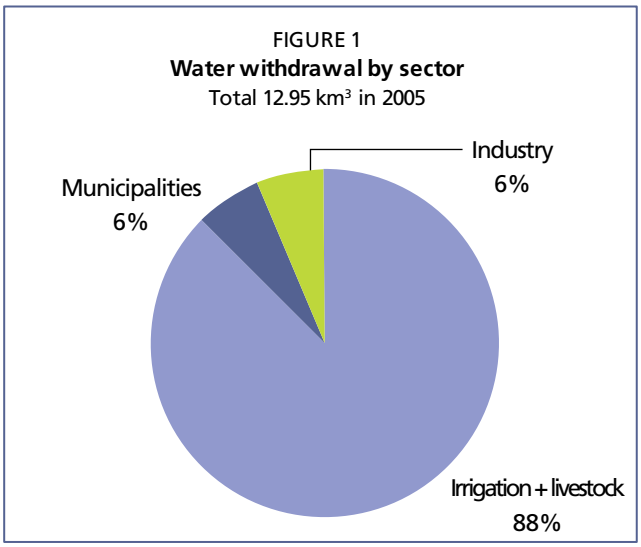
Large-scale development of water resources for irrigation and hydropower has progressed rapidly in the last 50 years. In 2005, the total water withdrawal was an estimated 12.95 km^3, of which about 11.31 km^3 (87.4 percent) for agriculture, 0.81 km^3 (6.2 percent) for municipalities and 0.83 km^3 (6.4 percent) for industries (Table 2 and Figure 1). Irrigation withdrawal for rice represent 10.63 km^3. Irrigation total withdrawals are estimated assuming 35 percent of irrigation efficiency. The Eastern, North-Western, and North-Central provinces and Hambantota in the Southern Province account for 76 percent of the total withdrawals (Amarasinghe, 2009).

Groundwater resources are widely used for domestic, commercial and industrial purposes, and small-scale irrigation. About 80 percent of rural domestic water supply needs are met by groundwater from dug wells and tubewells. In many areas, where surface water systems are not fully reliable, groundwater provides industrial and commercial users with a margin of safety. Most industries in the country depend heavily on deep wells where groundwater is safe and of good quality, and can be self-managed. The demand for groundwater in Sri Lanka is steadily increasing, especially for urban and rural water supplies, irrigated agriculture, industries, aquaculture, small and medium enterprises and urban housing schemes. The rapid expansion of these projects is exerting much pressure on available groundwater resources (WRB, 2005).

Sri Lanka is covered with a network of thousands of artificial lakes and ponds, known locally as 'tanks' (after *tanque,* the Portuguese word for reservoir). Some are truly massive, many are thousands of years old and almost all show a high degree of sophistication in their construction and design (Goldsmith *et al.,* 1984). A recent study undertaken by the International Water Management Institute (IWMI) in Sri Lanka's dry zone, where groundwater use for farming is greatest, highlighted a significant rise in the numbers of water pumps and 'agro-wells' (wells used mainly for agriculture) sunk over the past few decades. Researchers estimated that there are close to 50 000 agro-wells in the dry zone. The number of pumps is higher, around 100 000, as it includes those used to pump water from rivers, irrigation canals and tanks, and not just those fitted to agro-wells. This boom in agro-well construction occurred partly because a government subsidy programme for brick and concrete-lined wells was introduced in 1989, but also because many aquifers are quite close to the surface, which makes digging shallow wells and drilling tubewells relatively cheap (IWMI, 2005).

On a nation-wide basis, piped water systems deliver safe water to almost 90 percent of the nation's urban population, and protected wells to approximately 60 percent of the rural population. The National Water Supply and Drainage Board (NWSDB) distributes the major portion of the, mostly urban, water requirement of the country, over 310 million m^3 per year to cater for a population of over 5.3 million. Many of the large urban centres along the coast get their water supply from river systems. They are experiencing water supply interruptions as a result of salinity intrusions in the lower reaches of these rivers (WRB, 2005).

FIGURE 1
Water withdrawal by sector
Total 12.95 km³ in 2005



IRRIGATION AND DRAINAGE DEVELOPMENT

Evolution of irrigation development

Irrigation activities in Sri Lanka date back 2 500 years. Initially, these activities started

with a small-scale village tank and a simple channel system. Later, from the fourth to the end of the twelfth century, these systems were developed. Dams were built to intercept river flows across shallow valleys, or water flowing down perennial rivers was diverted by weirs and it conveyed through long excavated canals to be impounded in large reservoirs at appropriate locations to supply large areas.

However, most of these systems fell into disuse and were abandoned after the twelfth century. In the nineteenth century, some of the tanks, such as those at Kalawewa, Tissa Wewa and Kantale, were restored. In 1857, an irrigation ordinance was introduced to give legislative status to the rules governing irrigation activities. In 1900, during the colonial period, British Governors established the Irrigation Department, a separate department distinct from the former Public Works, to handle irrigation works. In the early 1930-1940 period there was the need to resettle people in the dry zone of Sri Lanka and greater emphasis was placed on the local effort to produce food. This resulted in putting the Irrigation Department in the front line of development activities (ID, 2010).

The Gal river multipurpose scheme and reservoir, launched in 1952, was the first major multipurpose project ever undertaken in Sri Lanka, which was followed in the 1960s by Mahaweli, the largest multipurpose scheme. These multipurpose projects were not only to develop irrigation and settlement but also to generate hydropower. The Mahaweli project, which is by far the largest government project in the country, envisaged the development of more than 300 000 ha of new irrigated land and the generation of 800 MW of hydropower at the completion of the project.

The Land Reform Act of 1972 limits the private ownership of land to a ceiling of 10 ha/person for paddy, 20 ha for tea, rubber and coconut, and 0.2 ha for residents. This act also established a land reform commission with the power to acquire and dispose of properties.

During the period 1985-1992 the Major Irrigation Rehabilitation project took place, funded by the World Bank. A 150 ha pilot project was implemented in a distributary canal in the Rajangana system with two structural modifications: an automatic constant downstream level gate associated with modular distributors at the head of the distributary canal, and baffle distributors at the head of field canals. During the period 1992-1998, the National Irrigation Rehabilitation project was implemented. This project undertook many major systems for rehabilitation under World Bank funding (Godaliyadda *et al.,* 1998). Recently, the International Development Association (IDA) of the World Bank has funded the North-East Irrigated Agriculture Project to restore irrigation schemes and rural roads as a means of restoring food security for displaced communities.

Given the state of irrigation development and the present level of technology in agriculture and in construction engineering, since the mid-1990s little economic potential is left to be exploited by new irrigation construction. Hence, it is reasonable to assume that the country has reached its irrigation potential, but there is large scope for improvement of the existing areas.

The total area equipped fro irrigation is 570 000 ha, which has not changed since the mid to late 1990s (Table 3). From 1963 to 1993, the area irrigated by major irrigation schemes increased by about 110 percent, mainly as a result of the major irrigation projects implemented by the Government. The total water managed area increased by 17 percent during the period 1989-1999.

In Sri Lanka, irrigation schemes can be classed as minor, medium or major depending on the area they serve. Minor schemes provide facilities for less than 80 ha. They serve about 200 000 ha (35 percent). Medium schemes, providing facilities for areas of 80-400 ha, serve 61 000 ha (11 percent). Major schemes provide facilities for more than 400 ha and serve the remaining 309 000 ha (54 percent) (Figure 2).

TABLE 3
Irrigation and drainage

Irrigation potential		570 000	ha
Irrigation			
1. Full control irrigation: equipped area	2006	570 000	ha
- surface irrigation	2006	570 000	ha
- sprinkler irrigation	2006	0	ha
- localized irrigation	2006	0	ha
• % of area irrigated from surface water	2002	98.8	%
• % of area irrigated from groundwater	2002	1.2	%
• % of area irrigated from mixed surface water and groundwater		-	%
• % of area irrigated from non-conventional sources of water		-	%
• area equipped for full control irrigation actually irrigated	2006	462 500	ha
- as % of full control area equipped	2006	81	%
2. Equipped lowlands (wetland, ivb, flood plains, mangroves)		-	ha
3. Spate irrigation		-	ha
Total area equipped for irrigation (1+2+3)	**2006**	**570 000**	**ha**
• as % of cultivated area	2006	29	%
• % of total area equipped for irrigation actually irrigated	2006	81	%
• average increase per year over the last 10 years	1995-2006	0	%
• power irrigated area as % of total area equipped	1995	30	%
4. Non-equipped cultivated wetlands and inland valley bottoms		-	ha
5. Non-equipped flood recession cropping area		-	ha
Total water-managed area (1+2+3+4+5)	**2006**	**570 000**	**ha**
• as % of cultivated area	2006	29	%
Full control irrigation schemes: **Criteria:**			
Small-scale schemes < 80 ha	2006	200 000	ha
Medium-scale schemes 80-400 ha	2006	61 000	ha
Large-scale schemes > 400 ha	2006	309 000	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	2006	744 000	ha
• Annual crops: total	2006	736 600	ha
- Rice	2006	699 900	ha
- Maize	2006	700	ha
- Other cereals	2006	100	ha
- Pulses	2006	800	ha
- Oil crops	2006	4 100	ha
- Roots and tubers	2006	4 300	ha
- Vegetables	2006	9 300	ha
- Sugarcane	2006	17 400	ha
• Permanent crops: total	2006	7 400	ha
- Fruits	2006	7 400	ha
Irrigated cropping intensity (on actually irrigated area)	2006	156	%
Drainage - Environment:			
Total drained area		-	ha
- part of the area equipped for irrigation drained		-	ha
- other drained area (non-irrigated)		-	ha
• drained area as % of cultivated area		-	%
Flood-protected areas		-	ha
Area salinized by irrigation		-	ha
Population affected by water-related diseases		-	inhabitants

The major irrigation schemes can be classed as:

- storage schemes;
- diversion schemes;
- lift irrigation schemes; and
- drainage, flood control and saltwater exclusion schemes.

Storage schemes have two purposes: storage and flood control. Water is impounded in tanks by building dams across valleys, and then released when required to service areas downstream.

Diversion weirs, commonly called *anicuts,* are constructed in perennial streams in the wet zone to convey water to the fields below. Here, a masonry or concrete wall is built across the stream to head up and divert water. The diverted water is distributed to the fields by gravity.

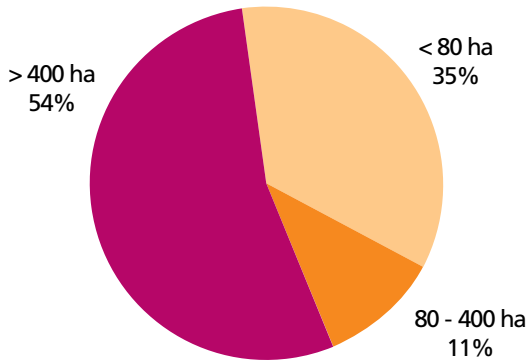
Lift irrigation schemes with mechanically or electrically operated pumps were introduced during the 1990s to irrigate the highlands.

In 1995, it was estimated that around 1 000 ha were being irrigated by groundwater wells. In 2002, equipped area irrigated by groundwater was 6 828 ha (Department of Census and Statistics, 2009) (Figure 3).

Surface irrigation dominates in Sri Lanka, with the main surface irrigation methods being basin and furrow irrigation.

Agriculture in the Kalu, Kelani, Gin, Bentota, and Nilwala river basins is mainly rainfed, and dominated by plantation crops such as rubber, coconut and tea. The Mahaweli river basin is the most important basin for irrigated agriculture in the country. The basin of the Gal river is known for its irrigated rice production. The Jaffna Peninsula mainly uses groundwater for agriculture requirements (Amarasinghe, 2009).

FIGURE 2
Type of full control irrigation schemes
Total 570 000 ha in 2006



Role of irrigation in agricultural production, economy and society

In 2006, the total harvested irrigated cropped area was an estimated 744 000 ha, of which 699 900 ha was rice representing 94 percent of the cropped area. Other important crops are sugarcane, vegetables, fruits, roots and tubers and oil crops accounting for 17 400 ha (2.3 percent), 9 300 ha (1.3 percent), 7 400 ha (1.0 percent), 4 300 ha (0.6 percent) and 4 100 ha (0.6 percent) respectively. Pulses account for 800 ha, maize for 700 ha and other cereals for 100 ha (Table 3, Table 4, Table 5 and Figure 4) (Amarasinghe, 2009). In 2006, the total harvested rainfed cropped area represented 1 311 200 ha, thus, total harvested cropped area accounted for 2 055 200 ha.

FIGURE 3
Source of irrigation water on area equipped for full control irrigation
Total 570 000 ha in 2002

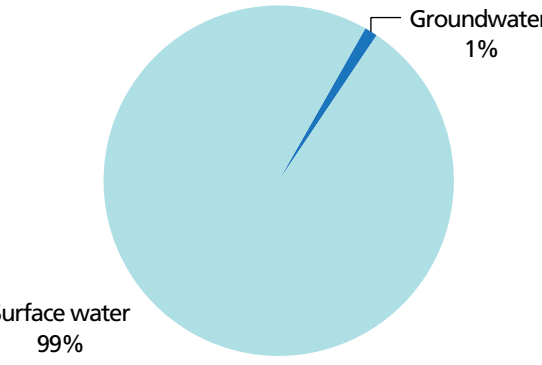


TABLE 4
Irrigated and rainfed harvested cropped area (1 000 ha) (2006)

	Irrigated crops			Rainfed crops			Total		
Crops	**Maha**	**Yala**	**Total**	**Maha**	**Yala**	**Total**	**Maha**	**Yala**	**Total**
Paddy	423.5	276.3	699.9	162.4	37.9	200.3	585.9	314.3	900.2
Maize	0.0	0.7	0.7	23.5	3.7	27.2	23.5	4.4	27.9
Other cereals	0.0	0.1	0.1	4.7	0.9	5.6	4.7	1.1	5.7
Pulses	0.0	0.8	0.8	18.2	6.4	24.7	18.2	7.2	25.5
Oil crops	1.4	2.8	4.1	10.3	7.9	18.2	11.6	10.7	22.3
Roots and tubers	0.0	4.3	4.3	21.1	16.9	37.9	21.1	21.2	42.2
Vegetables	3.8	5.5	9.3	43.4	28.7	72.1	47.2	34.2	81.4
Sugarcane			17.4			-			17.4
Total seasonal crops	**-**	**-**	**736.6**	**283.6**	**102.4**	**386.0**	**-**	**-**	**1 122.6**
Fruits			7.4			91.8			99.2
Tea			-			212.7			212.7
Rubber			-			116.5			116.5
Coconut			-			394.8			394.8
Other						109.4			109.4
Total permanent crops			**7.4**			**925.2**			**932.6**
Grand total	**-**	**-**	**744.0**	**283.6**	**102.4**	**1 311.2**	**-**	**-**	**2 055.2**

Two-thirds of the total harvested irrigated cropped area is located in Eastern, North-Western and North-Central provinces. Over 80 percent of the total harvested area in Ampara, Manner and Polonnaruwa districts are irrigated (Amarasinghe, 2009).

In 2006, rice accounted for only 44 percent of the total harvested cropped area, but irrigated rice accounted for 94 percent of the irrigated harvested area. Of the total harvested rice area of 900 000 ha, 78 percent, or 699 000 ha, was irrigated (Amarasinghe, 2009).

In 1985, the average cost of developing major surface irrigation schemes was US$1 350/ha. In 1993, the average operation and maintenance cost for a major surface irrigation scheme, such as Kaudulla, was US$12/ha/year.

Studies have revealed that the cost-benefit ratio of investments in irrigation construction fell sharply in the early 1980s and hit a record low in 1986.

Status and evolution of drainage systems

In the wet zone, flood control and drainage schemes have been incorporated into the irrigation system mainly in the lower reaches of rivers. In the coastal areas, saltwater exclusion schemes have been commissioned where water salinity affects agriculture. Flood bunds and pumps are the main features in flood protection schemes, whereas gated regulators are adopted in saltwater exclusion schemes.

WATER MANAGEMENT, POLICIES AND LEGISLATION RELATED TO AGRICULTURAL WATER USE

Institutions

Although water is managed as an input to major development sectors such as irrigation, hydropower and human and industrial water supply, there is little coordination between these sectors. It is estimated that there are more than 50 government and semi-government institutions dealing with subjects relating to water in Sri Lanka, with little coordination.

TABLE 5
Irrigated cropped area by province and district (1 000 ha) (2006)

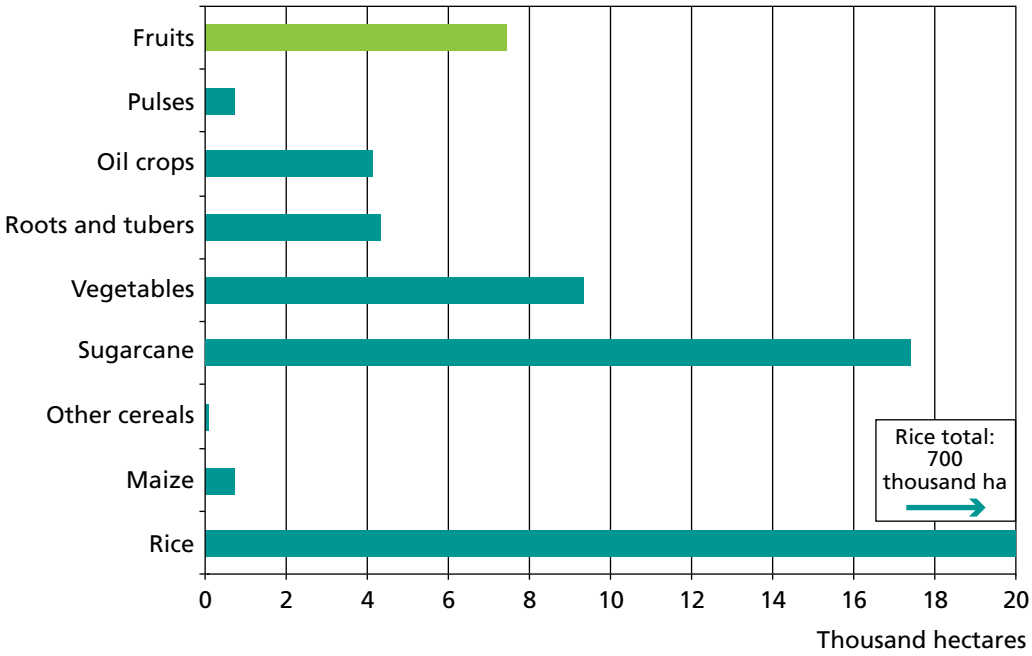
Provinces and districts	HCA*	HICA*	HICA % of HCA	RCA*	RCA % HCA	RICA*	RICA % HICA
Sri Lanka	**2 055**	**744**	**36**	**900**	**44**	**699**	**94**
Wet-zone	674	67	10	152	23	65	98
Dry-zone	1 381	677	49	748	54	634	94
Provinces	**% of HCA**	**% of HICA**		**% of RCA**		**% of RICA**	
Western	9	1	4	4	23	1	100
Central	10	6	23	6	26	6	95
Southern	12	8	27	11	42	9	99
Northern	5	6	51	6	65	5	83
Eastern	13	23	70	24	86	25	100
North Western	18	13	28	14	36	13	93
North Central	15	30	77	24	76	31	97
Uva	9	9	39	6	32	7	71
Sabaragamuwa	10	3	13	5	20	3	96
Districts	**% of HCA**	**% of HICA**		**% of RCA**		**% of RICA**	
Colombo	1	0	6	1	23	0	100
Gampaha	3	0	4	1	16	0	100
Kalutara	4	0	4	3	30	0	100
Kandy	3	2	24	2	31	2	97
Matale	3	3	38	3	42	3	91
Nuwara Eliya	4	1	10	1	10	1	100
Galle	4	0	0	2	28	0	100
Hambantota	5	7	50	6	52	7	99
Matara	3	2	18	3	41	2	100
Jaffna	1	1	27	1	45	0	0
Kilinochchi	1	2	45	2	76	2	94
Mannar	1	1	84	1	84	1	100
Mullaitivu	1	1	45	1	62	1	87
Vavuniya	1	1	64	1	58	1	88
Ampara	7	15	81	13	85	16	100
Batticaloa	4	5	48	7	86	5	99
Trincomalee	2	4	72	4	86	4	100
Kurunegala	14	11	28	12	39	11	95
Puttalam	4	3	27	2	23	2	83
Anuradhapura	9	16	69	13	68	16	96
Polonnaruwa	6	13	88	11	89	14	100
Badulla	5	4	35	4	36	4	93
Moneragala	4	5	43	3	28	3	50
Kegalle	4	0	5	2	18	1	100
Ratnapura	6	3	18	3	22	3	96

*HCA: Harvested cropped area; HICA: Harvested irrigated cropped area; RCA: Rice cropped area; RICA: Rice irrigated cropped area

At national level, the main institutions are (Nanayakkara, 2009):

- Irrigation Department (ID), established in 1900: the principal government organization responsible for the regulation and control of inland water. It is responsible for planning, design, construction, operation and management of all major and medium irrigation

FIGURE 4
Irrigated crops on area equipped for full control irrigation
Total harvested area 744 000 ha in 2006 (cropping intensity on actually irrigated full control area: 156%)



schemes and for works related to flood control, drainage and salinity extrusion.

- Ceylon Electricity Board (CEB): is responsible for power generation, transmission and distribution.
- Mahaweli Authority of Sri Lanka (MASL), was established in 1979: is responsible for water and related infrastructure development in designated basins, not only in Mahaweli project.
- National Water Supply and Drainage Board (NWSDB): is the regulator for drinking water and operator of integrated urban and small town schemes.
- Department of Agrarian Development: is responsible for village irrigation.
- Department of Fisheries Aquaculture: is responsible for fisheries management.
- National Aquatic Research Agency (NARA): is responsible for aquaculture and fisheries research.
- National Aquaculture Development Authority (NAQDA): is responsible for the development of aquaculture and inland fisheries.
- Water Resources Board (WRB), was established in 1968: is responsible for hydrogeological investigations.
- Central Environmental Authority (CEA): is responsible for environmental quality standards and environmental impact assessment procedures (tolerance limits for discharge of effluents into inland waters).

The following institutions have been proposed:

- Water Resources Council (WRC): would be the policy formulating body for water resources allocation.
- National Water Resources Authority (NWRA): would be responsible for water rights and bulk entitlements.

At provincial level, the main institutions are:

- Provincial Ministry of Irrigation;

- Provincial Ministry of Local Government.

At divisional level, the main water managers are:

- Divisional Secretary: is responsible for the Divisional Agricultural Committee, and Kanna meetings.
- Farmer organizations: are responsible for operation and maintenance of field channels, and distributory channels, village irrigation.

At local government level the main water managers are:

- Municipal Councils: urban water supply systems;
- Urban Councils: unintegrated urban systems, small towns water supply schemes;
- Pradeshiya Sabha: responsible of rural water supply schemes.

At village level, community-based organizations (CBOs) and non-governmental organizations (NGOs) represent community water supply schemes (piped, gravity schemes, rainwater harvesting schemes).

Water management

Freshwater resources in Sri Lanka remain a free public good, with the State acting as the trustee and custodian of the resource. Water rights are linked to land ownership and, as such, landowners are regarded as owning the water underneath their land and have the right to pump all the water from the common aquifer, lowering the water table. Furthermore, they may use or abuse all the rain that falls on their land. However, all the streams that flow across private land fall within the public domain (Nanayakkara, 2009).

Irrigation development, operation and maintenance and rehabilitation have been predominantly state activities. However, in the 1970s participatory approaches were incorporated in certain irrigation rehabilitation projects. A national programme of water management was initiated 1981-1983 in 24 major systems covering about 80 000 ha. Positive results were achieved, and a programme for the Integrated Management of Major Irrigation Schemes (INMAS) was launched in 1984 in 37 major systems covering 155 000 ha. This was the first official attempt, at the national level, to mobilize farmers in participatory management for major irrigation. Key elements of the programme included the creation of Farmer Organizations and Project Management Committees (Brewer, 2004). In 1988, the government accepted the policy of participatory management including beneficiary involvement at all stages of decision-making and in the management of irrigation schemes.

In 1994, the Institutional Assessment for Comprehensive Water Resources Management Project was completed. This was executed by the National Planning Department of Sri Lanka in association with more than 30 agencies and organizations concerned with water resources development and management. Technical assistance was provided by the Asian Development Bank and the United States Agency for International Development (USAID). The strategic framework formulated and adopted by the project steering committee for the process of comprehensive water resources management included nine elements under three main headings:

1. The policy and legal basis:
   - national policies and goals;
   - water sector policies and goals;
   - laws and regulations.
2. The actors:
   - government agencies;
   - communities;

- private sector;
- mechanism for collaboration.

3. The information and technology basis:
   - technology and research and development;
   - data and information.

On the basis of this strategic framework, a time-bound action plan was drawn up which focused on:

- national water policy: to develop a national water policy;
- national water legislation and regulations: to prepare and enact a national water act through amendments to water related legislation;
- institutional development: to define water sector functions and create an independent agency for water resources management to strengthen the capacity of water sector agencies to carry out these functions;
- river basin planning: to carry out comprehensive planning in selected watersheds; and
- information systems and public consultation: to establish an improved system to provide data and information required by decision-makers and others concerned, including the public.

In July 1995, the Government approved the implementation of the strategic framework and action plan together with the establishment of the Water Resources Council to oversee the implementation of the action plan.

There is a need to rehabilitate or modernize existing schemes to increase their overall productivity. In addition, systems are being designed to diversify cropping and achieve higher cropping intensities and proper watershed management. Currently, the government of Sri Lanka is attempting to transform the way irrigation schemes are operated, maintained, and financed. The goals are to improve the productivity of irrigated agriculture and to reduce government expenditures on irrigation operation and maintenance. The core of this effort is a policy, called 'participatory management', to transfer irrigation management responsibilities to farmer organizations (Brewer, 2004).

No effective systems for groundwater planning or management have been put in place. Developing such systems is a challenge because a large number of scattered farmers are involved, and because there are seven different types of aquifer on the island, five of which are in the dry zone, each with its own constraints and opportunities. Certainly, much more detailed information on each particular resource and how it is being used is needed. Even very basic information, such as the actual number of agro-wells throughout the country is currently unavailable. Data on groundwater collected by some agencies are inconsistent, unreliable, and lack sufficient coverage (IWMI, 2005).

Finances

In 1984, the government instituted an irrigation fee for the first time (Brewer, 2004).

In 2010 Sri Lanka received a US$16 million loan from the Organization for the Petroleum Exporting Countries Fund (OPEC) for International Development for an irrigation project in the island's central region. The Kalu river development project is part of the Moragahakanda development programme. The first phase of the project is estimated to cost US$167 million. The Kalu river dam, which will be 67 m high and 546 long with two saddle dams, would cost US$102.2 million to build. The Kuwait Fund for Arab Economic Development is providing US$37 million, the Saudi Fund for Development US$46 million and the balance will be borne by the government of Sri Lanka (LBO, 2010).

Policies and legislation

There are over 50 acts of parliament concerning the water sector. These laws have been enacted over time to meet specific needs, often with little consideration for existing legislation or future needs. Laws are administered by numerous agencies with a wide range of responsibilities, and there are overlaps, gaps and conflicting jurisdictions.

ENVIRONMENT AND HEALTH

The quality of the groundwater is generally fairly good and relatively constant throughout the year. However, in the northern and northwestern coastal areas excessive concentrations of iron and nitrates, from agrochemicals and fertilizers, have been reported. Furthermore, as a result of the uncontrolled abstraction of groundwater for domestic and agricultural uses, brackish water intrusion has occurred in the coastal areas.

It has been shown that large water development projects have increased the malariogenic potential of areas through increased vector propagation, aggregation of labour and resettlement from non-malarious areas of people with no immunity.

High incidences of water-related illness indicate that there are serious water quality problems.

PROSPECTS FOR AGRICULTURAL WATER MANAGEMENT

Sri Lanka's population will peak in the early 2040s, with an addition of 15 percent to the population. Given the high level of water development for irrigation, increasing irrigation efficiency is one of the feasible options available for meeting future water demand. If irrigation efficiency is increased to 45 percent from the currently assumed level of 35 percent, the irrigation demand shall decrease by 22 percent. The major irrigated areas will contribute to 78 percent of the reduction in demand through this level of efficiency increase. If irrigation efficiency is increased to 55 percent, irrigation demand will decrease by 35 percent. A decrease in irrigation demand in such a scenario is more than 3.9 km^3, which is equivalent to about 32 percent of the total water demand. Such scenarios of efficiency growth show that if the currently developed water supply is properly managed, only a part of these water savings is adequate for meeting future irrigation demand (Amarasinghe, 2009).

Note:

The expressions 'Oya' and 'Ganga' that are often added to the names of rivers, mean 'river' in Singhalese. Therefore, in this English version of the country profile, these words have been removed from the name of the river and replaced by the word 'River'. As an example, Kelani ganga has been changed to Kelani river and Maha oya has been changed to Maha river.

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