Climate Change Vulnerability in Sri Lanka

Sector Vulnerability Profile:
Water

Supplementary Document to:
The National Climate Change Adaptation Strategy for Sri Lanka
2011 to 2016

Sector Vulnerability Profile: Water

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Sector Vulnerability Profile on Water

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List of Acronyms and Abbreviations

ADB	Asian Development Bank
BOI	Board of Investment of Sri Lanka
CA	Comprehensive Assessment of Water Management in Agriculture
CCCS	Centre for Climate Change Studies
CCD	Coast Conservation Department
CCS	Climate Change Secretariat
CDM	Clean Development Mechanism
CEA	Central Environmental Authority
CEB	Ceylon Electricity Board
CFE	Caring for the Environment
CWSSP	Community Water Supply and Sanitation Project
CZMP	Coastal Zone Management Plan
DMC	Disaster Management Centre
DSD	Divisional Secretariat Divisions
DSWRPP	Dam Safety and Water Resources Planning Project
EIA	Environmental Impact Assessment
EMS	Environmental Management Systems
EPL	Environmental Protection License
ET	Evapo-transpiration
GIS	Geographic Information System
GN	Grama Niladari
GOSL	Government of Sri Lanka
GTZ	German Technical Cooperation
GWP	Global Water Partnership
IFS	Industrial and Financial Systems
IPCC	International Panel on Climate Change
IRC	International Water and Sanitation Centre
IWMI	International Water Management Institute
IWRM	Integrated Water Resource Management
JBIC	Japanese Bank for International Cooperation
Km	Kilometre
LA	Local Authorities
MCM	Million Cubic Metres
MENR	Ministry of Environment and Natural Resources
MM	Millimetre
MOE	Ministry of Environment
MT	Metric Tonnes
MW	Megawatt
NAP	National Action Programme
NAQDA	National Aquaculture Development Authority
NARA	National Aquatic Resources and Research Agency
NARESA	Natural Resources, Energy and Science Authority
NBRO	National Building Research Organization
NCSA	National Capacity Needs Self Assessment
NDMP	National Disaster Management Plan
NEAP	National Environmental Action Plan
NPD	Department of National Planning
NPPP&P	National Physical Planning Policy and Plan
NWSDB	National Water Supply and Drainage Board
RWSSD	Rural Water Supply and Sanitation Division
SAARC	South Asian Association for Regional Cooperation
SVP	Sector Vulnerability Profile
UNEP	United Nations Environment Programme
UNFCC	United Nations Framework Convention on Climate Change

Water for Domestic Needs and Irrigation

Water is essential for life and human wellbeing. It is used in both productive and consumptive activities and contributes to rural and urban livelihoods in myriad ways. Adequate access to water is a prerequisite for realizing the right to development.[1] Water is a vital resource for all sectors of the national economy of Sri Lanka and for maintaining a clean and healthy environment. Enabling unimpaired access to freshwater for human consumption and domestic needs and irrigated agriculture are high priorities for national development, and are recognized as such in the *Mahinda Chintana and* the Action Plan for the *Haritha Lanka* Programme. Major infrastructure programmes to provide drinking water for all by 2016 and to provide adequate irrigation water to optimize agriculture are presented in detail in the *Randora* National Integrated Development Programme. There is recognition that optimizing water use requires sustainable use of Sri Lanka's available freshwater resources which, though yet abundant, are limited. This requires proper management of the water sector[a] by taking into account the ramifications of climate change and possible adaptation measures during national planning.

1.0 Introduction

At the global level: Fifty years ago the world had less than half the population it has today. The pressure they inflicted on water resources was also less due to less consumption of calories and meat due to lower buying power and overall wealth. Thus, requiring less water to produce the food requirements – taking only a third of the water that we take from the rivers today.[1] With increasing demands on water resources due to increasing trends in population, urbanization and industrialization, questions on water allocations, conflicting water demands, issues on water quality, etc. have arisen and will continue to exacerbate with predicted changes in climate, unless they are addressed in a timely manner.

Water satisfies a basic human need, and is a vital resource for the proper functioning of all sectors of Sri Lanka's economy, be it agriculture, health, energy, supply of water for drinking and sanitation and industry. National recognition of the water sector is expanded in BOX 1.

A large number of people need and use water for a wide range of essential activities, including earning much-needed incomes. Thus, deliberately making provisions for the multiple uses of water when designing and managing water-supply and irrigation schemes could greatly reduce poverty, increase gender equity, and improve health—at little additional cost.[2]

BOX 1: RECOGNITION OF THE IMPORTANCE OF WATER FOR NATIONAL DEVELOPMENT

1. Vision of the *Mahinda Chintana* 2010:

- Water is a natural resource of strategic importance
- Feasibility studies should optimize use of water resources
- Reduction of water pollution and wastage
- Provide safe drinking water for all
- Enhance water holding capacity of the Dry Zone by rehabilitating and building tanks and canals
- Undertake major water resources development projects that will meet the current water shortages

2. National Action Plan for the *Haritha Lanka* Programme, Mission 7 aims to:

- Establish a systematic water allocation system and improve efficiency and equity in water distribution for varied uses
- Rehabilitate small tanks and revitalize the tank cascade system
- Transform the irrigation system to meet new challenges
- Prevent contamination of drinking water by proper zoning and control
- Integrate the practices of conservation, re-use and recycling at all levels of water use
- Strictly enforce the principle of polluter pays for industries and activities that pollute sources of water
- Strengthen implementation of integrated water management systems
- Reduce leaching of fertilizer and eutrophication

3. The *Randora* National Infrastructure Development Programme targets investments worth:

- Rs 67,122 million for major irrigation projects and dam safety
- Rs 79,460 million for water supply and sanitation schemes
- Rs 8,085 million for community water supply and sanitation schemes

(see APPENDIX A for more details)

[a] Note: The water sector is defined in this document as the water used and managed for irrigation and domestic requirements.

Enhancing irrigated agriculture to be commercially viable and maximizing water use is recognized as critical for development of Sri Lanka's agricultural sector in the *Mahinda Chintana.*[3,4] Likewise, the provision of sufficient safe water for drinking and domestic needs for all of Sri Lanka's population is a government priority. Mission 7 of the National Action Plan for the Haritha Lanka Programme addresses "Water for all and always"[5] reiterates the thinking of the *Mahinda Chintana* to meet the freshwater needs of Sri Lanka's population by 2016. The government's commitment to this end is shown by the investment projects lined up for large national scale water supply and irrigation schemes, as well as water supply projects for small towns and arid areas in the *Randora* National Infrastructure Development Programme.[6]

Each day a person drinks 2-4 litres of water and eats food that requires 2,000 – 5,000 litres of water in its production. Hence providing the basic water needs to people is not a water problem but a political problem and a challenge especially in the light of population increase.

Source: CA, 2007[1] and Clausen and Bjerg, 2010[7]

Sri Lanka is blessed with fresh water from abundant rain and inland waters and falls into the little or no water scarcity category in the global context in terms of access to freshwater.[1] However, the potential impacts of already felt and future climate change on rainfall regimes could imperil the island's water resources that are almost totally dependent on rainfall. Strategically adopting climate change adaptation measures to meet these risks can, however, enable Sri Lanka to move ahead without interruption of the country's national development agenda. Using IWRM can help achieve this end.

Integrated Water Resource Management in Sri Lanka

The competition for water within a river basin especially between upstream and downstream users, and dominance of one over the other will not yield optimal results for the country.[8] This is true for all the multiple uses that rely on Sri Lanka's water resources along any river basin in the country. The adoption of Integrated Water Resource Management (IWRM) principles thus offer a widely accepted planning framework for minimizing the trade-offs between the multiple uses, and has been suggested and encouraged for Sri Lanka. Sri Lanka is currently in the process of formulating an IWRM Plan under the Dam Safety and Water Resources Planning Project (DSWRPP) under the Ministry of Irrigation and Water Resources Management.

IWRM includes all aspects of water resources development, management and use, and is central to the key issues of water supply, sanitation and infrastructure-building. Its role in sustainable development was recognized at the 2002 World Summit on Sustainable Development which called for all countries to develop IWRM and water efficiency strategies or plans. This call was reinforced by the 2005 World Summit.[9]

1.1 The resource

The average per capita availability of freshwater amounting to 2,592 m^3/yr, is adequate for the country's needs.[10] However, water availability in several major cities (e.g. Colombo, Puttalam and Jaffna) drops below 1000 m^3, well below the recommended levels for human health and quality of life. With the projected population increase by 2025,[b] several more towns (e.g. Kandy, Gampaha and Kurunegala) are expected to record equally low per capita water levels in the future.[10]

Of the total volume of 120,000 mcm rainfall received in Sri Lanka, 10% is used for irrigation, 6% for domestic and industrial purposes, while about 23% of the total volume escapes to the sea as runoff through 103 river basins and 54 small drainage basins. The amount of surface water indirectly available is nearly 36%. The remainder is lost as evapo-transpiration (ET).

Source: Data from Ministry of Irrigation and Water Resources Management provided for this report in 2010

- *Rainfall*

Rainfall is the primary source of soil moisture, stream-flow and groundwater in Sri Lanka; the contribution from mist, dew, hail and frost to surface waters are relatively insignificant except in the central highlands.[11] Thus, Sri Lanka's abundant water resources are mainly due to an average annual rainfall of over 2000 mm, which provides an annual average volume of over 130 billion m^3 of freshwater.[11] Of this, about 35% contributes to stream flow; a further 20% serves to replenish soil moisture and groundwater bodies, while the balance is released to the atmosphere as evapo-transpiration.[11]

[b] An increase to 21.7 million by 2025 has been projected by the Demographic and Health Survey 2000, and World Population Policies, 2003 cited in www.searo.who.int/LinkFiles/Family_Planning_Fact_Sheets_srilanka.pdf

Spatial variation

FIGURE 1 indicates the spatial variation of rainfall in the island and the resultant agro-ecological zones. The location of the south-central highlands causes interception of monsoonal rains from the southwest, and creates a 'rain shadow' on the other side.[11] This has given rise to an ever-wet region which receives abundant rainfall from two monsoons and a Dry Zone that receives rainfall from only the north-east monsoon. The latter is characterized by long spells of drought during other months resulting in a "dryness" created due to high evapo-transpiration.[11] Consequently rainfall varies spatially across the island from about 1000 mm – 5000 mm annually.[12] More details about rainfall variation spatially are given in BOX 2.

Inter-annual variation

Sri Lanka also has considerable inter-annual variability of rainfall, which is less apparent in the Wet Zone, but is around 15-20% in the Dry Zone.[11] Due to irregularity of the incidence of tropical depressions and variability of rains, the north east-monsoon—which provides rain to both Wet and Dry Zones—is more variable than the south-west monsoon which provides rain only to the Wet Zone.[12,13] Extreme weather conditions that have resulted due to marked temporal variability of rainfall has frequently been the cause of natural hazards such as droughts, floods and landslides in Sri Lanka,[11] which annually take a heavy toll on the socio-economic status of the country.

BOX 2: RAINFALL REGIMES IN THE DIFFERENT CLIMATIC ZONES

Due to the location of the central mountains in the island, and the resultant rain shadow effect, the island is divisible into pronounced Wet and Dry Zones.[13] The Wet Zone which covers about a quarter of the island has a high average annual rainfall that ranges from 2000 - > 5000 mm [12,14] by the receipt of rain from both the south-west and the north-east monsoons, as well as inter-monsoonal rains during March - April and October - November. The first inter-monsoonal rains are often accompanied by warm conditions and thunderstorm type rains; the second is also characterized by thunderstorm type rains and depressions and cyclones that originate in the Bay of Benga[12]—although Sri Lanka lies outside the main cyclone belt.[15]
The Intermediate Zone, with a mean annual rainfall between 1750 and 2000 mm, lies between the Wet and Dry Zones.[12] The Dry Zone, which is spread over much of the lowland plains has a mean annual rainfall of 1250 mm – 1750 mm.[12] It is subjected to several months of drought as it receives rain only from the north-west monsoon, which brings in more than two thirds of the annual rainfall to this region.[12] As such, more than 70% of the rains in the Dry Zone occur between October and December, resulting in a considerable seasonal variation in the rainfall of this region.[12]

- ***Inland surface waters***

Surface water has been defined as water that remains from rainfall after evapo-transpiration and infiltration.[11]

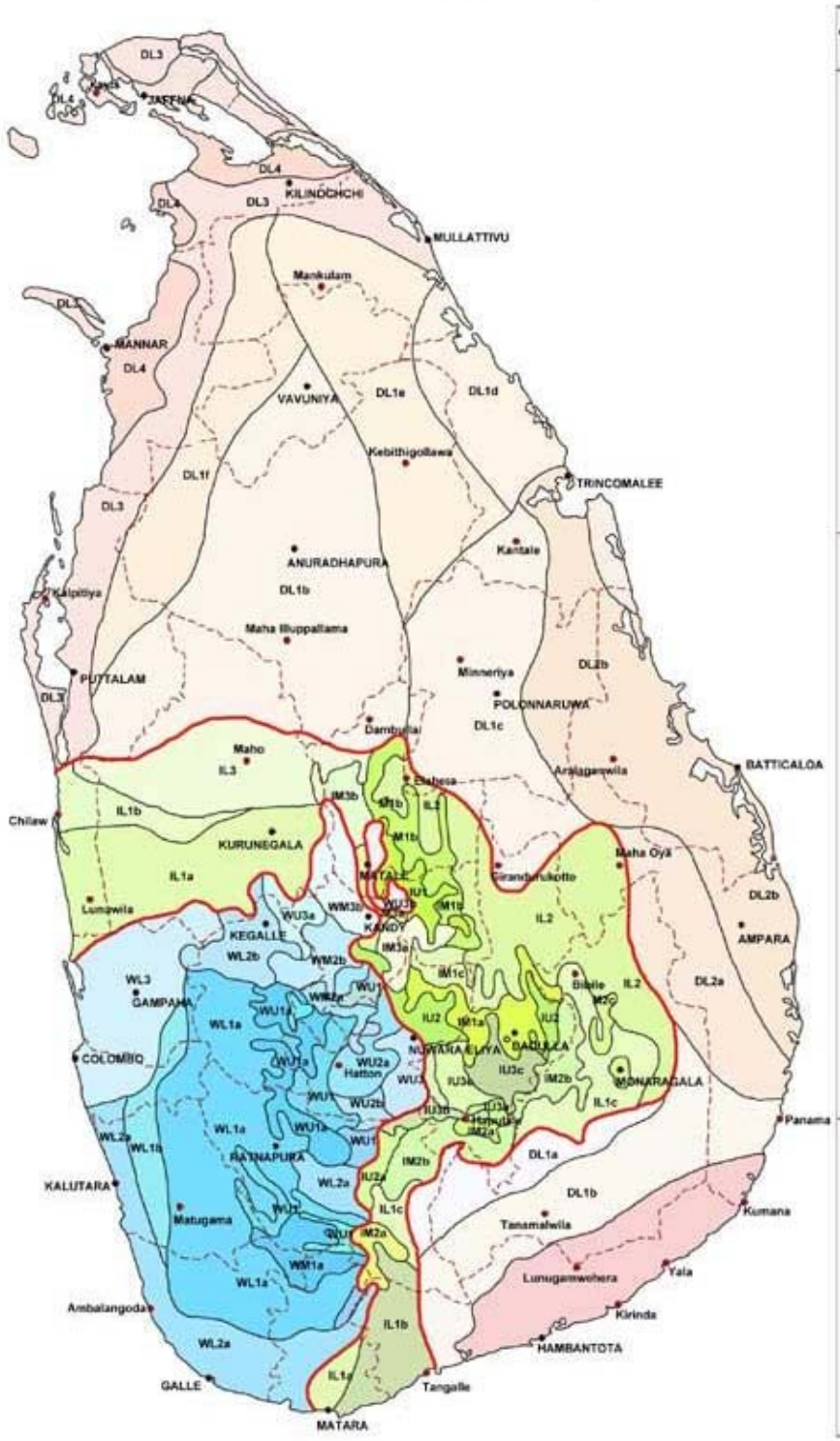
Natural

Sri Lanka's surface waters are both natural and man-made. The former comprises rivers and streams, freshwater marshes, small isolated freshwater bodies, freshwater springs and seasonal ponds. A network of 103 major river basins - amounting to total collective length of about 4,560 km[13] covers an area of 59,245 km^2 [13] including the river basins—which are the main source of natural inland surface waters. All major rivers originate in the forested watersheds of the island's central highlands and flow radially down across the lowland plains into the sea.[14] These river and stream basins vary from less than 10 to more than 10,000 km^2. In the high rainfall areas of the Wet Zone river discharge accounts for 50-70% of rainfall, but drops to less than 30% in the Dry Zone, even during high rainfall seasons due to a high infiltration rate.[10]

Classification of Sri Lanka's river basins

Sri Lanka's rivers are classified into three major groups based on the source of monsoon rains: Group I has 16 rivers in the Wet Zone that receive water from the south-west monsoon and carry about half the annual run-off. Group II has 26 rivers in the Dry Zone that are fed by the north-east monsoon, and Group III has three rivers that receive rainfall from both monsoons – including the Mahaweli river. The balance are very small coastal basins where the runoff is negligible.

Source: Data from Ministry of Irrigation and Water Resources Management provided for this report in 2010.



CLIMATIC ZONE	AGRO-ECOLOGICAL REGION		75% EXPECTANCY VALUE OF ANNUAL RAINFALL (MM)
WET ZONE	UP COUNTRY	WU 1	> 3,100
		WU2a	> 2,400
		WU2b	> 2,200
		WU3	> 1,800
	MID COUNTRY	WM1a	> 3,300
		WM1b	> 2,900
		WM2a	> 2,200
		WM2b	> 1,800
		WM3a	> 1,600
		WM3b	> 1,400
	LOW COUNTRY	WL1a	> 3,200
		WL1b	> 2,800
		WL2a	> 2,400
		WL2b	> 2,200
		WL3	> 1,700
INTERMEDIATE ZONE	UP COUNTRY	IU1	> 2,400
		IU2	> 2,100
		IU3a	> 1,900
		IU3b	> 1,700
		IU3c	> 1,600
		IU3d	> 1,500
		IU3e	> 1,400
	MID COUNTRY	IM1a	> 2,000
		IM1b	> 2,000
		IM1c	> 1,500
		IM2a	> 1,800
		IM2b	> 1,000
		IM3a	> 1,400
		IM3b	> 1,200
		IM3c	> 1,100
	LOW COUNTRY	IL1a	> 1,400
		IL1b	> 1,100
		IL1c	> 1,300
		IL2	> 1,000
		IL3	> 1,100
DRY ZONE	LOW COUNTRY	DL1a	> 1,100
		DL1b	> 900
		DL1c	> 900
		DL1d	> 900
		DL1e	> 900
		DL1f	> 800
		DL2a	> 1,300
		DL2b	> 1,100
		DL3	> 800
		DL4	> 750
		DL5	> 650

Source: Department of Agriculture[c]

FIGURE 1 Agro-ecological regions of Sri Lanka

[c] Provided for preparation of this report in 2010

Most rivers flowing entirely through the Wet Zone are generally perennial; they account for about half of the total mean annual yield of all the rivers in Sri Lanka, although the Wet Zone catchments total only about 19% of all catchment areas in the country.[13] The Dry and Intermediate Zones exhibit wide variation in the spatial distribution of rainfall and the average annual rainfall and run-off.[13] Many of the rivers in Sri Lanka show extreme seasonal variability of flow: some have a propensity for flooding during high intensity rainfall, while others that originate and flow mainly through the Dry Zone may dry up, or have a minimum flow, for a few months annually.[16]

Man made

Sri Lanka has a large number of man–made surface water bodies **(Table 1)** which include irrigation tanks that dot the island's Dry Zone to trap rainwater as a legacy of the island's proud hydraulic civilization (FIGURE 2). These tanks in the Dry Zone compensate for the unequal spatial distribution of surface waters in the island which has resulted due to most major river basins being located in the Wet Zone. Apart from the ancient irrigation tanks, more recent irrigation works have been carried out to impound water for agriculture in the rain-limited Dry Zone since the country gained independence in 1948. They include the Gal Oya Scheme, the Walawe Ganga Scheme, the Kirindi Oya Development Scheme and the Mahaweli Ganga Development Scheme. Among these reservoirs are several large multi-purpose irrigation reservoirs that are located in the Wet Zone and numerous man-made irrigation canals and aquaculture ponds.[13]

TABLE 1 Estimated surface water area of lakes, tanks and reservoirs in Sri Lanka

Type of reservoir (number)	Area (ha)	Percent of all
Major irrigation reservoirs (73)	70,850	41.7
Medium scale irrigation réservoirs (160)	17,001	10.0
Minor irrigation reservoirs (>10000)	39,271	23.1
Flood plain *villus*	4,049	2.4
Recent upland hydro-electric reservoirs (7)	8,097	4.8
Recent Mahaweli Multi-purpose reservoirs *(Madura Oya, Victoria, Kotmale, Randenigala, Ulhitiya –Rathkinda)*	13,650	8.0
Other	17,023	10.0
Total area	**169,941**	**100.0**

Source: Sri Lanka Environmental Outlook 2009, Ministry of Environment and Natural Resources and the United Nations Programme, 2009[10]

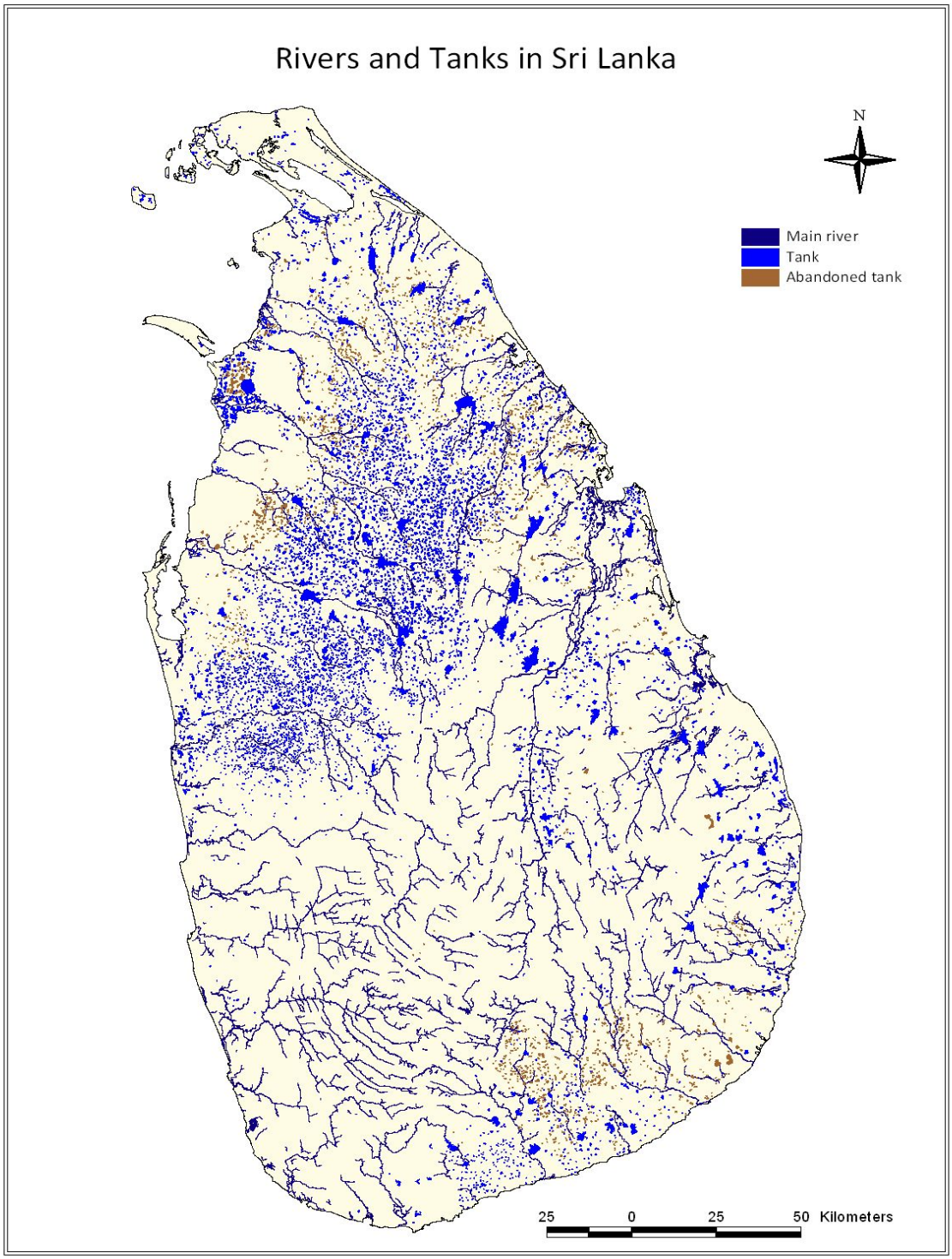
Overall, man-made water bodies include 309 irrigation reservoirs that irrigate over 80 ha each, and a further 18,000 minor irrigation reservoirs, of which about 12,000 are currently in use.[d] These waters provide multiple services, such as irrigation water for agriculture and water for sanitation and drinking purposes.[e]

The Mahaweli Ganga Development Programme

The Mahaweli Development Programme, which is the largest integrated rural development programme implemented in Sri Lanka, was based on the water resources of Mahaweli Ganga and six other allied river basins. The main objectives of this programme were: to greatly expand the area available for irrigated agriculture, capacity for hydro-power generation and opportunities for employment; to promote settlement of the landless poor, and for flood control. This involved building four new dams (i.e. Victoria, Kotmale, Randenigala and Rantembe), four principle trans-basin diversions in the upper catchments of the Mahaweli river, and eight reservoirs (i.e. Kotmale, Polgolla, Victoria, Randenigala, Rantembe, Bowatenna, Ulhitiya/Ratkinda and Maduru Oya). The Accelerated Mahaweli Development Project which commenced in 1979 to provide irrigation to 128,000 ha of land in the Dry Zone and to generate 470 MW of hydro-power was overseen by the Mahaweli Authority of Sri Lanka—set up by the Mahaweli Authority Act No 23 of 1979.

Sources: Website of the Mahaweli Authority, http://www.mahaweli.gov.lk accessed on 2.5.10) and Manchanayaka and Madduma Bandara,1999[13]

[d] Data provided by the Ministry of Irrigation and Water Resources Management for preparation of this report in 2010.
[e] Inland fisheries are discussed in the Agriculture and Fisheries Sector Vulnerability Profile



Source: Generated during this project using Survey Department maps (1:50,000)

FIGURE 2 Distribution of rivers and tanks (including those abandoned)

- *Groundwater*

There are many different types of aquifers associated with groundwater; the richest source of groundwater in Sri Lanka is found in the Miocene limestone deposits in the Dry Zone areas of the north and north-east, which extend over about 250 km².[11] *The coastal sand aquifer area in the north-west is particularly important for agriculture.*[17]

Groundwater is derived largely from direct rainwater seepage and the recharge from surface water bodies such as streams, canals and reservoirs.[11]

The total groundwater availability in the island from infiltration, percolation and sub-surface circulation is estimated to be around 7,250 – 7,800 mcm per annum, which is about 15% of the country's surface water resources.[11,13]

Of the two recognized types of groundwater, those associated with near surface hydrologic processes (i.e. renewable sources) would be affected by climate change, unlike groundwater deposited a long time ago in deep sediments (i.e. non-renewable) that are less susceptible.[17] The shallow aquifers are important to provide domestic needs from traditional wells, and for recharge of rivers and other water bodies during dry periods.[17] However, any reduction in the availability of renewable groundwater in the country will lead to inevitable exploitation of the non-renewable water bodies where it is technically feasible, so that there could be increased threat to the non-renewable groundwater bodies due to water scarcity caused by climate change.

Groundwater water quality also becomes crucial during dry periods, when there is reduced recharge, due to the tendency for concentration of minerals (such as fluoride and calcium) in the available water, well above the recommended levels for potable water. Similarly, accumulated pollutants from human activities tend to get concentrated during dry periods, as seen particularly in the northern part of Sri Lanka (information received from CEA). The extraction of groundwater to supplement irrigation is also currently being explored in Sri Lanka.[18]

1.2 Economic importance of the freshwater resource

Inland freshwaters are the country's only source of water for drinking and other domestic requirements, irrigated agriculture and hydropower for a population of over 20 million. They also provide for a multitude of other uses such as the inland food fishery, industry, recreation and tourism, and are the basis of foreign exchange earnings through the export of freshwater ornamental fish. In addition, a large segment of the rural population in Sri Lanka, which constitutes over 70% of the total population, depend on rainfall-based sources of income, such as agriculture, livestock production and inland fishery. In addition to these "human" requirements, inland freshwaters also provide for the country's basic environmental needs. Freshwater availability is, therefore, a key limiting factor for food production and enhancement of the national economy.

- *Irrigation*

The major irrigation systems in place provide water for around 60% of the irrigated lands in Sri Lanka. Of the total water withdrawal, about 80% is used for irrigated agriculture leaving the remainder for industries and domestic needs.[6]

Sri Lanka's inland waters are the most important supply of water for agriculture. Consequently, irrigation waters are vital for enhancing productivity of the agriculture sector.[f] Overall, 96% of water from the hydrological cycle is used for agriculture and food production, which contributes about 16% to the national economy.[10] Agriculture in the Wet Zone is mainly rain-fed, due to the considerable reliability and intensity of rainfall regimes in this region.[13] Conversely, in the Dry and Intermediate Zones where rainfall is limited, water collected in numerous surface reservoirs is a vital source of water for cultivation to supplement water received from the north-east monsoon and inter-monsoonal rains.[13] The importance of irrigation surface water is underscored by the large number of major irrigation related projects that are planned or on-going in the country (**Table 2**).

At the global level, irrigation has ensured the global food supply and raised millions out of poverty—especially in Asia. For many developing countries investments in irrigation will continue to represent a significant proportion of investments in agriculture. However, it has been documented that new investments will focus more on enhancing productivity of existing systems by upgrading infrastructure and reforming management processes.[l]

[f] Enhancing agricultural productivity in the face of climate change is addressed in the Agriculture and Fisheries SVP.

Taking the multiple uses approach, these projects have multiple aims of transforming dry lands in all parts of the country into fertile agricultural lands, increasing the current cropping intensity, providing drinking and domestic water to more people, hydro-power generation, and for enhancement of the inland food fishery.

Multiple Use Approach and Gender

A more integrated, multiple-use approach in irrigation can maximize the benefits and productive potential of available water supplies – leading to increased incomes, improved health and reduced workloads for women and children. Systems that cater to multiple uses are also more likely to be sustainable, because users benefit more from them, have a greater stake in them, and are more willing and better able to pay for them. In essence, a multiple use approach involves (1) assessing the range of water needs in collaboration with end users, (2) examining the water sources available—from rainwater to wastewater to piped systems, and (3) matching water supplies to needs based on the quantity, quality and reliability required for various purposes. Improved water availability also promotes gender equity, as poor women are primarily responsible for fetching water. Multiple-use approaches to water supply are deliberately gender-sensitive, taking into account women's water needs for cooking, food processing, cleaning, and other domestic tasks—which are often otherwise considered secondary to the need for drinking water. In addition, for women who are landless or landpoor, or who cannot go far from their houses for cultural or security reasons, multiple-use facilities near to their homes can provide valuable income-earning and food-security opportunities. A variety of options, besides piped domestic water, can be used. Examples include rooftop water-harvesting structures, new or enlarged family wells, and household run-off storage tanks, which allow wastewater from washing and bathing, for example, to be used productively.

Source: IWMI, IRC & GWP (2006) [2] and Castillo and Namara (2007) [19]

TABLE 2 On-going and planned investments for major development of irrigation water resources

Type of reservoir (nos)	Main purpose	Climatic Zone	Cost (Rs) (million)
Menik Ganga (Weheragala) Development†	Increasing cropping intensity, provision of drinking water, providing water to the Lunugamvehera National Park	Dry Zone	1,772
Deduru Oya Reservoir†	Increasing cropping intensity, enhancing productivity of existing agricultural lands under minor irrigation schemes, additional hydro-electricity to national power grid and providing drinking water	Dry Zone	6,500
Rambukkan Oya Reservoir†	Increasing cropping intensity and development of new land, providing pipe-borne water	Dry Zone	2,500
Moragahakanda and Kalu Ganga Development†	Increasing cropping intensity and increased extent of crop lands, provision of domestic and industrial water, adding 20 MW of hydro-electricity, annual production of 4500 MT of inland fish	Dry Zone and Wet Zone	48,950
Yan Oya Reservoir Scheme*	Increasing cropping intensity and increased extent of crop lands, provision of domestic and industrial water	Dry Zone	8,700
Uma Oya*	Increasing cropping intensity and increased extent of crop lands, provision of domestic and industrial water, 120 MW of hydro-electricity. Mainly a diversion scheme from wet to dry zone.	Dry and Wet Zone	75,000

*Source: Randora, National Infrastructure Development Programme† and Ministry of Irrigation and Water Resources Management**

The ultimate goal of these projects is regional development, economic growth and productivity enhancement. In addition to new development, considerable investment has been channelled into the rehabilitation of the existing irrigation systems in the country which are summarized in **Table 3**.

TABLE 3 Sri Lanka's annual investments in the rehabilitation of irrigation system

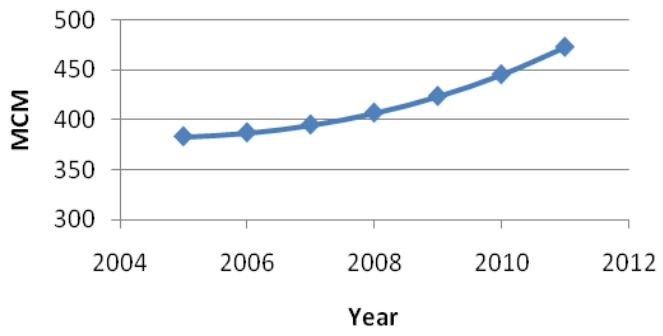
Year	2003	2009	2010	2011
Cost	1,528	1,449	1,500	2,000

Source: State Investments in Sri Lanka from 2008 to 2011 [20]

- ***Drinking and other domestic needs***

The government views access to safe drinking water as a basic human need and a preliminary indicator of human development. There is a target for 100% of Sri Lanka's population to have safe drinking water provided to them in the medium-term by the National Water Supply and Drainage Board (NWS&DB) by 2025.

Sri Lanka depends solely on its surface and groundwater resources for domestic use. At the time Sri Lanka received independence in 1948 only a segment of the urban population in Colombo and Kandy had piped water, while the main sources of drinking water at the time were unprotected wells, rivers, tanks and canals.[21] Interestingly the share of water used by the urban population in Sri Lanka is projected to increase to 45% by 2015 and to 65% by 2030,[22] which is bound to increase the pressure to meet the national targets for drinking water.



Working towards achieving the Millennium Development Goals, the NWSDB has a target of providing 85% of the population access to safe drinking water by 2015 and 100% by 2025. The occurrence of droughts has impeded achieving these targets. More prolonged droughts can hamper achieving these goals even further. A new corporate plan is being developed with detailed projections up till 2016.[23]

Source: NWSDB Corporate Plan, 2007-2011[23]

FIGURE 3 NWSDB drinking water demand projection

Currently, 35.5% of the entire population in the island have access to pipe-borne water,[24] but rural populations continue to rely considerably on wells for their drinking, culinary, washing, bathing and laundering requirements, while others use water from tanks and reservoirs for these needs.[17] Although around 84.8% of the population has access to safe drinking water,[24] the water sector faces considerable challenges to meet its target of providing an uninterrupted supply of water to all in the medium-term due to rising demand. Considerable investments are being made to bridge this gap (**Table 4**).

TABLE 3 On-going and planned investments for enhanced drinking water supply

Type of reservoir	Climatic Zone	Cost Rs (million)
Integrated water supply scheme for Ampara District	Dry Zone	16,919
The phase 1 stage 2 of the Kalu Ganga water supply scheme	Wet Zone	11,181
Water supply and sanitation project for small towns and rural arid areas	Dry and Arid Zones	10,050
Towns north of Colombo water supply scheme stage 2	Wet Zone	6,090
Jaffna water supply scheme	Dry Zone	11,800
Community water supply and sanitation project (1,435 GN divisions in 12 districts)	All Zones	8,085

Source: Randora, National Infrastructure Development Programme[6]

1.3 Environmental concerns regarding the freshwater resource[g]

The increasing demand for freshwater is beginning to strain the limits of the inland water resources due to anthropogenic actions that have led to environmental problems, which in turn reduce the availability of the quantity and quality of water for irrigation and public use.

The problems include:

- Adverse agricultural practices associated with poor water management and over-extraction of groundwater (i.e. through tube wells) for domestic use and agriculture.
- Unregulated abstraction of groundwater for industrial and commercial purposes.
- Over-exploitation of groundwater resources tends to deplete aquifers and lower the water table, which also may cause salinity intrusion in coastal areas.
- Over-extraction and heavy usage of groundwater leads to salinization of top-soil which hinders/retards plants growth especially at seed germination stage.[25, discussions with CEA]
- The past practice of planting exotic species such as *Pinus* and *Eucalyptus* that are heavy on water use to enhance tree cover could have adversely affected groundwater availability in areas where they are extensively cultivated.
- Disposal of waste and toxic chemicals into rivers and urban lowlands, leaching of residual fertiliser and agrochemicals into groundwater via surface run-off, and microbial contamination of surface and groundwater through prolific unsanitary latrines.
- Unauthorised release of untreated waste water from industrial sources into inland waterways.
- The prolific growth of aquatic weeds such as salvinia and water hyacinth that reduced surface water for public use.
- Decrease of water quality due to pollutants and river sand mining.
- Poor planning with regard to water use that has led to social issues and need for re-location of communities.

Groundwater is generally extracted from shallow dug wells and deep tube wells and is often used to meet water requirements during drought caused by the failure of monsoon rains.[13] *Over the past few decades, however, there has been increased use of groundwater for public use to meet demands of a rapidly increasing population, industrial growth and agricultural expansion. For example, in the past, the Free Trade Zone Industrial Complex in the Greater Colombo Development Area was provided with tube wells yielding over half a million gallons of water per day, through a network of tube wells tapping local groundwater bodies.*[13] *In Puttalam, Mannar, Paranthan, Kilinochchi and Mulaitivu in the Dry Zone, over-extraction of groundwater through 130 tube wells has already caused saltwater intrusion.* [10]

[g] Most of the environmental concerns listed above have been discussed and validated at the Workshop to finalise this SVP. A few have been subsequently added from deskwork and individual discussions with stakeholders for which references are provided.

2.0 Climate Change Related Issues and Vulnerability

According to the IPCC, *vulnerability* is the degree to which a system is susceptible to, or unable to cope with adverse effects of climate change. Vulnerability is a function of the character, magnitude and rate of climate variation and its effects to which a system is exposed, its sensitivity, and its adaptive capacity. *Exposure* means the nature and degree to which a system is exposed to significant climatic variations. *Sensitivity* is the degree to which a system is affected either adversely or beneficially by climate related stimuli. *Adaptive capacity* is the ability of the system to adjust to climate change (including climate vulnerability and extremes) to moderate potential damages, to take advantage of new opportunities or to cope with the consequences.

BOX 3: IMPACTS OF CLIMATE CHANGE ON THE WEATHER IN SRI LANKA

Increasing temperature

- Air temperature in Sri Lanka has increased by 0.64^{0}C over the past 40 years and 0.97^{0}C over the last 72 years, which revealed a trend for an increase of 0.14^{0}C per decade. However, the assessment of a more recent time band of 22 years has shown a 0.45^{0}C increase over the last 22 years, suggesting a rate of 0.2^{0}C increase per decade.
- Consecutive dry days are increasing in the Dry and Intermediate Zones.
- Ambient temperature (both minimum and maximum) has increased.
- the number of warm days and warm nights have both increased, while the number of cold days and cold nights have both decreased.
- The general warming trend is expected to increase the frequency of extreme hot days.

Rainfall variability

- The precipitation patterns have changed, but conclusive trends are difficult to establish.
- A trend for rainfall decrease has been observed historically over the past 30-40 years, but this is not statistically significant.
- There is a trend for the increase of one day heavy rainfall events.
- An increase in the frequency of extreme rainfall events is anticipated, which would lead to more floods.

Drought

- The increased frequency of dry periods and droughts are expected.

Source: Department of Meteorology, Sri Lanka, provided for preparation of this report in 2010.

There is considerable socio-economic and environmental importance of maintaining an adequate and uninterrupted supply of freshwater. As such, the possible climate change induced change in rainfall regimes on availability of water for irrigation and public use could have wide ranging and serious implications on Sri Lanka's food security and nutrition, public health and economic development. As an island nation, Sri Lanka is vulnerable to the risk of sea level rise and increased frequency of storms. Furthermore, change in rainfall regimes and its impacts, sea level rise, and other climatic features associated with climate change could increase the prevalence of natural disasters such as floods, droughts, landslides and storms with consequent negative impacts on livelihoods, economic development and civil life.

The key climate change-related issues and risks related to the water sector--by way of irrigation and domestic water use in the country--are stated below.

2.1 Climate Change Induced threats

The analysis of climate data for Sri Lanka clearly indicates changes in rainfall and temperature throughout the country (see BOX 3). As climate change is expected to change the pattern and quantity of rainfall, evapo-transpiration, surface run-off and soil moisture storage, changes in water availability for irrigated agriculture and public use could well be anticipated.

- ***Vulnerability to natural hazards***

Sri Lanka is frequently subjected to several natural hazards, mainly floods, landslides, coastal erosion and droughts (See BOX 4). Cyclones are less felt in the island than in the Indian subcontinent as Sri Lanka is situated outside the cyclone belt, although the impacts of several serious cyclones have been experienced periodically. The frequency and intensity of these hazards are expected to increase with the outcomes of climate change such as sea level rise and coastal flooding, changes in rainfall regimes and the rise in ambient temperature. These factors are expected to be exacerbated by various anthropogenic factors that already threaten freshwater resources in the island and have resulted in many socio-economic and environmental problems. These are stated below.[h]

Possible impacts of sea level rise and coastal flooding:

- This is expected to cause saline intrusion inland to considerable distances along rivers discharging to the sea, especially along the southern and eastern coasts.
- Saline intrusion could seriously affect freshwater availability for agriculture and public use.
- Effects of saline intrusion into coastal aquifers will be widely felt (Particularly as 25% of the island's population, 62% of industrial units and 70% of the tourist infrastructure are located in the coastal region).[26]

Possible impacts of changes in rainfall regimes:

- The increased variability of rainfall can adversely affect all climate sensitive resources and phenomena including water resources and water related disasters.[17]
- The change in rainfall distribution can cause a shift in the demarcation between the Dry and Wet Zones, with a reduction in the area of the Wet Zone.[17]
- The increase of one day heavy rainfall events, especially along the western slopes of the central mountain massif, can increase soil erosion, landslides, and the run-off of more water to the sea, reducing retention and recharge.
- Unusual flash floods can damage headworks of irrigation schemes and canal structures creating problems and incurring costs for remedial measures in the irrigation sector.
- Increased intensity of rainfall in the Wet Zone due to climate change is expected to increase the propensity for flooding of flood prone rivers and to increase the intensity and frequency of landslides associated with prolonged and heavy rains in this region.
- As most Wet Zone rivers are flood prone, the state incurs considerable expenditure annually as compensation for damage due to floods and landslides, which will increase with higher rainfall.[27]
- In the regions where precipitation is generally high, more intense rainfall expected from climate change scenarios would lead to more soil and land erosion and increase the frequency of floods and landslides.
- Changes in rainfall regimes could adversely affect seasonal flows of rivers that originate and flow entirely through the Dry Zone; low flows during the drought periods will exacerbate water deficient problems especially in the Dry Zone. Added to this there is lack of reliable flow data.
- Changes in rainfall regimes in the Wet Zone and longer dry spells may cause seasonally serious depletion of water for multiple uses in the large Wet Zone irrigation reservoirs for which the state has invested considerable funds.
- Droughts and unpredictable rainfall regimes already experienced in the Dry Zone are expected to become more prolonged and unpredictable, and this leads to reduced river flows and surface water availability for irrigation and public use in the Dry Zone, where much of the irrigated paddy cultivation is located.
- The increased occurrence of droughts can impede meeting the targets for providing drinking water for all.

The Miocene limestone aquifers in the Dry Zone coastal districts such as Mannar and Jaffna are particularly vulnerable to saline intrusion, leading to reduction of availability and quality of well water that provides people with their basic drinking and domestic water supply. [27]

[h] The possible climate change impacts have been discussed and validated at the Workshop to finalise this SVP, subsequently added through individual discussions with stakeholders or obtained from the Second National Communication to the UNFCCC. The latter two are referenced where relevant.

- Nearly 70% of the paddy cultivated in Sri Lanka is in the Dry Zone where the annual rainfall is temporally variable and less than 1750 mm. The Dry Zone now shows an increasing number of consecutive dry days, which has increased the need for irrigation water to maintain crop yields.[17]
- Lowering of river flows during drought periods in the face of rising sea water levels can increase saltwater intrusion that would reduce fresh water availability in the coastal regions.
- Variable rainfall regimes will result in lower amounts of freshwater in hydro-power reservoirs during drought periods, which will affect the national power supply[i] and the water available for irrigation and other uses.

Possible impacts of a rise in temperature:

- Warming of the atmosphere increases the capacity to hold moisture. This, in turn, increases the rate of evaporation so that a significant rise in temperature as well as the dryness caused by droughts will affect water for irrigation and public use in the Dry Zone tanks and rivers.
- Increasing ambient temperature can be expected to increase evapo-transpiration, which will in turn reduce the availability of surface water for irrigation and public use, particularly in the Dry Zone.
- Increased ambient temperature leading to increased water evaporation and transpiration, can reduce soil moisture, affect stream-flow and groundwater table recharge, and hence reduce the availability of water for crop production, especially in the Dry Zone.
- Increasing average evaporation due to a temperature increase could increase the crop water requirement, creating a crisis in both the supply and demand side of irrigation.[17]
- Intensified evaporation, coupled with less rain, could increase salt accumulation in the soils of the Dry Zone.

According to the climate scenario for Sri Lanka, the projected average temperature increase by:

- *2025 is 0.4^{0}C*
- *2050 is 0.9^{0}C*
- *2075 is 1.6^{0}C*
- *2100 is 2.4^{0}C*

Source: Data from the Meteorology Department provided for preparation of this report in 2010

2.2 Vulnerability enhancing factors

- *Anthropogenic factors*

- Saltwater intrusion inland in coastal areas due to over-extraction of water from tube wells.
- Overuse of ground and surface waters in the past for irrigation and hydro-power development resulting in water shortages.
- Reduced recharge of groundwater due to heavy run-off coupled with minimal area for surface absorption as a result of expansion of built-up areas (mainly in urban areas).
- Reduced water quality due to pollution of surface and groundwater with nitrates, industrial effluents and agro-chemicals and spread of aquatic weeds in surface waters.
- Lowering of water quality due to encroachments and inappropriate activities in water supply catchment areas. Increasing pressure on water resources due to population expansion and urbanisation, and agricultural practices that require more water.

Saltwater intrusion can occur even at distances of about 600 to 800 m from the shoreline due to over exploitation of groundwater; and the remediation of such situations become uneconomical. Such instances have been reported in Colombo. For example, the groundwater table below the IFS building is completely saline beyond a depth of 22m. Salinization of coastal groundwater due to over extraction of water from tube wells to irrigate cash crops in agricultural farmlands has been seen in coastal areas of the North-eastern and North-western provinces.

It is estimated that 40% of the tube wells constructed in the last decade were abandoned due to contamination from iron, manganese and fluorides.[17] A UNEP study in 2005 has also shown nitrate concentration of over 200 mg/L in groundwater within the Jaffna peninsula coupled with severe bacterial contamination from pit latrines.[17]

[i] This aspect is dealt with in the Sector Vulnerability Profile on Urban Development, Human Settlements, Economic Infrastructure.

- Increased sediment transport in rivers due to (a) long-term deforestation in catchments and river banks, (b) improper cultivation practices in upper catchment areas of river drainage basins, and (c) river sand and gem mining in catchment areas, that result in increased siltation of tanks and reservoirs and reduction of water holding capacity and increased risk of flooding.
- Salt water intrusion into rivers, and increased sediment transport to the coast due to river bank erosion as a result of heavy river sand mining inland.
- Increase vulnerability to landslides due to heavy surface water run-off and soil erosion due to poor land use practices, especially in hilly areas.

Socio-economic factors

- Vulnerability of the Sri Lankan community to climate changes is influenced by several socio-economic factors, such as poverty and status of food security, education attainments, amount of resources available to communities, type of livelihood, level of congestion in the environment (in both urban and rural areas), institutional support and government policies.
- Increased competition for water resources used for irrigated agriculture and public use due to climate change impacts that reduce water availability will mostly affect marginalized groups that have limited capacity to adapt to changes in their environment, especially when their incomes, health and general living conditions are affected.[17]

Natural causes that increase vulnerability

- The 2004 Tsunami which struck the eastern, southern and south-western coasts caused much damage to beach vegetation rendering the coast more vulnerable to storm surges and coastal flooding. The damage to beach vegetation may increase potential for salinization of coastal water bodies.
- Natural geo-chemical composition of the soils and rocks may render areas prone to salt-water intrusion as already seen in small areas near Hambantota and Puttalam.[17]

Poor planning in the water sector

- Past projects that used surface waters extensively have caused significant impacts on water flow regimes and water balance in down-stream areas.
- Large scale river diversion schemes that have affected the long-term stability of water flow in rivers. This coupled with land use changes in catchments have increased seasonal floods and the siltation of water bodies.
- Unplanned over-exploitation of groundwater in the past for domestic purposes, agriculture and industry.
- There are more than 40 key stakeholders in the water sector with no focal coordinating body, resulting in poor coordination of activities.
- Lack of reliable and up-to-date information on river flows— especially with regard to dry weather flows.

BOX 4: NATURAL HAZARDS THAT AFFECT SRI LANKA

"Natural hazards occur due to natural phenomena that have a human element, and result in a large number of fatalities and/or large scale damage to property."(MENR, 2002)

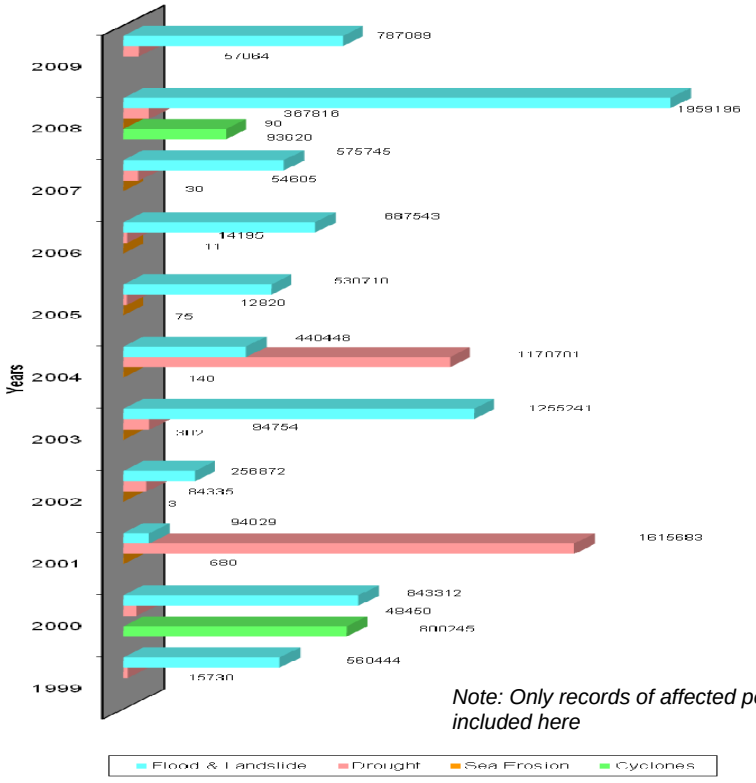
Coastal erosion affects Sri Lanka's beaches and adjacent coastal lands that are constantly subject to erosion, by winds, waves and currents that pound the coast. Available records indicate an average rate of coastal erosion of about 0.5 m/year and an accretion rate of about 0.2 m/year.[26]

Landslides have been a frequent problem in Sri Lanka for many decades, and they generally follow heavy rains exceeding a threshold of 125 within 24 hours (data from NBRO data provided for preparation of this report, 2010).

Floods are associated with extreme rainfall conditions, and occur in almost all river basins in Sri Lanka. Serious flooding frequently occurs in the Kelani, Kalu and Mahaweli river basins. Floods occur mainly in the Wet Zone, in areas having high rainfall, though flooding may sometimes occur in the Dry Zone as well. (Madduma Bandara, 2000[11], Manchanayake and Madduma Bandara, 1999[13])

Drought is the major natural hazard experienced in Sri Lanka, which, despite the lack of a heavy toll on life, has very serious negative impacts on the economic and social life of the country due to considerable expenditure by the government for compensation of crop failure due to drought (Manchanayake and Madduma Bandara, 1999**).**[13]

Cyclones are less felt in the island than in the Indian subcontinent as Sri Lanka is situated outside the cyclone belt. However, several serious cyclones have been felt periodically, with most damage occurring in the Northern and Eastern parts of the island, and to a lesser degree in some areas of the North Central Province.[15] (*note: This situation can vary in the future with climate change, although no conclusive data or projections are available for the Sri Lankan context).*



Note: Only records of affected people provided by the DMC have been included here

Source of data for graph: DMC, 2010

Number of people affected by natural disasters

2.3 Mapping climate change vulnerability

A vulnerability mapping exercise, using GIS, was undertaken in order to better understand climate change vulnerability in key sectors in Sri Lanka, building on the IPCC definitions of exposure, sensitivity, and adaptive capacity as defined in section 2.0 above.[j] The analysis is intended for use as a macro level planning tool, to illustrate where sector-specific vulnerability is high, in relative terms, across the nation, and to guide decisions on prioritization and targeting of potential climate change adaptation responses.

General methods

The basic methodology involved in the GIS mapping exercise was to develop indices for exposure, sensitivity and adaptive capacity as relevant to each given sector. These three indices were then combined to create a composite sector-specific vulnerability index. The analysis is largely based on publicly available data sources including the 2001 National Census. Areas where complete and comparable data sets of relevant indicators could not be obtained (such as the Northern and Eastern Provinces for which census data are not available) were not analyzed, and will need to be evaluated at a future stage, perhaps after the 2011 census is complete.

Separate *exposure indices* for flood, drought, and landslide exposure were developed based on historic data on the frequency and scale (i.e. assessed in terms of number of people affected) from the Disaster Management Centre (DMC). The index for sea level rise was based on a ratio of the area of land within 2 m above sea level as a percentage of total land area within 5 km from the coastline in each DS Division. Topography data was obtained from ASTER 30 m Digital Elevation Model. These exposure indices are common across all sectors, however only exposure types relevant to a given sector were analyzed and illustrated. *The sensitivity and adaptive capacity indices are unique to each sector and the indicators used in their formulation are given in the following pages along with the vulnerability maps.*

It must be noted that the mapping exercise itself is preliminary and limited in scope, and should be refined on an on-going basis, based on detailed data which may become available from various government agencies. It is also noted that several relevant agencies are carrying out detailed hazard mapping at the national or regional levels.[k]

What the vulnerability maps foretell

- *Irrigation Water*

FIGURE 4 illustrates the geographic distribution of vulnerability to drought in the irrigation sector. The indicators considered in developing the sensitivity and adaptive capacity indices are given below. The DSD vulnerability ranking table and the larger scale map is in APPENDIX B.

The sensitivity index	**The adaptive capacity**
A composite of data (at DSD level) on: • number of tanks • area of tanks • total population density	A composite of data (at DSD level) on: • percentage of people above the poverty line • percentage of people who have completed secondary education • percentage non-agricultural employment
Raw data sources: Survey Department 1:50,000 topographic maps, Population and Housing Census, 2001	

[j] IWMI's CC Vulnerability Index as in Eriyagama *et al.*, 2010[28] was used as a starting point and substantially refined for finer grain and sector specific analysis.

[k] For example, the Disaster Management Centre is currently coordinating a detailed risk profiling exercise for the major disaster types, at a much higher level of detail, in collaboration with the Coast Conservation Department (CCD), Irrigation Department, the National Building Research Organization (NBRO), and several others. The maps generated through the DMC exercise would provide much finer grain information for exposure indices than those presented here.

Vulnerability of irrigation water to *drought* exposure:

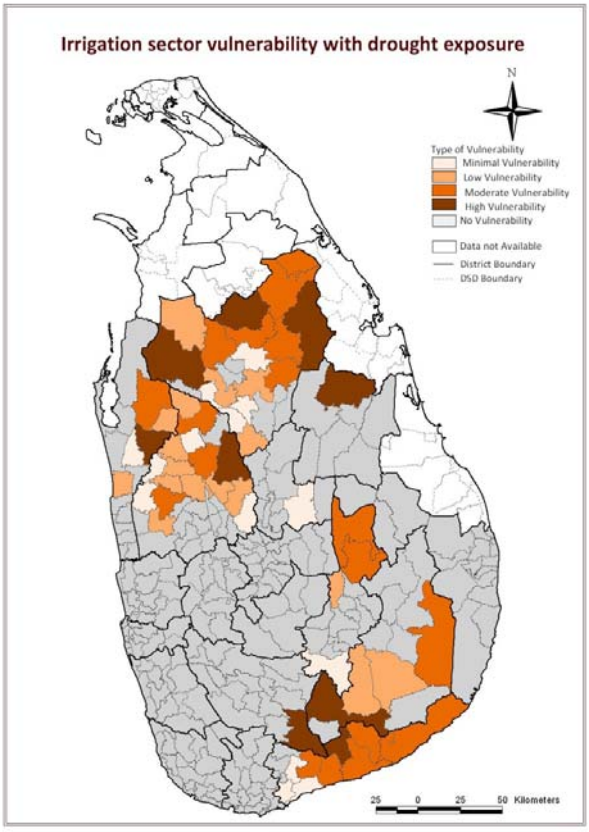


FIGURE 4 Vulnerability of the irrigation sector in Sri Lanka to drought exposure

- Vulnerability of irrigation to expected increases in drought are widespread in the island, but more concentrated in the Dry Zone where there is high dependency on irrigation for agriculture.

- 9 DS Divisions (DSDs) appear to be highly vulnerable in this regard. These DSDs have:
  - 2,375 tanks covering a total area of 240 km^2
  - a total population of 448,440 people, of whom nearly 25% are below the poverty line
  - about 97,570 people engaged in jobs related to agriculture

- The 3 most vulnerable DSDs are Thanamalwila, (Moneragala District), Anamaduwa (Puttalam District) and Horowpothana (Anuradhapura District).
  - Historically, the population in these three DSDs are highly vulnerable due to high poverty levels and high exposure to drought. The dependency on agriculture in these DSDs ranges from 28% to 24% of the population.
  - Thanamalwila alone has 464 tanks (the second highest number in the nation per DSD) covering 26 km^2

- A further 18 DSDs are in the moderately vulnerable category. They have:
  - a total population of 789,115 people
  - 145,880 people with agriculture-based jobs

- *Drinking water*

FIGURES 5-7 illustrate the geographic distribution of vulnerability to drought, flood and sea level rise in the drinking water sector. The indicators considered in developing the sensitivity and adaptive capacity indices for drinking water are given below. The DSD vulnerability ranking tables and larger scale maps are in APPENDIX B.

The sensitivity index	**The adaptive capacity**
A composite of data (at DSD level) on: • Percentage of *Grama Niladari* Divisions with more than 2 types of water sources • Percentage of households with primary water source within premises • Incidence of water borne disease • Population density	A composite of data (at DSD level) on: • percentage of people above the globally accepted poverty line • percentage of people who have completed secondary education
Source of raw data: Population and Housing Census,2001	

Vulnerability of drinking water to *drought* exposure:

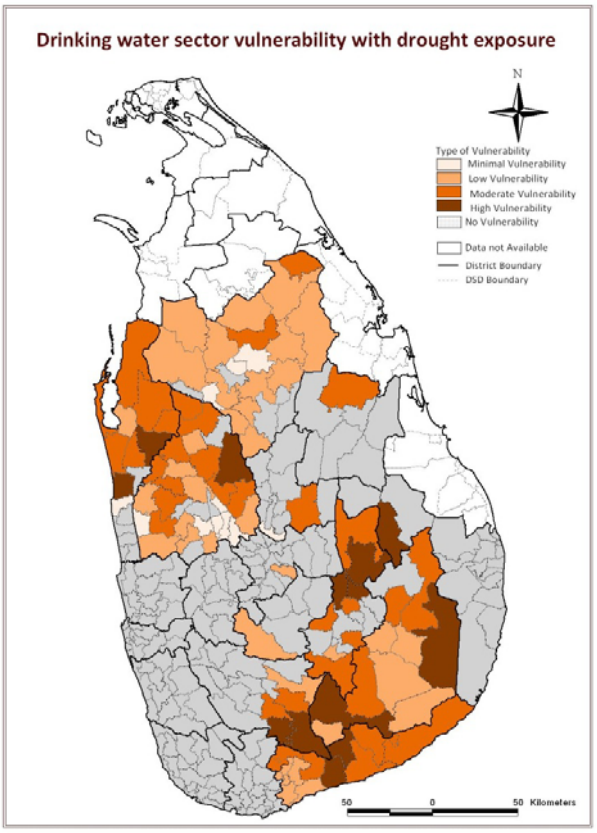


FIGURE 5 Vulnerability of the drinking water sector in Sri Lanka to drought exposure

- Vulnerability is widespread, but the south/south-central, north-western and north-central regions of the country are particularly vulnerable.

- 13 DSDs emerge as highly vulnerable to the impacts of drought. These DSDs have:
  - a population of 575,287
  - 143,036 housing units
  - 194,950 people below the poverty line

- In the highly vulnerable DSDs
  - 71.6% of the population depend on groundwater (i.e. 63.5% depend on either protected/unprotected wells and 8.1% depend on tube wells)
  - 18.1% of the population have access to pipe-borne water
  - 9.2% of households depend on rivers, streams and tanks as their primary source of water; only 28.2% of households have their primary source of water within their own premises

- Embilipitiya (Ratnapura District), Rideemaliyadda (Badulla District) and Siyambalanduwa (Moneragala District) emerge as the 3 DSDs most vulnerable to impacts of drought on their drinking water supply.
  - In the Embilipitiya DSD, 54% of the housing units used groundwater as their primary source of drinking water
  - In the Rideemaliyadda DSD, 89.3% of the 10,681 households use groundwater as their primary source of water
  - In the Siyambalanduwa DSD, 90.9% of the households used groundwater as the primary water source
  - All three of these DSDs have very high levels of poverty and low education levels (especially Rideemaliyadda and Siyambalanduwa DSDs)
  - Embilipitiya and Rideemaliyadda have high incidences of water borne diseases

- Another 35 DSDs emerged as having moderate vulnerability of their drinking water to drought exposure. They have:
  - 15.2% of households with access to pipe-borne water
  - 75.1% of households that use groundwater as their primary source of water
  - 8.3% of households that use water from rivers, streams and other sources
  - only 28.7% of households with their primary source of water within their own premises

Vulnerability of drinking water to *flood* exposure:

FIGURE 6 presents the **v**ulnerability of the drinking water sector in Sri Lanka to flood exposure.

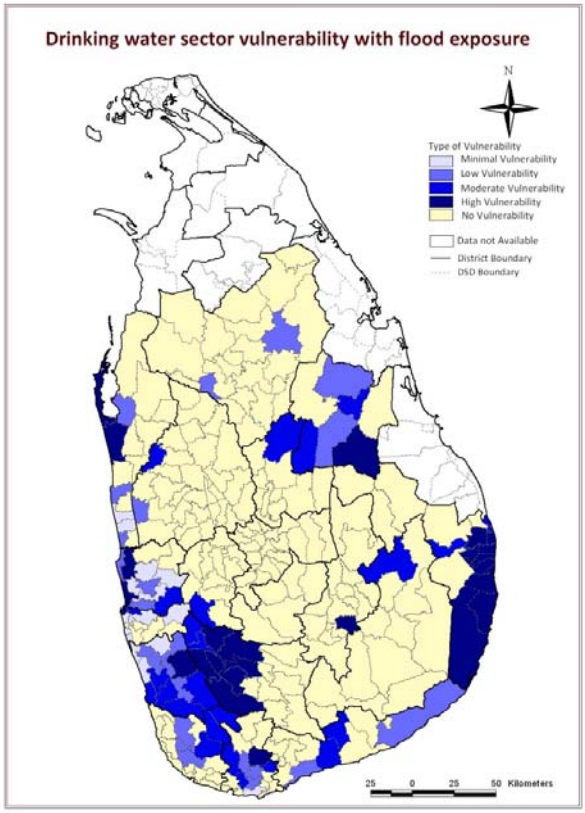


FIGURE 6 Vulnerability of the drinking water sector in Sri Lanka to flood exposure

- Vulnerability is widespread, and is prevalent in many areas of the country.

- 26 DSDs emerge as highly vulnerable to the impacts of floods. These DSDs have:
  - a population of 1.84 million
  - 412,886 housing units
  - 364,364 people below the poverty line

- These highly vulnerable DSDs have
  - 53.4% of the population depend on groundwater (i.e. 48% depend on either protected/unprotected wells and 5% depend on tube wells)
  - only 34% of the population have access to pipe-borne water
  - 11% of households depend on rivers, streams, and tanks as their primary source of water
  - only 17.2% of households have their primary source of water within their own premises

- Elapatha (Ratnapura District), Addalachchenai and Pottuvil (both in the Ampara District) emerge as the 3 DSDs most vulnerable to floods in terms of the drinking water.
  - All 3 DSDs have limited access to pipe-borne water and rely heavily on groundwater and people in Elapatha also rely significantly on other sources such as streams and rivers (on average dependency on groundwater is 78.7%)

- All 3 of these DSDs show high incidence of water-borne diseases

- Another 26 DSDs emerged as having moderate vulnerability of their drinking water to floods. They have:
  - 22.8% of households with access to pipe-borne water
  - 69.1% of households that use groundwater as their primary source of water
  - 6.8% of households that use water from rivers, streams, and other sources
  - only 43.2% of their households with their primary source of water within their own premises

Vulnerability of drinking water to *sea level rise* exposure:

FIGURE 7 presents the vulnerability of the drinking water sector in Sri Lanka to sea level rise exposure

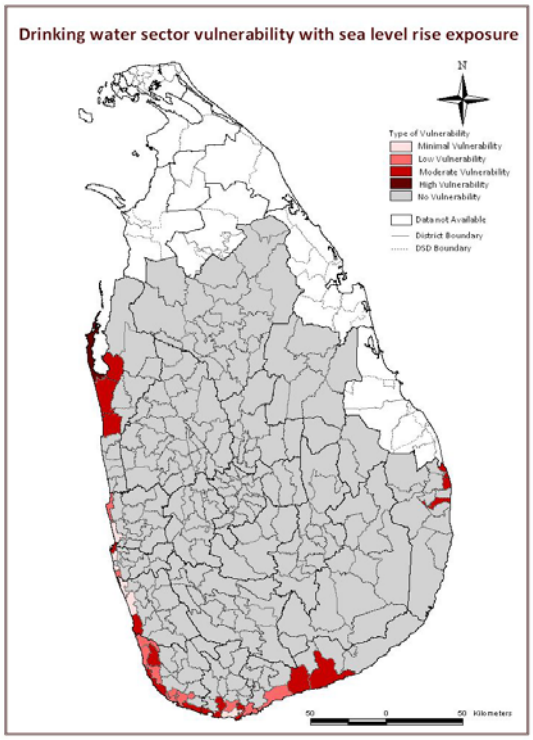


FIGURE 7 Vulnerability of the drinking water sector in Sri Lanka to sea level rise exposure

- The drinking water in the north-west and the southern regions emerge as the most vulnerable to sea level rise in the current analysis.

- Kalpitiya DSD in the Puttalam District displays the highest vulnerability. It has:
  - A population of 81,780 of which 20% of persons are below the poverty line
  - A high dependence of 86% on various forms of groundwater as their primary source of water

- Drinking water in a further 17 DSDs showed moderate vulnerability to sea level rise. They had:
  - a total population of 1,304,608
  - 54% household dependency on groundwater

- 4 of the 17 moderately vulnerable DSDs with the highest incidence of water-borne disease, such as dysentery, are in the Ampara District where education levels are also relatively low.

- It is suspected that vulnerability will be high in the northern and eastern provinces, due to high levels of exposure to sea level rise, but adequate and comparable data sets were not available to perform vulnerability analysis, so that these areas are not included in this analysis.

3.0 Institutional and Policy Framework

The State is vested with the right to use, manage and control water in any public water body under Section 72 of the Crown Lands Ordinance of 1947. Accordingly, almost all freshwater resources come under the control of the government, except where it is defined otherwise by law. Despite the process of devolution of administrative power to the provincial administration, all inter-provincial river systems and irrigation projects continue to remain under the Central Government; other water bodies come under Provincial Councils, and water bodies and groundwater from wells located in private lands are subject to the rights of private use.

3.1 Institutional set up[I]

The principal agencies actively involved in management of irrigation and drinking water are given in **Table 5**. More than 40 agencies have a stake in the water sector, and a large number of institutions are mandated with management of water for public use and irrigation. Poor institutional co-ordination, and the duplication of functions that result among the large number of institutions that are stakeholders in using and managing water has led to low efficiency of water use and allocation in the country.

TABLE 5 Institutions involved with management of the water sector

Key Ministries	Key Agencies	Other agencies /groups with impact
• Ministry of Irrigation &Water Resources Management • Ministry of Water Supply & Drainage • Ministry of Land & Land Development • Ministry of Fisheries & Aquatic Resources Development • Ministry of Environment • Ministry of Disaster Management	• Water Resources Board • The National Water Supply and Drainage Board • The Irrigation Department • Mahaweli Authority of Sri Lanka • Pradeshiya Sabha • The Ceylon Electricity Board	• Central Environmental Authority • The National Planning Department • The Department of Agriculture • The Department of Agrarian Development • The Forest Department • The Department of Wildlife Conservation • The National Aquatic Resources Research and Development Agency (NARA) • National Building and Research Organization (NBRO) • National Disaster Management Centre (DMC) • Provincial Councils • Local Authorities • Plantation Human Development Trust • Board of Investment of Sri Lanka (BOI) • Farmers' organizations • Communities managing water supply schemes

[I] This section has been validated at the workshop to prepare the Water SVP and reflect the views of the many stakeholders consulted during the SVP development process.

The main agencies responsible for provision of water for drinking and domestic use are the National Water Supply and Drainage Board (NWSDB), while the Water Resources Board has an advisory role to play in this regard. The responsibilities for dealing with the public water supply are shared by the Central Government and the Local Authorities. Irrigation waters are mainly under the purview of the Irrigation Department, but agricultural development in irrigation settlement schemes, including extension and support, are under the purview of the Department of Agriculture. Diversion of water and management of reservoirs are carried out by the Irrigation Department; Mahaweli Development Authority and the Ceylon Electricity Board are also key stakeholders in the water sector. In addition, there are various other agencies with limited or special functions pertaining to specific water bodies, rivers and watersheds. Several major water schemes are under the purview of Provincial Councils. The irrigation waters come under the jurisdiction of Provincial Councils as well.

The National Aquatic Resources Research and Development Agency (NARA) collects data and manages some components of the water resource; the CEA is responsible for surface water quality monitoring and has been engaged in site surveys and preparation of management plans for important wetlands; monitoring of coastal water quality, identification of polluting sources and coastal water management through development of standards, strategies, policies and plans are responsibilities of the CCD.

The Departments of Irrigation, Meteorology, and Agriculture are the main government agencies responsible for collection of hydro-meteorological data needed for water resource management on a scientific basis. The Meteorology Department helps to maintain the national meteorological network, among which are principal weather stations covering the entire Island. They record rainfall, sunshine, relative humidity, wind speed, maximum and minimum temperature and cloudiness. The Agriculture Department also maintains a network of meteorological stations (agro-met stations) and a network of evapo-transpiration pans.

3.2 Key policies and legislation that govern the sector

Key sector policies

The government thrust on water resources has been directed towards greater efficiency in irrigation water management and raising agricultural productivity through crop diversification and higher cropping intensities; groundwater development for agriculture and domestic use; improvement of drainage and flood protection; development of small and large scale irrigation systems and hydro-power schemes, watershed management, and improvement of the industrial and domestic pipe-borne water supply systems.

Sri Lanka's current development strategy espouses the importance of water as a valuable natural resource to "fulfil agricultural development potential as well as to quench the thirst" of people in the country. The need for efficient water management in the future is thus consonant with the overarching policies, plans and programmes that govern national development in the country, namely: The *Mahinda Chintana*[3,4] and the *Randora* Infrastructure Development Programme.[6] Water needs are also addressed in the **National Action Plan for the** *Haritha Lanka* **Programme under Mission 7**[5] (BOXES 1 & 6)**.** The current policy for irrigation consists of the development of new water resources, and rehabilitation and improvement of existing reservoirs and schemes, as well as enhancing and extending safe drinking water to all. However, the absence of a governing policy with regard to the institutions involved with water resource management is a major factor that impedes water resource management in the country. More details of the development policies, plans and programmes that influence water resource management for irrigation and public use are given in section 4.0.

Legislation

The main laws that govern management of water for irrigation and public use are given in **Table 6**. There are over 50 Acts dealing with water supply, quality, drainage, irrigation, etc.[27] To some extent this has led to confusion, duplication and inaction in the water sector, so that although many of the laws are strong, their implementation remains inadequate. However, it is important to note that there are no laws governing excessive water extraction by civil society or the private sector—and this could be a potential problem for water management in the future.

TABLE 6 Legislation/policies/plans/strategies and influencing management of water for irrigation and public use

Legislation governing the sector[m]	Other legislation with impact	Policies /plans/strategies
• The State Lands Ordinance No. 8 of 1947 • Irrigation Ordinance No. 32 of 1946; Act No.1 of 1951 and its subsequent amendments. • National Water Supply and Drainage Board Act No. 12 of 1974 and subsequent amendments. • Water Resources Board Act No.29 of 1964 and subsequent Act No. 42 of 1999. • Flood Protection Ordinance No. 4 of 1924. • Mahaweli Authority of Sri Lanka Act No. 23 of 1979 and subsequent amendments. • Soil Conservation Act No. 25 of 1951 and subsequent amendments. • The Fauna and Flora Protection Ordinance No. 2 of 1937,and subsequent amendments including Act No. 49 of 1993 as amended by Act No. 53 of 2000.	• The National Environmental Act No. 47 of 1980 and the amendment No. 56 of 1988. • The Land Grant (Special Provisions) Act No. 43 of 1979. • The Electricity Act No. 19 of 1950. • Mines and Minerals Act No. 33 of 1992. • Coast Conservation Act No. 57 of 1981, and the amendment Act No.64 of 1988 • Agrarian Services Act No. 58 of 1979, and its subsequent amendments. • The Agriculture and Agrarian Services Act of 1999. • The Fisheries and Aquatic Resources Act No. 2 of 1996. • The Forest Ordinance No. 16 of 1907, and its subsequent amendments. • North Western Provincial Council Environmental Statute No 12 of 1990 • The Urban Development Authority Law, No. 41 of 1978 and subsequent amendments. • The Town and Country (Amendment) Act, No. 49 of 2000	• The National Environmental Policy of 2003 • The National Rainwater Harvesting Policy 2008 • National Watershed Management Policy of 2004. • The National Wetland Policy and Strategy of 2006 • The National Forest Policy of 1995 • The National Wildlife Policy of 2000 • The National Land use Policy of 2009 • The National Sand Policy of 2006 • National Environnemental Action Plan (NEAP), including the curent plan for 2008-2012 • The Coastal Zone Management Plan (CZMP) which is updated periodically (1991,1997 and 2006) • The Forestry Sector Master Plan of 1995 • The National Strategy for Solid Waste Management of 2000 • Standards for effluent discharge by gazette notification No 559/16 of February 2nd 1990 • The Biodiversity Conservation Action Plan of 1999 and addendum • The National Action Programme (NAP) for Controlling Land Degradation in Sri Lanka of 2002 • The Action Plan for Mitigating Pollution due to Land Based Activities of 2003 (ready for implementation)

[m] The laws presented in this table include the subsequent amendments, but only some of the key amendments are stated here due to lack of space to mention all amendments.

4.0 Current Policies/Plans/Strategies and Actions that Support Climate Change Adaptation

Adaptation **is the adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities. To minimize the impacts of climate change, it is necessary to adopt adaptation measures that promote managing the inland water resources efficiently after a comprehensive assessment of Sri Lanka's inland waters, its potential and uses, and potential vulnerability to climate change that may limit the availability of freshwater for the nation.**

4.1 Policies, plans and strategies

The following policies, plans and strategies could help adapt to climate change with regard to management of waters for irrigation and public use. BOX 5 cites the landmark actions taken by Sri Lanka in response to meeting the challenges of climate change.

BOX 5: LANDMARK ACTIONS TAKEN BY SRI LANKA IN RESPONSE TO CLIMATE CHANGE

- Ratification of the United Nations Framework Convention on Climate Change (1992) on 23 .11.1993 followed by the Montreal Protocol (on substances that deplete the ozone layer) and acceded to the Kyoto Protocol (which commits countries--i.e. mainly Annex I parties-- to reduce their collective emissions of greenhouse gases).
- Establishment of a Climate Change Secretariat (CCS) within the Ministry dealing with the Environment to facilitate, formulate and implement projects and programmes at the national level with regard to climate change.
- Preparation of an inventory of green house gases (2000) followed by an update which is on-going.
- Establishment of a separate Climate Change Division within the Ministry dealing with the Environment.
- Establishment of a Centre for Climate Change Studies (CCCS) under the Department of Meteorology in 2000 to conduct research, monitor climate change, and provide the general public with current information on climate change and allied issues.
- Preparation of the Initial National Communication on Climate Change under the UNFCCC in 2000 by the Ministry of Environment (MOE), which indicated the sectors most vulnerable to climate change and subsequent impacts, the sectors that most contribute to climate change, the required mitigation options and adaptation responses and research and development.
- Initiation of the second National Communication on Climate Change under the UNFCCC by the MOE which is on-going.
- Addressing national capacity needs to implement the UNFCCC through the National Capacity Needs Self Assessment Project (NCSA) and preparation of the NCSA Action Plan based on a thematic assessment of existing capacity to address climate change by the Ministry of Environment and Natural Resources.
- Formulation of a CDM Policy (at draft stage) and establishment of a CDM centre at the University of Peradeniya and University of Moratuwa.

- ***The National Environmental Policy***

This addresses conservation of water resources, including provision of an uninterrupted water supply for public use; protection of surface water catchments, protection of surface water bodies, management of irrigation water to reduce wastage and run-off, regulation of groundwater exploitation, reduction of wastage from water supply schemes, reduction of water pollution from agricultural and industrial sources and human/domestic wastes, and restoration of polluted water bodies.[29]

- ***National Environnemental Action Plan (NEAP)***

Conservation and management of water has been addressed by successive governments through the past National Environmental Action Plans prepared in 1991 (for the five-year period 1992–1996), 1994 (for the period 1995–1998); 1998 (for the period 1998-2001); and NEAP, termed Caring For the Environment (CFE) which was published in 2003 (for the period 2003-2008). The new Caring for the Environment – Path to Sustainable Development, Action Plan 2008-2012 published in 2008 has a dedicated chapter on Climate Change.[29] The CFE identifies absence of policy mechanisms to deal with climate change and the lack of developed adaptation strategies, the dearth of technical expertise to deal with climate change and a low level of preparedness among many sectors to deal with climate change as major gaps in meeting the exigencies of climate change affectively. Overall adaptation is not dealt with adequately in the CFE. The CFE also deals with water as a resource, identifies major issues that threaten the resource, and proposes actions to alleviate these problems.

- *SAARC Action Plan*

The water related response to climate change will be largely captured under the different sectors that are concerned with water use in the SAARC Action Plan on Climate Change: Sri Lanka 2009, which is currently being compiled.

- *Climate Change Policy*

A Climate Change Policy is under preparation, spearheaded by the Ministry of Environment.

- *Other Key Plans and Polices that Support Adaptation in the Water Sector*

Overarching plans and policies that govern national development – such as the *Mahinda Chintana* Policy Framework provide a strong framework to position adaptation measures to climate change with regard to promoting water management and sustainable use (BOX 6).

BOX 6: SUPPORT FOR WATER MANAGEMENT IN NATIONAL DEVELOPMENT POLICIES AND PLANS

- *The* **Mahinda Chintana** *–Vision for the future (2010 Presidential Election)*

This document pledges to eliminate pollution of water resources and wastage of water, while augmenting water resources to provide drinking water; ensuring public ownership of water; safeguarding the upper watersheds of the rivers; and using scientific knowledge to establish technologies for rainwater harvesting. It also states that an action plan will be developed to address environmental change including droughts, floods and cyclones. *More on the Mahinda Chintana is provided in* BOX 1 and APPENDIX A.

- *National Action Plan for the* **Haritha Lanka** *Programme*

This programme directly addresses climate change through Mission 3 and indirectly promotes adaptation through Missions 4 (wise use of the coastal belt and seas around), 5 (Responsible use of the land resource), and 8 (Green cities for health and prosperity). This programme has short-term, medium-term and long-term targets spanning 2009-2016 that could help adaptation to climate change. Mission 7 of this programme also specifically addresses providing 'water for all and always'. *More on this programme is provided in* BOX 1 and APPENDIX A.

- *National Physical Planning Policy and Plan Sri Lanka 2006 -2030*

This deals with reducing vulnerability to natural disasters with the objective to "Ensure that the people of Sri Lanka live in areas that are safe from natural disasters and the effects of global warming, including rising sea level." It also addresses 'Water resource development' with the objective to "Protect water catchments, water resources and tanks to improve water quality and ensure sufficient supply of water for domestic, agricultural, industrial activities and power generation." The NPPP&P proposes certain principles and strategies to achieve these objectives.[30]

4.2 Key actions that support adaptation

- *Increasing available irrigation water*

- Sri Lanka is famed for a hydraulic civilization which was concentrated around tanks built in the Dry Zone to catch and store rainwater for use during drought periods. Managing the water resource and maintaining the tanks to prevent water wastage was considered a prime duty of the state and citizens. Most of these tanks are still in use and are maintained by the Irrigation Department.

- Rehabilitation and improvement of a large number of minor irrigation schemes (tanks and anicuts) have been carried out. There are programmes to re-develop the rural economy by developing water resources in the small tank system of the river basins to increase crop and livestock production and water for drinking and bathing, and to improve groundwater recharge and enhance the microclimate.

- Ancient irrigation tanks such as the Anaiwilundawa Sanctuary, Minneriya National Park, Kaudulla National Park, Giants Tank Sanctuary and Tabbowa Sanctuary have been provided protection under the Fauna and Flora Ordinance of Sri Lanka by declaring them as protected areas.

- Major irrigation schemes are on-going and planned to enhance water availability for irrigation and public use.[6] **Table 2** lists the major on-going and planned investments for development of irrigation water resources in the country.

- *Safeguarding available irrigation water*

Ensuring dam safety:

- Taking into consideration the need to safeguard available water resources, the Atomic Energy Authority has established a Tritium Laboratory with technical assistance from the International Atomic Energy Agency using nuclear techniques to detect possible leakages, seepages and rates of sedimentation in several reservoirs. There is a need for more equipment and training to carry out in-depth studies.[10]

- Considerable expenditure (Rs 7,400 million) is allocated for a major project that addresses dam safety in view of the large number of dams that are found in the country.

The Dam Safety and Water Resources Management Project *commenced in 2007 and is expected to finish in 2013. The main objectives of the project are to (i) establish long-term sustainable arrangements for operation and maintenance of large dams; and (ii) improve water resources planning. The components to be completed over the six years are as follows: Component 1: Dam Safety and Operational Efficiency; Component 2: Hydro-meteorological Information Systems; Component 3: Multi-sectoral Water Resources Planning; and Component 4: Project Management and Monitoring. Overall there will be rehabilitation and provision of basic safety requirements and monitoring of 80 large dams; essential remedial works for 33 large dams and risk assessment of 48 dams. In addition the project envisages establishment and upgrading of 50 hydro-meteorological stations; improvement of the Irrigation Department's hydrology data bank; upgrading of the Mahaweli Development Plan and preparation of the national water use master plan.*

Source: Minisry of Finance and Planning[6]

Reducing siltation of reservoirs:

- Projects have been carried out to address land degradation and protection of catchments in critical watersheds such as the Upper Mahaweli Catchment Project (GTZ funded) Upper Watershed Management Project (ADB funded) and Watershed Protection in Selected Micro Catchments of the Mahaweli (World Bank funded).

The Upper Watershed Management Project*, mainly funded by the Asian Development Bank (ADB) was effective from 1998 for 7 years at a cost at appraisal of $23.70 million. The Project addressed forest and land degradation problems in the upper watersheds of four major river basins, namely Kalu Ganga, Kirindi Oya, Uma Oya and Walawe Ganga where there had been declining farm productivity and incomes in the watersheds and adverse impacts on downstream agriculture, irrigation, and hydropower resources due to flooding and siltation. This Project aimed to reduce land and forest degradation, protect the environment in the critical watersheds of the south central region of the country and reduce poverty by raising the incomes of beneficiaries in these areas as follows: (i) increasing forest cover through integrated and participatory approaches, (ii) raising crop productivity in cultivated areas through the promotion of conservation-oriented farming systems, (iii) strengthening the capacity and coordination of implementing agencies (IAs) and (IV) facilitating a long-term policy to enable the Government to achieve sustainable watershed management.*[31]

- *Increasing available water for public use*

- There have been major projects in recent years to enhance water for public use (**Table 4**). This lists several major ongoing projects to enhance and extend the drinking water supply to a greater segment of the population.
- Rainwater harvesting and artificial groundwater recharge programmes have been tested in water stressed districts of the Dry Zone *(example: Tanamalwila rainwater harvesting project) and the need for promoting these systems are specifically mentioned in the* Mahinda Chintana *and the current National Environmental Action Plan.*
- Among these are many programmes to increase access to safe drinking water and sanitation facilities for both urban and rural communities.[6]

The Community Water Supply and Sanitation Project

The Rural Water Supply and Sanitation Division (RWSSD) of the Ministry of Water Supply and Drainage is the National Agency responsible for rural water supply and sanitation sector development in Sri Lanka. The RWSSD has undertaken the implementation of two large scale Community Water Supply & Sanitation Projects (CWSSP) in 13 districts of Sri Lanka with financial assistance from the World Bank, Japanese Bank for International Cooperation (JBIC), the Government of Sri Lanka (GOSL) and participating beneficiary communities. Projects are designed to achieve the set objectives by integrating safe drinking water, basic sanitation, hygiene education, environmental programmes and diversifying community activities to enhance socio-economic and cultural fields.

Source: WWW.CWSSP.org[32]

- *Preventing industrial pollution of water*

- The NEA Amendment Act No. 56 of 1988 makes legal provisions for regulatory control of environmental (including water) pollution and to mitigate the adverse impacts of development activities on the environment through legally binding EIA procedures. It is therefore mandatory for all industries classified as low, medium or high polluting to obtain an Environmental Protection License (EPL) from the CEA. The issuing of EPLs to small and medium scale industries has been delegated to LAs from January 1994. Although the CEA has been active to control industrial pollution through the EPL scheme, monitoring of industries after the licenses are awarded is considered to be inadequate.

- The *Pavithra Ganga* programme was designed and launched in 1998 to promote conservation of the inland water resources through an integrated approach. Its aim was to control discharges of municipal wastes, industrial effluents, and other wastes in waterways, and to promote cleaner production mechanisms to control water pollution, monitoring and tree planting along river banks.

The Pavithra Ganga Programme

This programme was initiated and carried out by the Ministry of Environment with the aim of managing the quality of inland waters through integrated management. Monitoring committees were started at district level to monitor the quality of inland waters. Through the programme the water quality of the Kelani River was monitored bi-weekly at 12 sensitive locations and displayed in 24 notice boards placed along the river bank. Local Authorities were motivated with an awards scheme for their positive involvement. Educational programmes were conducted and school children were made aware of the project to get their participation. As an outcome school children and the public along the Kelani River have been made aware to get their participation in keeping the Kelani River clean. The MoE with the National Cleaner Production Centre has been conducting walkthrough audits and conducting Cleaner Production Dissemination Seminars for industries through this programme. The programme has been partly successful so far, as pollution has dropped at specific locations, but NWSDB monitoring has shown increased heavy metal pollution in some areas.[29]

- There have been ad hoc training and awareness programmes/workshops on cleaner production, waste audits, Environmental Management Systems (EMS), and ISO 14000, etc. organised by several organisations with the aim of promoting awareness and inducing cleaner production among the industrial sector. These initiatives are however ad hoc, and overall, there is inadequate awareness on the issues connected with water pollution in the country.

- *The Natural Disaster Management Plan (NDMP) of 1999*

This covers the major phases of Disaster Management by addressing preparedness, mitigation and preventive action; recovery, relief, rehabilitation and reconstruction; control of floods, landslide hazards and cyclones; and improvement of meteorological observations, forecast and warning systems.

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Appendices

Appendix A
Overarching Policies for Sustainable Development in Sri Lanka

Mahinda Chintana: A Vision for a New Sri Lanka

The Mahinda Chintana: A Vision for a New Sri Lanka - 10 Year Horizon Development Framework 2006-2016 provides the overarching development vision for the country. This gives a very high priority for irrigation and water supply and sanitation. This document states that by the year 2016, irrigated agriculture will be transformed into a commercially viable and technologically advanced sector producing for local consumption and processing as well as for export, using modern irrigation techniques that optimize water use and maximize production by increasing the productivity of irrigation systems. It also aims to develop a more productive minor irrigation sector through participatory activities to contribute to poverty reduction as well as full-fill socio-economic needs of the poorer farmer. New water resources development through trans-basin diversions and other means will be carried out to increase the water supply for irrigation and other uses.

The Mahinda Chintana also targets safe drinking water for 90% of the people by 2016. The aims are increasing overall access to improved water supply facilities with sufficient water and achieving adequate service levels and national drinking water standards. It also targets overall access to safe, adequate and improved sanitation facilities.

The Action Plan for Haritha Lanka

This programme was developed through an interactive process involving all key ministries. Its mission is to focus on addressing critical environmental issues which, if left unattended, would frustrate the nation's economic development programme. Actions to address key issues that would enable sustainable development are embodied in the strategies and proposed actions set out under the ten missions of the Haritha Lanka Programme. The implementation of the programme will be overseen by the Ministry of Plan Implementation, while the secretariat for the NCSD is located within the Ministry of Environment and Natural Resources.

The 10 missions of the Action Plan for Haritha Lanka Programme

1. Clean air – everywhere
2. Saving the fauna, flora and ecosystems
3. Meeting the challenges of climate change
4. Wise use of the coastal belt and the sea around
5. Responsible use of the land resources
6. Doing away with dumps
7. Water for all and always
8. Green cities for health and prosperity
9. Greening the industries
10. Knowledge for right choices

The National Environment Policy

This policy renews the government's commitment, in partnership with the people to manage the environment for the benefit of present and future generations. The objectives of the policy are to (i) promote the sound management of Sri Lanka's environment in its entirety without compromise, balancing the needs for social and economic development and environmental integrity, to the maximum extent possible while restricting inimical activities, (ii) manage the environment by linking together the activities, interests and perspectives of all groups, including the people, non-government organizations and government at both the central and the local levels, and (iii) to assure environmental accountability. The outcomes to be achieved, under water, are as follows:

1. An uninterrupted and adequate supply of water of the required quality maintained to meet national needs.

2. The catchment areas of rivers that are important sources of water are properly managed so as to ensure good infiltration and sediment free run-off.
3. Adequate protection given to streams, irrigation and drainage canals, reservoirs, tanks and other water bodies.
4. Irrigation water managed so as to eliminate wastage and ensure optimum use, while ensuring that water bodies used by the public and ecologically sensitive areas are not adversely affected by the run-off.
5. Productivity of water use is optimised by the selection of appropriate agricultural crops under irrigation, while giving due consideration to the need for maintaining food security.
6. Varieties of agricultural crops that use water economically are developed and their use promoted.
7. Groundwater exploitation so as to ensure long term sustainability and good water quality.
8. Wastage from water supply schemes minimised.
9. Agricultural and aqua-cultural practices that minimise the use of chemicals and other substances while maintaining high productivity are promoted.
10. Industries practice waste treatment recycling of water and avoid discharging harmful effluents to the environment.
11. Consideration given to drainage patterns, locations of water bodies, etc. to ensure that the quality and quantity of existing ground and surface water resources will not be adversely affected when carrying out development activities.
12. Polluted water bodies restored to their original (clean) condition and maintained accordingly.
13. Pollution of surface and groundwater by human and domestic waste (both solid waste and waste water) prevented through improved sanitation and through correct treatment and disposal mechanism.

Appendix B
Maps and Supporting Data Tables

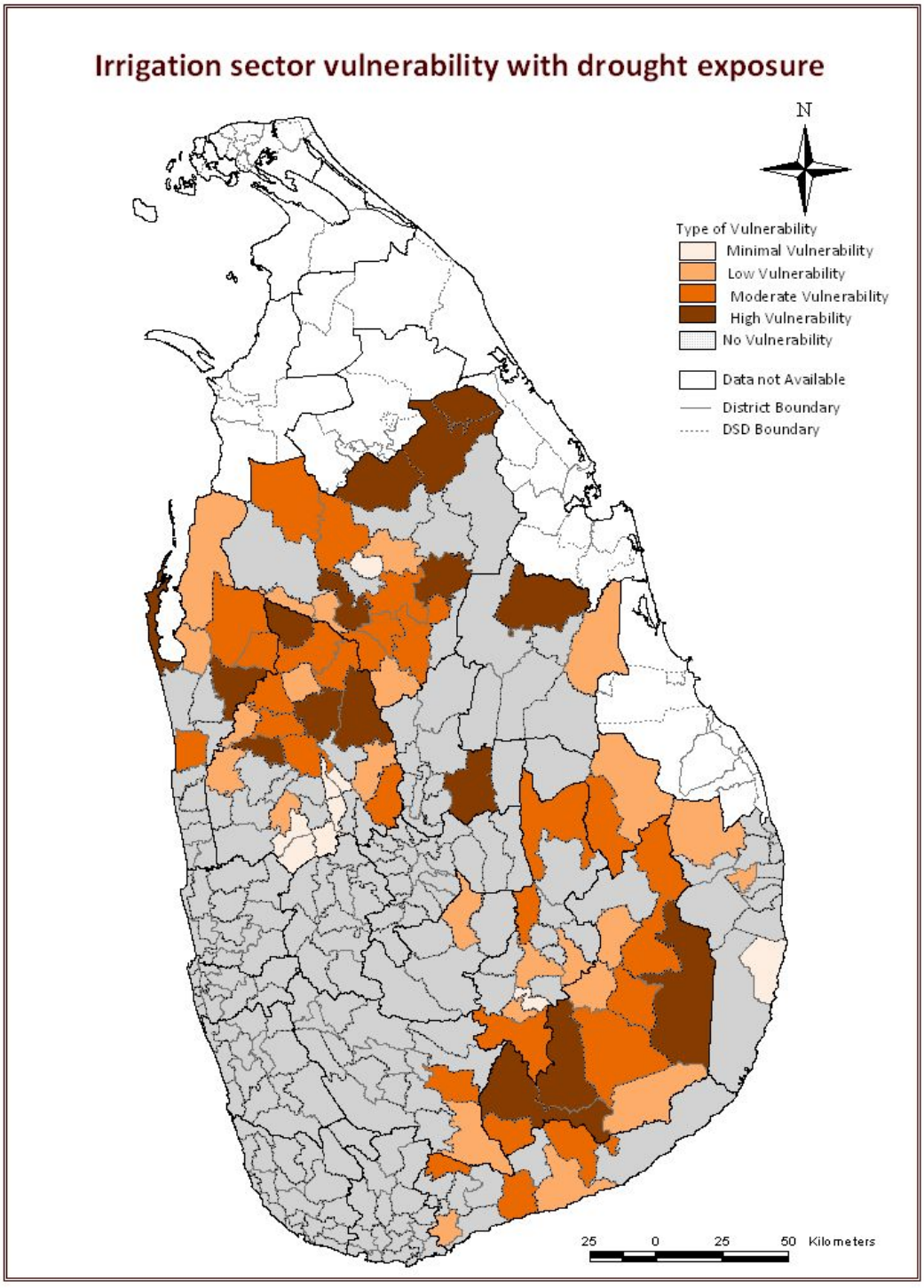
Irrigation — what the maps foretell:

Highly Vulnerable to Impacts of Droughts - Irrigation Water

Rank	District	DS Division	
1	Moneragala	Thanamalwila	Highly Vulnerable
2	Puttalam	Anamaduwa	
3	Anuradhapura	Horowpothana	
4	Anuradhapura	Nochchiyagama	
5	Kurunegala	Polpithigama	
6	Polonnaruwa	Medirigiriya	
7	Hambantota	Suriyawewa	
8	Ratnapura	Embilipitiya	
9	Anuradhapura	Medawachchiya	

Moderately Vulnerable to Impacts of Droughts- Irrigation Water

Rank	District	DS Division		Rank	District	DS Division
10	Hambantota	Ambalantota	Moderately Vulnerable	19	Puttalam	Karuwalagaswewa
11	Anuradhapura	Kahatagasdigiliya		20	Hambantota	Angunukolapelessa
12	Kurunegala	Panduwasnuwara		21	Anuradhapura	Galenbidunuwewe
13	Moneragala	Siyambalanduwa		22	Kurunegala	Galgamuwa
14	Hambantota	Tissamaharama		23	Hambantota	Lunugamvehera
15	Anuradhapura	Rambewa		24	Anuradhapura	Kebithigollewa
16	Anuradhapura	Padaviya		25	Anuradhapura	Nuwaragam Palatha Central
17	Kurunegala	Mahawa		26	Badulla	Mahiyanganaya
18	Badulla	Rideemaliyadda		27	Hambantota	Hambantota


Irrigation sector vulnerability with drought exposure
N
Type of Vulnerability
Minimal Vulnerability
Low Vulnerability
Moderate Vulnerability
High Vulnerability
No Vulnerability
Data not Available
District Boundary
DSD Boundary
25 0 25 50 Kilometers

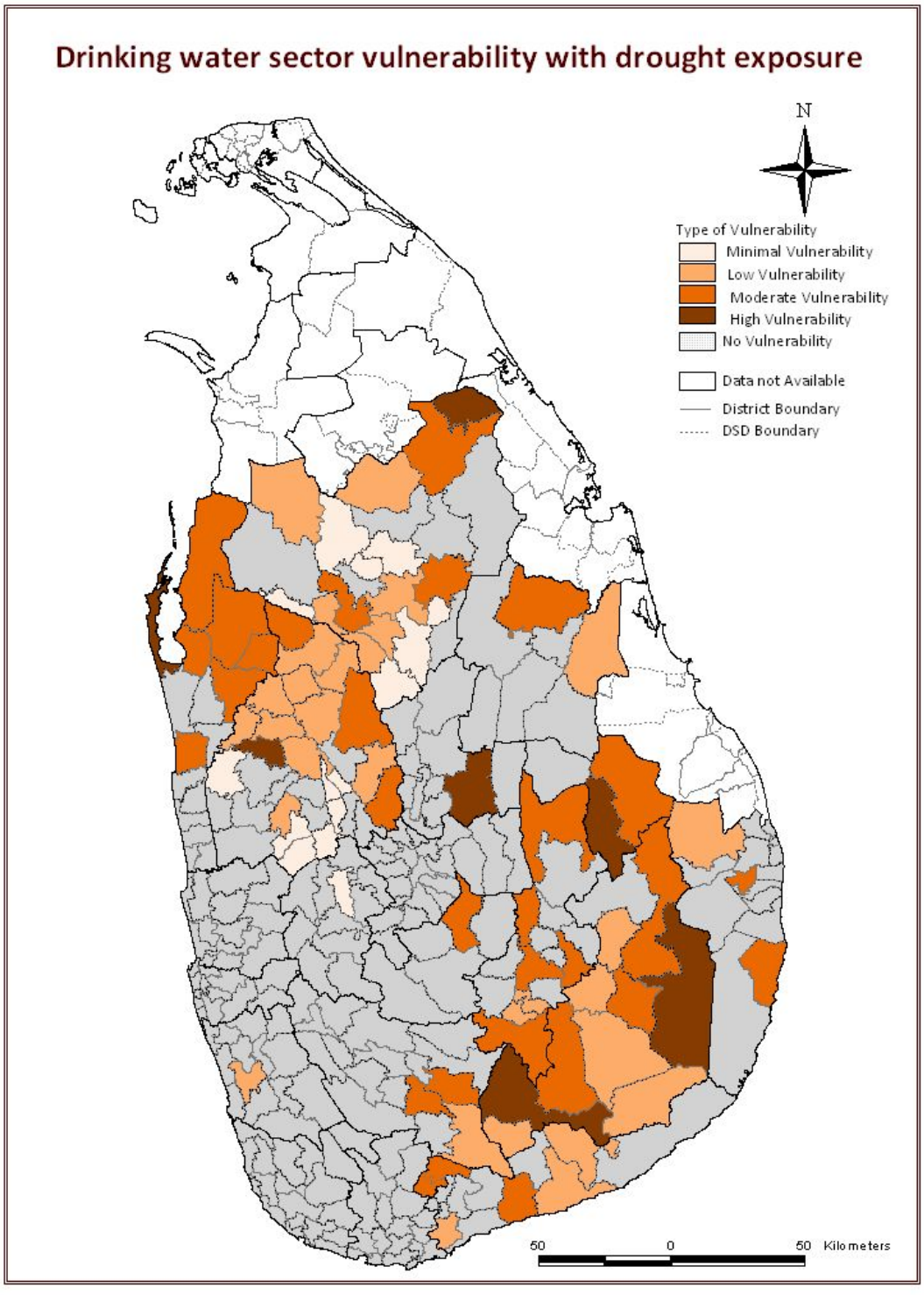
Drinking Water — what the maps foretell:

Highly Vulnerable to Impacts of Droughts - Drinking Water

Rank	District	DS Division	
1	Ratnapura	Embilipitiya	Highly Vulnerable
2	Badulla	Rideemaliyadda	
3	Moneragala	Siyambalanduwa	
4	Puttalam	Anamaduwa	
5	Badulla	Kandaketiya	
6	Ampara	Padiyathalawa	
7	Badulla	Meegahakivula	
8	Moneragala	Thanamalwila	
9	Hambantota	Suriyawewa	
10	Kurunegala	Polpithigama	
11	Hambantota	Ambalantota	
12	Puttalam	Arachchikattuwa	
13	Ratnapura	Kolonna	

Moderately Vulnerable to Impacts of Droughts - Drinking Water

Rank	District	DS Division		Rank	District	DS Division
14	Badulla	Uva Paranagama	Moderately Vulnerable	32	Moneragala	Wellawaya
15	Kurunegala	Kuliyapitiya West		33	Kurunegala	Galgamuwa
16	Ratnapura	Godakawela		34	Badulla	Ella
17	Ratnapura	Weligepola		35	Kurunegala	Panduwasnuwara
18	Puttalam	Mundalama		36	Anuradhapura	Rambewa
19	Anuradhapura	Padaviya		37	Kurunegala	Kobeigane
20	Puttalam	Kalpitiya		38	Kurunegala	Kotawehera
21	Hambantota	Lunugamvehera		39	Matale	Laggala-Pallegama
22	Hambantota	Angunukolapeles		40	Hambantota	Hambantota
23	Moneragala	Madulla		41	Polonnaruwa	Medirigiriya
24	Badulla	Soranathota		42	Moneragala	Medagama
25	Badulla	Mahiyanganaya		43	Kurunegala	Ibbagamuwa
26	Puttalam	Karuwalagaswewa		44	Puttalam	Nawagattegama
27	Puttalam	Vanathavilluwa		45	Hambantota	Tissamaharama
28	Kurunegala	Ganewatta		46	Kurunegala	Mahawa
29	Badulla	Haldummulla		47	Kurunegala	Giribawa
30	Hambantota	Katuwana		48	Kurunegala	Rasnayakapura
31	Puttalam	Mahakumbukkadawala				

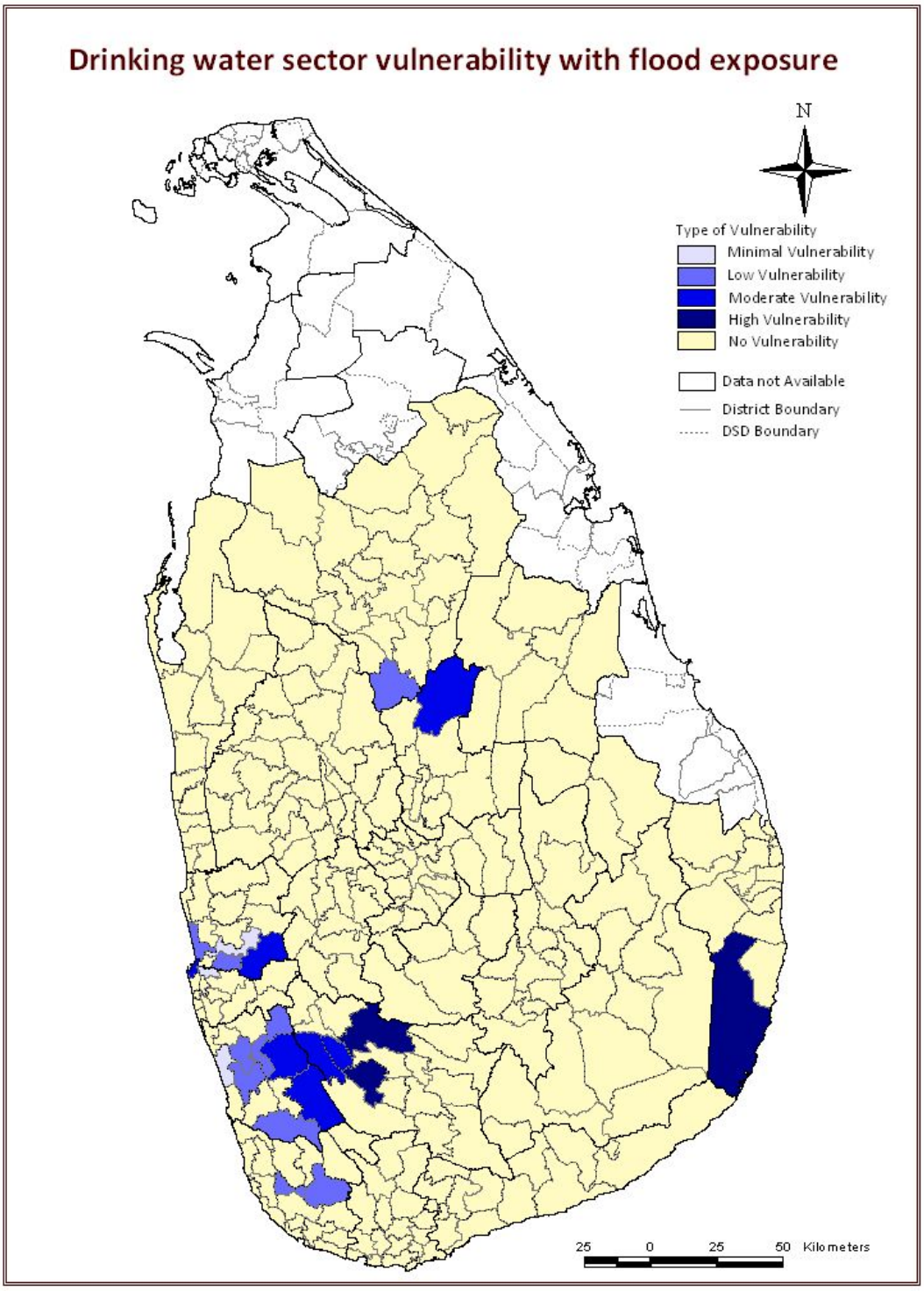

Drinking water sector vulnerability with drought exposure
N
Type of Vulnerability
Minimal Vulnerability
Low Vulnerability
Moderate Vulnerability
High Vulnerability
No Vulnerability
Data not Available
District Boundary
DSD Boundary
50
0
50 Kilometers

Highly Vulnerable to Impacts of Floods - Drinking Water

Rank	District	DS Division		Rank	District	DS Division
1	Ratnapura	Elapatha	Highly Vulnerable	14	Ampara	Thirukkovil
2	Ampara	Addalachchenai		15	Polonnaruwa	Dimbulagala
3	Ampara	Pothuvil		16	Ratnapura	Nivithigala
4	Colombo	Colombo		17	Ampara	Samanthurai
5	Ratnapura	Ratnapura		18	Ratnapura	Kuruwita
6	Ratnapura	Ayagama		19	Ampara	Ninthavur
7	Gampaha	Katana		20	Matara	Mulatiyana
8	Ampara	Sainthamarathu		21	Rathnapura	Pelmadulla
9	Ampara	Alayadiwembu		22	Puttalam	Mundalama
10	Ampara	Lahugala		23	Badulla	Ella
11	Rathnapura	Kalawana		24	Puttalam	Kalpitiya
12	Ampara	Akkaraipattu		25	Gampaha	Wattala
13	Ampara	Eragama		26	Kalutara	Bulathsinhala

Moderately Vulnerable to Impacts of Floods - Drinking Water

Rank	District	DS Division		Rank	District	DS Division
27	Gampaha	Dompe	Moderately Vulnerable	40	Ampara	Kalmunai
28	Kalutara	Palindanuwara		41	Kalutara	Mathugama
29	Ratnapura	Kiriella		42	Kurunegala	Rasnayakapura
30	Moneragala	Bibila		43	Kalutara	Dodangoda
31	Matara	Hakmana		44	Galle	Nagoda
32	Ampara	Karativu		45	Matara	Malimbada
33	Galle	Neluwa		46	Polonnaruwa	Lankapura
34	Ampara	Ampara		47	Kegalle	Dehiovita
35	Galle	Thawalama		48	Matara	Akuressa
36	Kalutara	Walallawita		49	Polonnaruwa	Elahera
37	Rathnapura	Eheliyagoda		50	Colombo	Kolonnawa
38	Hambantota	Suriyawewa		51	Kalutara	Beruwala
39	Hambantota	Ambalantota		52	Matale	Dambulla

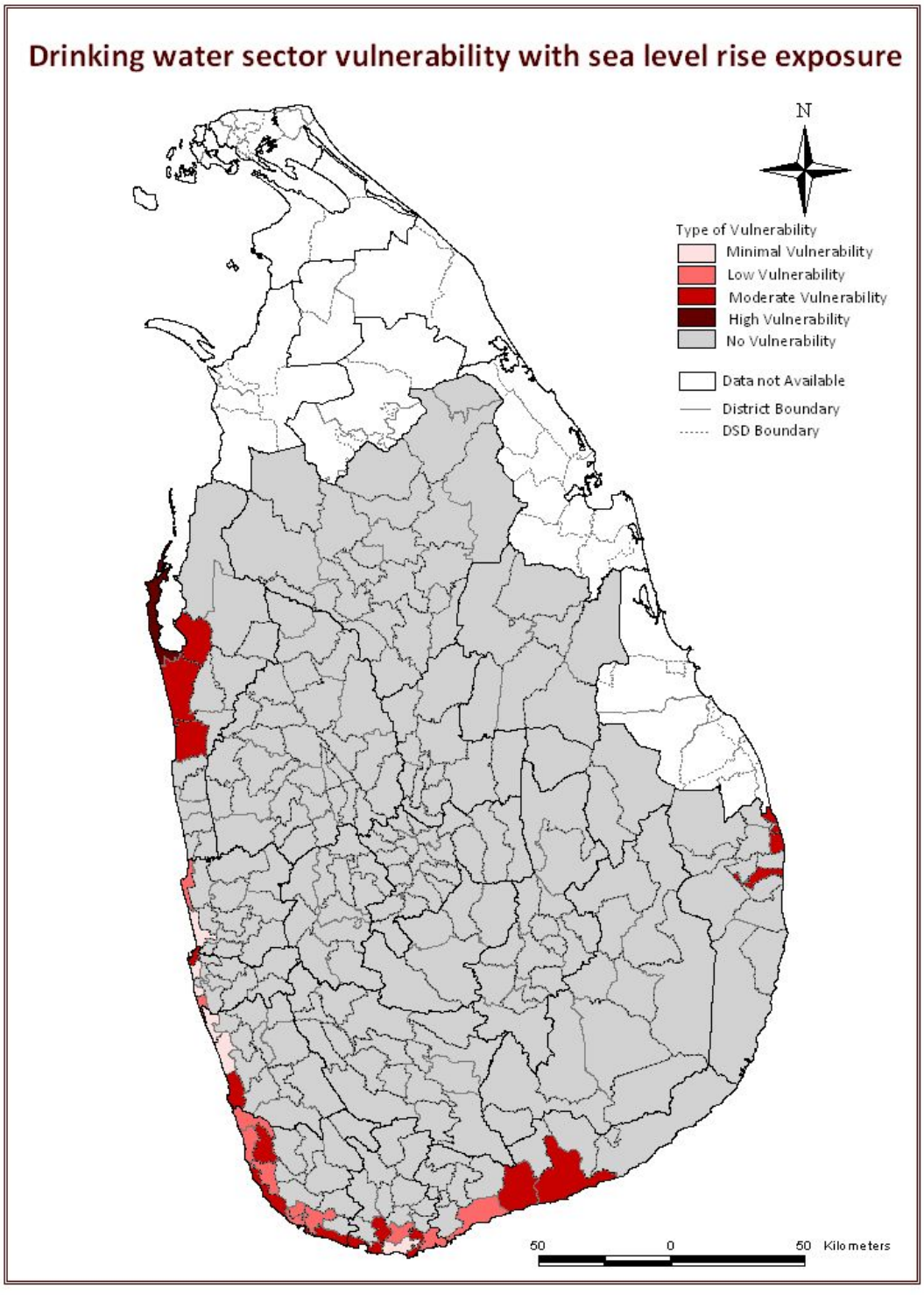

Drinking water sector vulnerability with flood exposure
N
Type of Vulnerability
Minimal Vulnerability
Low Vulnerability
Moderate Vulnerability
High Vulnerability
No Vulnerability
Data not Available
District Boundary
DSD Boundary
25 0 25 50 Kilometers

Highly Vulnerable to Impacts of Sea-level rise - Drinking Water

Rank	District	DS Division	
1	Puttalam	Kalpitiya	Highly Vulnerable

Moderately Vulnerable to Impacts of Sea-level rise - Drinking Water

Rank	District	DS Division	
2	Puttalam	Mundalama	Moderately Vulnerable
3	Ampara	Akkaraipattu	
4	Colombo	Colombo	
5	Ampara	Karativu	
6	Galle	Habaraduwa	
7	Ampara	Kalmunai	
8	Hambantota	Hambantota	
9	Matara	Weligama	
10	Ampara	Ninthavur	
11	Hambantota	Ambalantota	
12	Puttalam	Puttalam	
13	Matara	Malimbada	
14	Kalutara	Beruwala	
15	Puttalam	Arachchikattuwa	
16	Galle	Hikkaduwa	
17	Galle	Karandeniya	
18	Matara	Devinuwara	


Drinking water sector vulnerability with sea level rise exposure
N
Type of Vulnerability
Minimal Vulnerability
Low Vulnerability
Moderate Vulnerability
High Vulnerability
No Vulnerability
Data not Available
District Boundary
DSD Boundary
50
0
50 Kilometers

Appendix C
Key State Agencies Mandated with Implementing Water Management and Quality Control of Water for Irrigation and Public Use

- **The National Water Supply and Drainage Board (NWSDB)**

The NWS&DB is mandated with distribution and supply of clean water to the people. As such it is responsible for efficient domestic water supplies to urban and rural areas, disposal of water after use and the development, construction and use of water resources for domestic and industrial purposes. Presently, the NWS&DB is implementing many water supply schemes to provide water to both urban and rural areas. The NWS&DB is also mandated to distribute water in bulk; and to take over and operate any existing water supply system transferred to the Board. The NWS&DB has a Groundwater Branch that deals with the investigation and exploration of groundwater and maintains hydro-geological records.

- **The Water Resources Board**

This agency deals with the conservation and sustainable use of water resources in the country. It also addresses the exploration and use of groundwater resources and maintains rainfall records for its use.

- **The Mahaweli Authority of Sri Lanka**

This was formerly mandated by the Mahaweli Authority of Sri Lanka Act No 23 of 1979 to use and develop the water resources of the Mahaweli river. Its duties have now been expanded to cover all other major river basins in the country. They have to deal with all aspects of development including water supply, sanitation, human settlements, and irrigation construction and management.

- **The Irrigation Department**

This agency has full control of the irrigation systems through the Irrigation Ordinance No 32 of 1946 and its subsequent amendments. Currently, the administration of this Ordinance is carried out mainly by District and Divisional Secretaries through delegation. The Irrigation Act covers all matters connected with irrigation and paddy cultivation within irrigation schemes and the legal provisions concerning the prevention of waste and misuse of water. It specifically prohibits water wastage. Under the Irrigation Ordinance, provision is made for reservations around inland streams and reservoirs to help protect them from damage, siltation and pollution, but this requirement has been frequently ignored during the past state land alienation programmes.

- **The Central Environmental Authority (CEA)**

This agency is responsible for maintaining national water quality, but this responsibility has been partly delegated to Local Authorities. The CEA is also in charge of establishing effluent discharge standards as well as ambient water quality standards, under the provisions of the National Environmental Act and the regulations gazetted from time to time. It is also responsible to ensure that industries with potential to pollute keep to acceptable limits through the Environmental Protection Licensing (EPL) scheme. The activities of the CEA are decentralised via eight regional offices that have authority to award EPLs and carry out the CEA's monitoring functions. Since 1994, some powers of the CEA have also been devolved to respective Local Government Authorities or other institutions for local level investigation and regulatory action – such as the issue of licenses for 15 types of low polluting industries.

- **Department of Agrarian Services (DAS)**

This Department has responsibility for provision of wide ranging services to farmers in minor schemes including support for good water and soil husbandry, registration of farmer organizations and rehabilitation, with the level of support varying with the needs of farmers.

Appendix D
Country Profile in Brief

Population status
Sri Lanka is a multi-ethnic, multi-religious secular state, with a total population of over 20.4 million and a population density of 326 persons per km^2. The Wet Zone, with a very high biological diversity, and more favourable climate and better socio-economic considerations than the water scarce Dry Zone, contains about two thirds of the country's population despite its coverage of less than a third of the island. The population in Sri Lanka is still predominantly rural as only about 20% of the population live in urban areas.

Healthcare and life expectancy
Sri Lanka has achieved remarkable progress in health and social welfare relative to other low income countries and its neighbouring South Asian counterparts as shown by a Human Development Index (HDI) of 0.759 in 2007. This is due to a large share of public expenditure being redistributed to households perceived to be in need in the form of free education and health services, as well as food subsidies and subsidized credit to improve living standards.

Sri Lanka has relatively high standards of health care, and the national health indicators are comparable with those of developed countries. The Government of Sri Lanka provides free health care services through a network of western and traditional health care institutions including hospitals, dispensaries and health units located in all parts of the country. There is also significant enhancement of health services for women and children through pre- and post-natal care nutritional programmes. Sri Lanka's consistent decline in maternal mortality for over 5 decades is attributed to a wide network of maternal services which is integrated with childcare. The life expectancy at birth for males and females is respectively 70.3 and 77.9 years. Infant mortality rates are low at 10 (per '000), while under five mortality at 14 (per 1,000) live births is the lowest for the WHO South East Asian region.

Education
The net enrolment ratio in primary education exceeds 98%, and the country has an island-wide network of schools which include public, private and religious education centers. Education was made compulsory for all children between the ages of 5-14 in 1997 and is free of charge to all students in state schools since 1945. Hence, Sri Lanka has a high adult literacy rate of 92.5%. Sri Lanka has 15 universities, six postgraduate institutions and about seven institutions affiliated to the universities which offer Bachelor's Degree courses in specialised fields. University education is a public sector monopoly as yet and free of charge, except for the Open University which is open to students of any age and with varying basic educational backgrounds.

Status of women
Men and women are granted equal status and rights under the Constitution of Sri Lanka and Sri Lankan women - including women in the rural areas - have a comparatively better status than their counterparts in many developing countries. Gender wise the literacy rate is 94.5% for males and 90.6% for females. Sri Lanka has achieved gender equality in primary and secondary education in the generations that had access to free education. Overall there has been a perceptible upward social mobility in the status of women since gaining independence in 1948, mainly due to increased access to free education, economic opportunities for employment in the industrial sector and migrant domestic employment overseas. Sri Lanka's Gender Development Index (GDI) in 2007 was 0.756 but the Gender Empowerment Measure (GEM) was only 0.389.

Housing and lifestyles
Lifestyles are changing in Sri Lanka with increased household income, and household consumption is shifting from food (as in the past) to communication, education, recreation, housing and utilities. The average household size is at present 4.1 persons. About 79% of households now own a radio or TV and 36% own a refrigerator. Household access to motorized transport and telephone facilities stand at 22% and 25% of households respectively. The demand for houses and urban infrastructure is increasing. About 75% of the population outside the north and east live in houses with more than three rooms, and over 72% of houses throughout the island comprise modern building and roofing

materials such as bricks and cement for walls and tiles or asbestos for roofing; about 77% of households have sanitary and toilet facilities, 86% have electricity and 84.8% of households have access to safe water – although only about 35.5% have access to pipe-borne water. Consequently much of the rural population still depend mainly on well water, water from forest streams, reservoirs, canals and streams which become contaminated with faecal matter and other pollutants.

Economic trends and poverty

Per capita income in Sri Lanka exceeded US$2000 in 2009, but very high regional disparities remain. According to government figures, 15 percent of Sri Lankans live below the official poverty line of Rs 3,087 a month. The country's commitment to alleviating poverty is reflected in Sri Lanka's macroeconomic policies which are pro-growth and pro-poor while continuing to uphold market based economic policies. The economic policies of the country also encourage foreign investments by providing foreign exchange and employment opportunities to catalyze the development process. Overall, the country's monetary and fiscal policies are geared towards improving macroeconomic stability by enhancing development, increasing investment and poverty reduction. The country's economic growth and poverty alleviation programmes focus on regionally balanced growth with rural and small and medium private sector development with the medium-term objective of macroeconomic stability and a regionally balanced economic growth rate of about 6-8 percent**.** Being an open economy, open market operations prevail with considerable individual freedom. This has to some degree had a positive impact on the environment.

Importance of bio-resources for economic development

Sri Lanka's diverse bio resources serve to maintain a range of economic activities within the island. Foremost among these are agriculture, the marine and brackish water fishery and tourism. Agriculture, forestry and fisheries had contributed only about 12% of the GDP. The fisheries sector provides direct employment to about 208,731 people, and sustenance to at least 2.5 million. Fish also constitutes the top source of animal protein for Sri Lankans. Sri Lanka's rich biodiversity offers ample potential to support the government's current tourism related policy aimed at maximizing potential for nature-based tourism and cultural tourism.

Industrial growth

Sri Lanka has been gradually changing from an agricultural based economy to an industrial based one over the last few decades and presently follows a liberalized industrial policy. At present industry comprises 28.6% of the GDP. Sri Lanka has been promoting the development of private sector-led, export-oriented industries with sufficient diversification in relation to both products and geographical location. However, relatively little attention has been paid in the past to ensure environmentally sustainable economic growth.

Adapted from the Country Profile in Brief from the 4th National Report to the Convention on Biological Diversity as updated with data from Central Bank (2010), Human Development Report 2009, UNDP; Household Income and Expenditure Survey, 2005, Department of Census and Statistics.

Appendix E
List of Persons/Institutes Consulted

The Consulting team has attempted to consult a broad range of stakeholders throughout the SVP preparation process through working group discussions and individual consultations. All consulted across sectors are given below.

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Documents in this series:

National Climate Change Adaptation Strategy for Sri Lanka 2011-2016

Information, Education and Communications Strategy for Climate Change Adaptation in Sri Lanka

NCCAS Brochures

Compilation of Climate Change Adaptation Project Concept Notes

Sector Vulnerability Profiles:

- Urban Develoment, Human Settlements and Economic Infrastructure
- Agriculture and Fisheries
- Water
- Health
- Biodiversity and Ecosystem Services

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